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

4 A Marine Fisheries Program For The Nation—*by Roland Finch*

8 Lightning: A Search For The Source—*by Joan Vandiver Frisch*

10 Enter The Eel—*by Johanna Seltz*

12 Lakes Built of Numbers—*by Louise A. Purrett*

16 Salmon Is King Again—*by Gerald D. Hill, Jr.*

20 Report From Alaska—*by Carl A. Posey*

33 Miller Freeman and the Bering Sea

36 Caribbean Cooperation: It Works—*by Harris B. Stewart*

39 Seeing Eye Over The Gulf Stream—*by William J. Brennan*

42 The View From Space

44 Coastal Zone Management in 1977

48 Seafare: Take Two Pounds of Fish and Give It Glamour

53 Eat Fish, America!—*by Valerie A. Anderson*

56 Ten Telephone Poles Away—*by Nancy Pridgeon*

58 Owlie Skywarn on Winter Storms

60 A Way To Save The Beaches—*by James C. Elliott*

64 Charting The Pilot's Landmarks—*by John Stringer*

68 The Workaday World Of NOAA Divers—*by Lt. (j.g.) David H. Peterson*

72 NOAA/update

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A Message From the Administrator

The most significant event affecting the National Oceanic and Atmospheric Administration over the next few months will be—and already is—the change of Administration. Whatever our political persuasions, we cannot help but be impressed by the way in which our country carries out a peaceful, efficient transfer of political responsibility.

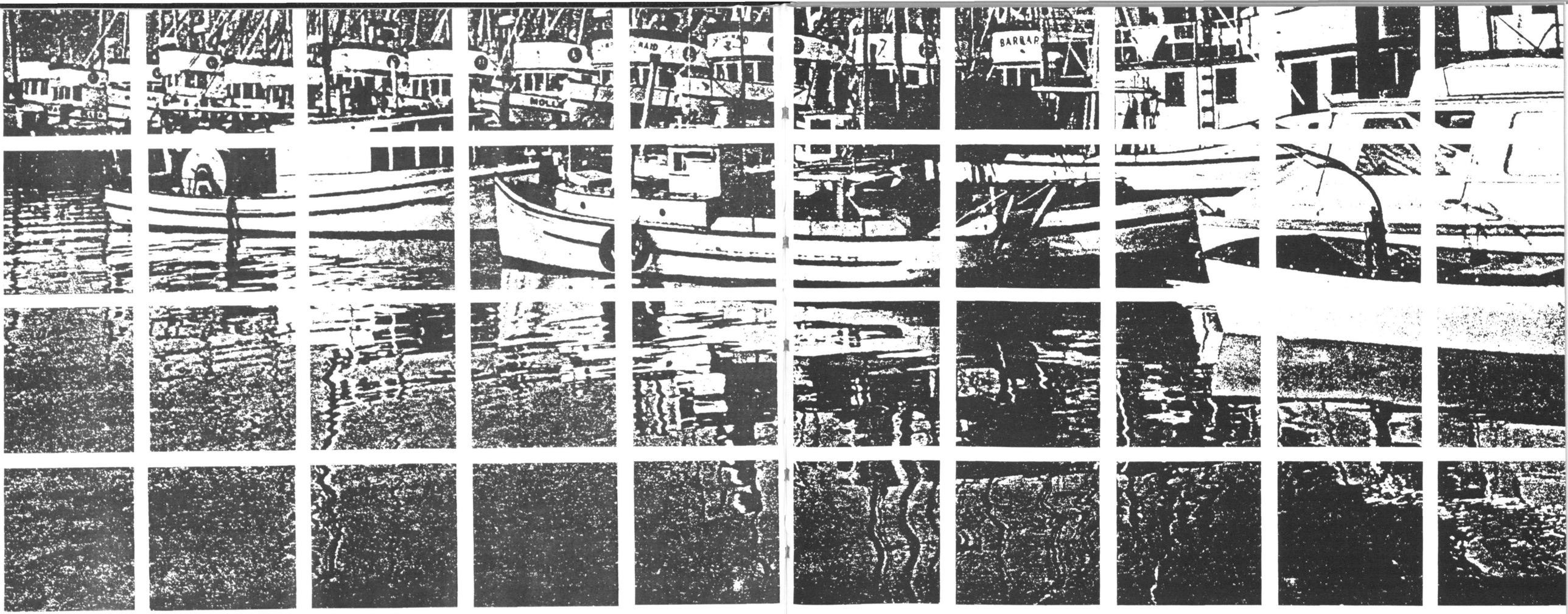
The process, as we have seen, is a complex one. Many members of the NOAA family have never witnessed a change in national administration within the Government. All of us have roles to play. NOAA science and service reach into virtually every American home, every day, in a great variety of ways and through a wide range of agencies. Every effort must be made to assist those who will now become responsible for the conduct of the Executive Branch to learn about NOAA and its programs, so that policies and decisions which may affect its service to the Nation may be taken in the full knowledge of their implications.

NOAA was founded and organized in 1970. In the past few years, it has grown significantly, in responsibility and in scope. New watershed legislation has changed NOAA's character, and brought it growth to match its vigor. NOAA has acquired major responsibilities through historic fisheries legislation, pioneering legislation for the management of our coastal zones and for the protection of our marine mammals. We have flourished since our beginnings; we are no longer the agency of 1970.

We will do our work under new leadership. It will be a stimulating time. There will be new ideas, new approaches, discussion of ways to change the Government's operation, proposals for new drives for NOAA. NOAA's lifeblood is ideas; let us look forward to the kind of intellectual and organizational ferment that keeps an organization dynamic, and let us make every possible contribution to it.

NOAA is basic to the national life; it will thrive. Your management, during this time of transition, will do everything possible to make sure the views and concerns of our family are carefully represented. If you have a message, it will be heard. And, as new directions emerge, I know NOAA will be in the vanguard, with the enthusiasm, dedication and professionalism which have been its hallmark for as long as we have been NOAA.

Robert M White



Toward conservation and sound use of a vital resource

A Marine Fisheries Program for the Nation

BY ROLAND FINCH*

FOUR years in the making, and drawing upon the talent, experience, and opinions of thousands of people—commercial fishermen, conservationists, food processors, biologists, charter boat captains, government employees at every level—a national program to conserve and develop America's marine fisheries was unveiled in November.

Unique in the history of U.S. fishery management, the program is designed to bring this major national resource to a new state of health and productivity, and to benefit consumers and industry in the process. It has four major goals:

—to restore and rationally use important marine fisheries;

—to develop and maintain a healthy commercial fishing industry;

—to improve marine recreational fishing;

—to ensure adequate consumer supplies of wholesome seafood.

**Roland Finch, now with NOAA headquarters, was until recently Director, National Fisheries Plan, NMFS*

Developed in parallel with this program was the Fishery Conservation and Management Act—a sweeping new action by the Congress which both extends the U.S. fisheries conservation zone to 200 nautical miles off our coasts, and establishes a unique joint management system that balances responsibility between eight newly created Regional Fishery Management Councils and the Federal Government. On March 1, 1977, the United States will assume exclusive jurisdiction over fisheries within the zone, an area that includes about 10 percent of the world's fish supply. The primary thrust of the new program—comprehensive management of America's marine fisheries—is made possible by the Act, but the Department's program has five other parts that relate to the ways in which these vast fishery resources will be used to provide our growing population with food and recreation.

That the Act and the program, two landmark events for fisheries, were promulgated in the same year is not wholly coincidental. They stemmed from the same set of needs, the same growing recognition of problems and of disturbing trends in fishery stocks. Indeed, some of the work and thought that went into developing the background material for the program was used in drawing up the Act.

What are the needs that resulted in "A Marine Fisheries Program for the Nation"?

In the dark green depths and sandy shallows of America's coastal waters live a rich variety of creatures. Many are familiar to the American public—New England lobster, Gulf of Mexico shrimp, Pacific tuna and salmon. Others, such as menhaden, squid, and anchovy, are much less well known, but occur in vast quantities. The literally thousands of species of plants and animals, from microscopic to mighty, form a huge, complex, and restless pattern of life throughout the rivers and oceans around our coasts—hatching, growing and dying, eating and being eaten.

The pressure of growing numbers of people in the world has increased the search for all kinds of food, and fishing fleets have increased as part of this movement. The rich stocks of marine life off the United States provided a tempting target, and starting about a decade ago, the number and size of foreign fishing vessels off our shores shot upward.

Nor were foreign fishermen the sole cause of reduced stocks. Concentration by U.S. fishermen on highly favored stocks such as California sardine contributed to their reduction, sometimes almost to extinction. Some stocks fell prey to fishermen harvesting other species. An intense Japanese trawl fishery for Alaska pollock, for example, netted so many juvenile halibut, which occur in the same location, that it affected the halibut stocks in following years. Changes in bays and rivers and in the estuaries along the coasts, changes caused by damming, dredging and filling, and industrial development, also affected the fish, most of which spend some part of their lives in these areas and thereby depend upon them for clean water, oxygen, and food. All these factors have led over the years to reduction in fish stocks and uncertainty as to their future.

Although certain of America's fisheries, especially those for tuna, shrimp, and King

crab, have made important strides, others have declined. While the national consumption of food fish has trebled in the last quarter century, the annual landings of food fish by domestic fleets has remained at about two and half billion pounds over the same time. This is also generally true of the catch of industrial fish, used for fish meal and oil.

As a result, the increasing business opportunity provided by growing markets for fish is going largely to foreign fishermen. This is a paradox at a time when the great potential wealth of fish around our shores is needed and desired by Americans.

A further demand is placed upon fish stocks by sport fishing, a longstanding and growing pastime in America's oceans and estuaries. People fish from beaches, off piers and docks, from one man skiffs, and from large party boats, some capable of carrying a hundred fishermen at a time to the Gulf stream and to other likely waters. It is estimated that an astonishing 30 million Americans every year get into salt water fishing.

In one form or another, these difficulties of our fisheries have long been the subject of public concern, and in the past quarter century several efforts have been made to deal with them. The interstate marine fisheries commissions were established to coordinate management by the coastal states. Programs authorized by the Fish and Wildlife Act of 1956, and the Saltonstall-Kennedy Act of 1954, provided some assistance to industry. More recently legislation was passed that helps to conserve fish habitats.

But valuable as these laws were, they were not enough. Foreign fishing increased, our domestic landings did not.

Reviewing the problems in 1972, the newly-formed National Advisory Committee on Oceans and Atmosphere expressed concern and a warning:

"Fishermen have long contended with one another. Competition for a common resource has set the commercial fisherman against the sportsman, one segment of industry against another, one nation against another. But now, as a consequence of technological improvement and over-capitalization, there exists the capability to fish to extinction."

The Committee urged that a National Plan for Fisheries be developed to address these problems. It suggested that the plan recommend the actions that government and industry should take to enable domestic fishermen to increase their catch, so that their products, rather than imports, could meet the future needs of U.S. consumers.

The Secretary of Commerce agreed to develop such a plan, and the work was undertaken by the National Marine Fisheries Service under the guidance of the Marine Fisheries Advisory Committee.

NMFS prepared an outline for discussion that defined the problems in more detail, and presented a wide range of alternatives for solving them. These issues were discussed at hundreds of meetings across the country, meetings organized with the help of the interstate marine fisheries commissions, Sea Grant universities, and the Marine Advisory

Photo: Bob Williams, NOAA

Service. Many were led by State officials; they often took place in fishing ports—in town halls, community centers, school auditoriums, or wherever the audience, usually 10 to 100 citizens, could be accommodated.

Discussion was often vigorous and noisy, and there was frequent dissension. But although the various groups at the meetings rarely ended up in complete agreement, there was a surprising amount of common ground. As the reports of the many meetings rolled in, a pattern of public opinion began to emerge.

Taking these results into account, together with written comments from many people, including trade associations, national environmental and recreational groups, and NMFS regional offices and research centers, the Fisheries Service rewrote the original outline, and in the summer of 1975, this "issues and options" paper was given the same extensive review as the earlier outline. Finally, a special subcommittee of the Marine Fisheries Advisory Committee gave advice on the policy and program options to be included. Upon completion, the document became the National Plan for Marine Fisheries, and was submitted to the Secretary of Commerce. This plan, upon which the national program is based, is included as an Appendix to the program.

The program outlines national action on behalf of marine fisheries, with the Department of Commerce, through NOAA's National Marine Fisheries Service, taking a lead role. Other agencies and organizations with important parts to play are the U.S. Coast Guard, Department of State, Department of the Interior, Environmental Protection Agency, the States, and the regional councils and other regional organizations.

Part 1 of the program—to conserve and manage living marine resources—emphasizes the importance of implementing the Fishery Conservation and Management Act rapidly and effectively, and the Department assigns high priority to NOAA to do this. Thus, says the program, the Department will:

—Integrate the management responsibilities assigned to it by the Marine Mammal Protection Act of 1972, the Endangered Species Act of 1973, and the Fishery Conservation and Management Act of 1976;

—Support the regional councils by supplying scientific information and other assistance;

—Develop guidelines to assist the regional councils in preparing fishery management plans and revisions, and work with the councils in preparation of other plans required by the Act;

—Take all other measures, such as establishing a permit and fee system for foreign fishermen, required by law;

—Expand and reorganize research capabilities to meet the greatly enlarged needs created by the Act for scientific, economic, legal and other information;

—Assist the Secretary of State in negotiating foreign access to U.S. coastal fisheries, and in negotiating access for U.S. fishermen to underutilized resources within the economic zones of other countries, and cooperative arrangements for high seas fisheries of interest to the United States;

—In cooperation with the Secretary of State propose and support favorable U.S. fishery positions at the Law of the Sea Conference;
—Participate in appropriate international research;
—Review the working of the Act and propose changes if needed.

Effective management, the program affirms, will halt overfishing of our coastal resources. It will restore many marine species now depleted, and ensure that they will continue to thrive. This in turn can provide a self-renewing supply of twenty or more billion pounds annually of fish—more than triple the amount now taken by domestic commercial and recreational fishermen from U.S. waters.

Part 2 of the program deals with the need to conserve, restore, and enhance fish habitats. It calls for slowing down the loss and pollution of habitats, restoring habitats in some cases, and enhancing present habitats to make them more productive. The Department of Commerce will undertake a five-part effort toward these ends:
—Support amendment of the Fish and Wildlife Coordination Act to clarify the Department's responsibilities under the Act and to ensure fuller coverage of marine fisheries values in environmental decision-making;
—Initiate and develop improved mechanisms for close coordination in the review of proposed environmental modifications in cooperation with other concerned agencies;
—Increase review and research of proposed environmental modifications, with a view to protecting, restoring, and upgrading fish habitats;
—Cooperate in programs to inventory and describe fish habitat areas, including those critical to threatened species, and support efforts to establish and manage sanctuaries and refuges;
—Assure that plans developed under the Coastal Zone Management Act provide adequate consideration for living marine resources.

Developing and maintaining a healthy commercial fishing industry is the focus of Part 3 of the program. It points out that the Fishery Conservation and Management Act offers, for the first time, the means to ensure that through proper conservation the fish stocks of America's coasts can continue to yield rich catches to commercial and recreational fishermen. The purpose of the Commerce Department's activities in achieving this end will be to provide the means through which the private sector can achieve economic efficiency, largely through its own support. Working closely with industry, the Department will:
—Identify fisheries that have a high potential for expansion, and identify the technical and other factors limiting their commercial development;
—Select certain of these fisheries and carry out regional programs for their development, by improving technology, marketing, and other factors, in conjunction with regional advisory groups;
—Seek re-legislation of the fisheries loan fund (now under moratorium), to encourage the development of presently under-utilized fisheries and to improve productivity aboard fishing vessels;
—Continue the present basic support program of providing market outlook reports, economic and statistical information, evaluation of vessel safety, and advice for fishery cooperatives;
—Investigate means for strengthening the ability of the private sector to increase operations on a self-generating and self-sustaining basis.

Recognizing the importance of recreational or sport fishing, Part 4 of the program is aimed at strengthening the contribution of marine resources to recreation. The two most important requirements of recreational fishermen, it notes, are fish to catch and access to places to catch them, and the Commerce program will address these two needs. Specifically, the Department will take steps to:
—Ensure that stock assessment and research programs give full consideration to species of interest to recreational fishermen;
—Require full consideration of recreational needs in fishery management plans;
—Encourage and support adequate consideration of recreational access;
—Ensure that plans developed under the Coastal Zone Management Act give adequate consideration to access for recreational fishermen;
—Conduct surveys on the numbers of recreational fishermen and their activities to improve consideration of recreational needs in management plans, to determine the effects of recreational fishing on fish resources, and to develop a data base to assist the supporting industries;
—Survey commercial activities serving marine recreation to provide improved estimates of their economic significance.

If the fisheries resources are to be expanded to meet the nation's needs, more will be required than just restricting foreign fishing and efforts to restore present stocks. Many habitats cannot be restored because they have found other uses of equal importance to humankind. Yet the demand for fishery products continues to increase, and even with all other efforts, there will be a gap in prospective supply of some species that are widely sought but whose natural stocks are limited. The slack must be taken up in part, the program notes in its Part 5, by aquaculture. World production from aquaculture is presently estimated to be about 13.2 billion pounds annually, mostly of fresh water species.

The Department of Commerce, working through the National Marine Fisheries Service and the Office of Sea Grant, will therefore increase present programs of research and development, to provide scientific, technical, legal, and institutional bases for such an effort, accelerate the application of research results, and seek to provide solutions to long-range problems such as developing genetic strains that are cost-effective and disease resistant. The Department will also undertake to coordinate many of the aquaculture research and development activities being conducted by Federal and State governments, universities and industry.

Finally, the program aims, in its Part 6, to assure the safety, quality, and identity of seafoods for U.S. consumers. It recognizes that, because fresh fish spoil more rapidly than most foods, the quality of seafoods offered for sale and their acceptance by consumers "are variable and sometimes low". Moreover, the present voluntary seafood inspection program covers only about 30 percent of the national production, and five percent of American processing facilities. The Department of Commerce will therefore actively support legislation to bring about mandatory surveillance of all seafood plants and products, and, in the interim, will continue to expand the present voluntary program.

It will also:
—Improve present procedures for examining the safety and quality of fishery products;
—Support legislation to prevent agricultural and industrial chemical use from resulting in residues in seafood that will harm consumers;
—Carry out a national education program to inform consumers about quality and safety in fishery products.

How much will the program cost? It will be phased in over a five-year period, with modest increases in the Department's budget for activities relating to marine fisheries. It is anticipated that the total Federal cost will be reduced significantly by the fees paid to the general treasury by foreign fishermen for permits to fish within the 200 nautical mile zone that goes into effect March 1, 1977. In sum, the Department will in fiscal 1977 devote most of its fisheries budget, about $100 million, to the program, as compared with about $76 million for corresponding activities the previous fiscal year. By 1985, when the program will be in full effect, it is anticipated that the budget will increase only another $67 million. The largest single portion of this, $21 million, will go toward resource management, and the second largest, $19 million, toward habitat conservation—the two making up well over half the project increase, and aimed at obtaining a continuous source of marine fish for our own and our children's use.

The benefits will far outstrip the costs. In sum, marine fisheries now generate some $10 billion in the economy, and future growth in commercial and recreational fishing can add several billion dollars to this. Intangible benefits will go hand in hand with the tangible benefits—the pleasure of recreational fishermen will be enhanced, the American consumer will obtain safer and fresher seafood products, and future generations will be assured of continuing benefits.

Restoring, conserving and in a growing measure using the vast marine fisheries off our coasts for the people of the United States is now possible through the Fishery Conservation and Management Act, which provides the legal basis. The Department's program, supplementing the law, will guide NOAA in working with the Regional Fishery Management Councils, the States, and many others, not only to protect these remarkable and diverse resources, but to encourage their growing use. □

LIGHTNING

A SEARCH FOR THE SOURCE

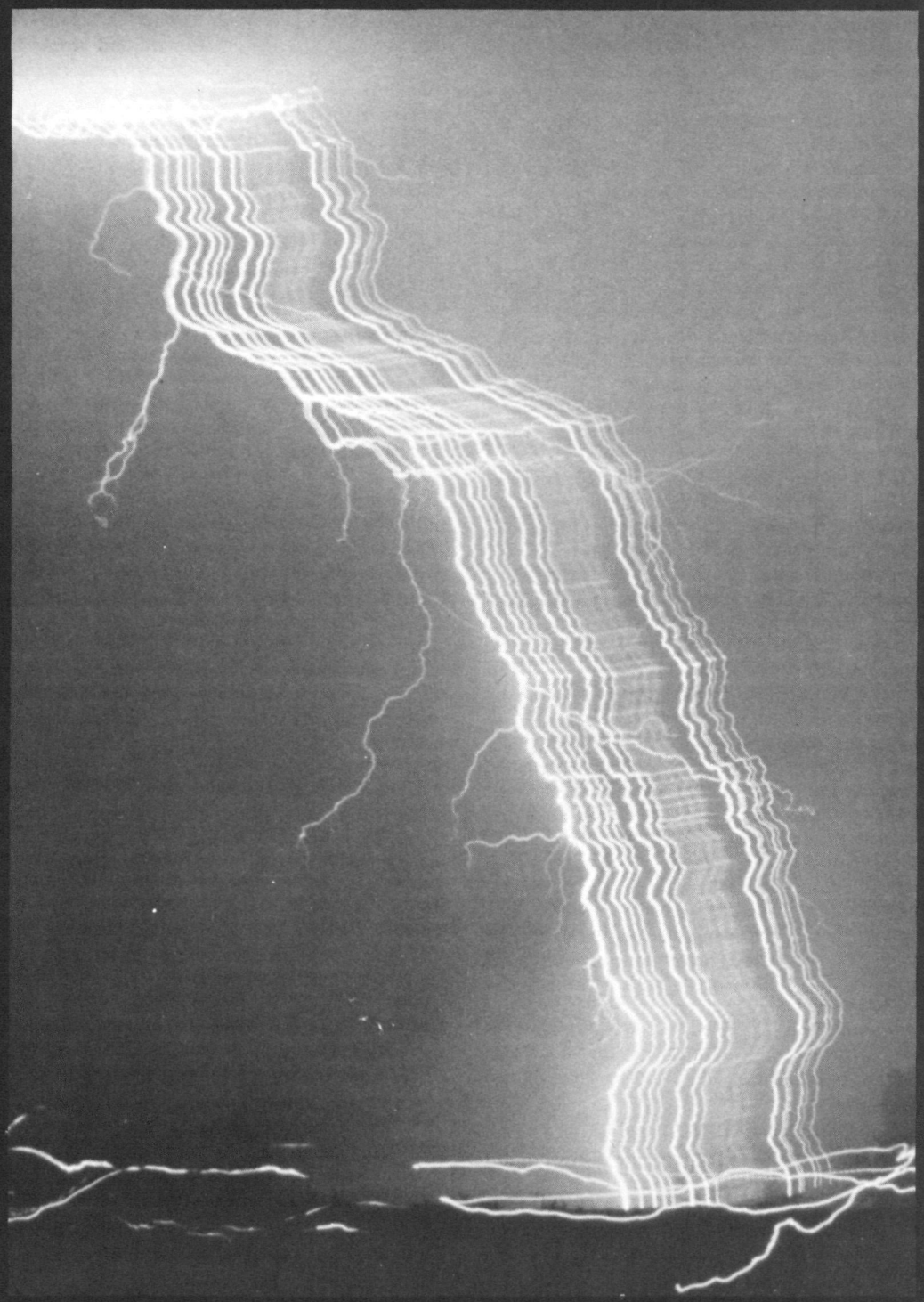
BY JOAN VANDIVER FRISCH

WHILE some modern-day scientists are coming nearer to duplicating the origins of life in the laboratory, others still search for the birthplace of one of nature's most destructive killers—lightning. The thunderstorm-related phenomenon remains a mystery because scientists understand little about the intricacies of lightning's origins and its interactions with the many other elements in thunderstorms.

Since the electrical experiments of Benjamin Franklin and his kite and key, scientists have pursued the elusive quantities of lightning. Today, they understand lightning in a general way—they know that it is a secondary effect of electrification in a thunderstorm; that lightning is the gigantic spark between large centers of positive and negative electrical charge; and that there are important—but poorly understood—correlations between storm electrification and precipitation, wind fields, and electrical orientation in the thundercloud. But where in the thunderstorm does the electrification process occur with respect to precipitation formation, how are the two related, what processes are active in the electric charge separation and discharge within the thunderstorm? These questions, and the questions they generate in their turn, are still among the imponderables of the atmosphere.

William L. Taylor, a physicist with NOAA's Wave Propagation Laboratory in Boulder, Colorado, is pondering them with research focused on the electrical origins of lightning storms—the forge where Vulcan hammers out the thunderbolt for Zeus. However, there is no mythology in Taylor's study. It is work done with electronic devices designed to pinpoint where lightning is being born within the thunderstorm.

The human eye sees only about one-tenth of a storm's lightning activity. Taylor's instruments let him "see" the other nine-tenths. His "eyes" are radio receivers tuned from just below the citizen's radio band to frequencies just below the FM broadcast band. By setting his receivers between 20 and 80 megaHertz (million cycles per second), Taylor can fix the position at which the different branches, or "kinks," of the lightning's main channels are located. By



The visible lightning showing up on this time exposure made in Boulder constitutes only one-tenth of a thunderstorm's electrical activity. Remote sensing equipment designed by NOAA physicist William Taylor (above, at receiver unit) detects the other nine-tenths by sensing radio energy emitted when the lightning stroke branches.

changing the sensitivity of his receivers, he can observe either the main channel or the little branches or offshoots of the lightning stroke. Coupling this information with precipitation concentrations observed by weather radar, Taylor can locate where lightning is occurring with respect to the concentration of water and ice particles in the storm.

"We know that some clouds produce rain without any observed electrical activity while other clouds produce considerable lightning activity with no rain reaching the ground," Taylor explains. "This happens often in Colorado and may be caused by large updrafts blowing the rain upward vertically or horizontally until the raindrops evaporate."

By analyzing electrical data gathered through his electronic window, and comparing it with weather radar data showing where the rainfall was concentrated, Taylor may be able to determine what electric field conditions produce the most rainfall.

"We know that the lower portion of the cloud is negatively charged and the upper portion positively charged, but we do not know how the charge gets separated in the cloud," he says. "One theory is that water droplets carry the negative charge down and leave the positive charge in the upper part of the cloud. By comparing our data with information from weather radars, we may be able to prove or disprove this theory."

How would such information be applied?

If scientists could correlate the location of the lightning strokes with precipitation and wind fields in the clouds weather forecasters could use this information to predict better regions of potentially severe weather conditions including tornadoes.

Data from Taylor's instruments could also be valuable for atmospheric scientists involved in lightning suppression experiments, by telling them where in a thundercloud to sow metallized fibers.

And, if scientists identify a close correlation between where the lightning originates and hail forming processes in a thunderstorm, data from Taylor's instruments could aid weather researchers in deciding where to seed clouds to suppress the formation of crop-ruining hail.

"Relating the space-time history of lightning discharges to the locations and variations in the wind field and precipitation regions of thunderstorms will give us a tremendous opportunity to further our knowledge of thunderstorm processes," Taylor says.

Although he has been engaged in thunderstorm studies for the past 20 years, it was not until 1969 that the soft-spoken scientist began his basic research on the electromagnetic signals emitted by tornadic storms.

During three successive years of severe storm field programs at Norman, Oklahoma, he began detecting the existence of electrical "bursts" associated with tornado-bearing thunderstorms. As a result of these studies Taylor designed a directional tornadic storm detector which could determine the arrival-sequence of electrical impulses received less than a billionth of a second apart.

Although the tornadic storm detectors were activated by increased electrical activity within the thunderstorm, Taylor found the equipment responded to too general a signal from the storms; a more specific signal, if there was one, hid in the poorly understood processes involved in the birth of a lightning stroke.

"We learned that tornadoes are more apt to happen in storms with high electrical activity," Taylor explains, "and our analysis of many tornadic storm records shows that approximately 15 minutes of high electrical activity takes place before a tornado touches the ground.

"But some fundamental research must now be done to establish the place of this electronic impulse burst rate in the larger electrical context of the thunderstorm. Then, perhaps the technique can be applied as a viable tornado detection tool."

That research has taken the form of Taylor's search for the lightning source. After designing equipment to measure the direction of arrival of very-high-frequency impulses with simplified antennas, he designed the required circuits and conducted field tests with his new equipment during the summer of 1975 on a few local thunderstorms near Boulder. Results of these early tests showed that Taylor's equipment was capable of locating the sources of the electrical impulses produced during a lightning stroke.

"From these tests we concluded that the horizontal direction and elevation of lightning discharges could be measured to an accuracy of half a degree from spaced antennas separated by only 14.5 meters [50 feet]," Taylor reports. "We noticed that the lightning discharge generally occurred below a certain level in the cloud—five to six kilometers [3 miles] above the earth where the air temperature was minus 10 degrees Celsius [14 degrees Fahrenheit]. Even in the biggest of thunderstorms it is unusual to have lightning higher than about 13 kilometers [8 miles] above the earth. Normally we register a discharge every 10 seconds or less in an active thunderstorm—one that produces hail. But in smaller storms, a discharge may occur only every minute or two." The number of electrical impulses produced during a discharge may exceed a hundred thousand.

To extend his interrogations of thunderstorms, Taylor and his equipment participated in the Thunderstorm Research International Program (TRIP) which was held at the National Aeronautics and Space Administration's Kennedy Space Center at Cape Canaveral, Florida, in the summer of 1976.

More than 20 scientific teams from Federal laboratories and universities participated in the project. From mid-June to the end of July, Taylor had two sets of antennas operating at two separate sites, approximately 20 kilometers (12 miles) apart. One site was located at Cape Canaveral Air Force Station and the other was situated near the launch pad used for NASA's Apollo missions to the moon. The total area in view of the antennas was approximately 200 square miles (650 square kilometers)—the major portion of the Center.

The sites were chosen at those particular locations because of atmospheric conditions conducive to thunderstorm generation in the area. Often in the summer, a breeze blows across Florida in the morning from the southwest and a sea breeze fans in from the southeast. Where the two air currents converge, a line of thunderstorms often forms, intersecting the Indian River area of the Kennedy Space Center.

Last summer, as cumulus clouds near the Space Center grew into thunderstorms, Taylor would track the developing storm with his equipment, which consisted of two pairs of six-foot (2-meter) antennas made from 5/8 inch (16-millimeter) aluminum tubing. One pair of antennas was spaced about 50 feet (14.5 meters) apart while the second set was attached vertically the same distance apart on one pole. The latter set of antennas was located on a triangular pattern from the first two antennas.

The first pair of antennas measures the difference between the time an impulse reaches the first antennas and when it arrives at the second antenna. This result gives Taylor the horizontal direction, or azimuth, to the source of the signal. The second set of antennas determines the elevation of the signal source.

But what exactly is his equipment seeing?

In thunderstorms, when the initial cloud-to-ground lightning stroke forms, it advances gradually, as the charge overcomes and ionizes (electrically charges) the insulating air, and pushes groundward. This process, according to Taylor, is a very low-current phenomenon, and generally produces no signal his instruments can detect.

"We see the return stroke," he says, "which may carry current in the tens of thousands of amperes. It flows back up the ionized channel sent down from the cloud initially, and everywhere it branches it emits the radio energy we pick up in the form of impulses from the storm. This return flow branches almost infinitely into a tree-shaped configuration inside the cloud, trying to tap the energy in every charged particle in that part of the storm. Although we don't see every branch to every particle, we do detect what amounts to the trunk and major branches of the stroke. This permits us to trace the lightning bolt back into the cloud, and into the area where the stroke began."

Taylor points out that two sets of his equipment, separated by 40 to 50 kilometers (25 to 30 miles), could fix the source of lightning to within about 250 meters (235 yards).

Taylor plans to set up his instruments in cooperation with the National Severe Storms Laboratory in Norman, Oklahoma, during its 1977 spring project.

"We hope the laboratory's dual Doppler radars will help us detect any unusual or peculiar lightning sources within the storm that could indicate tornado activity, or sources within the funnel itself," he explains. Taylor also plans to participate in the second Thunderstorm Research Program at Cape Kennedy next summer, in the hope of finding answers to the persistent questions of where, and when, and how the thunderbolt is forged. □

Beautiful? No Profitable? Yes

ENTER THE EEL

BY JOHANNA SELTZ*

"Oh, eel, how . . . interesting," the woman said stepping back as the plate came her way. "Would I like to taste some? Why, no, thank you."

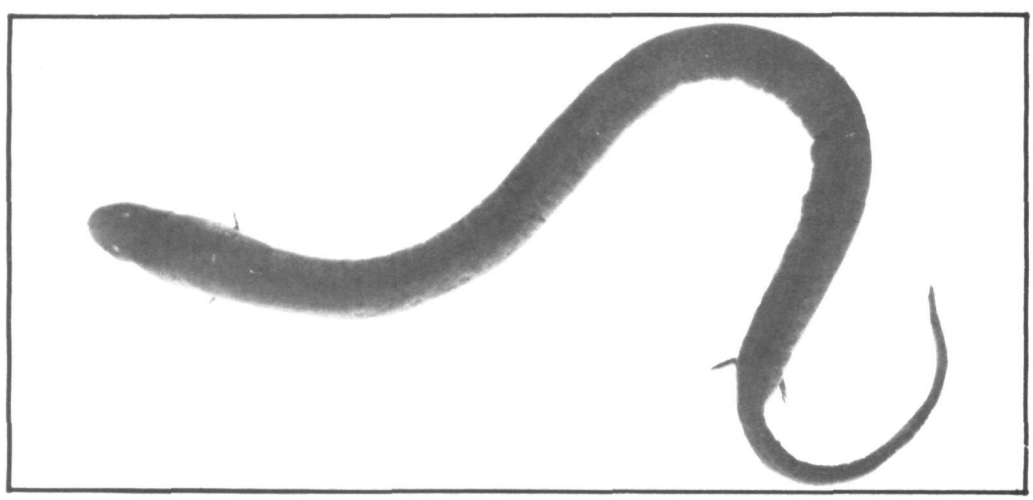
She gagged slightly, and politely but rapidly smiled her way out of the room.

If eel is unappreciated in most North Carolina dining rooms, the slinky fish is gaining some avid fans in fishing circles. At last count, 350 state fishermen were bagging eel and pulling in—in 1975—more than $600,000. Translated into related expenditures, the eel made a $6 million impact on the coastal economy, according to Skipper Crow, University of North Carolina Sea Grant advisory agent.

Crow is one of the Sea Grant workers most responsible for spreading the word about eels. Since 1972, he and co-worker Walt Jones have trained hundreds of fishermen to harvest, handle and market eels and helped East Carolina Industries—a Fairfield, North Carolina business started in 1971 to provide full-year employment for migrant workers—become the state's major eel exporter.

Before Sea Grant began actively pushing the eel on fishermen, few people cared about the fish. The only market was for salted eel which sold for pennies a pound as crab bait. As late as 1972, the salted eel was selling for a mere 18 cents a pound and only about 18,000 pounds traded hands. In 1975, the eel price had risen to 50 to 55 cents a pound to the fishermen and an estimated 1.7 million pounds of North Carolina-landed eel were exported frozen to Europe and Asia.

Simple economics of supply and demand explain the rise of both price and catch, according to Crow. Demand for eel, a luxury food in Asia and Europe, has risen phenomenally in the past few years. Consumption increased 5 million pounds in 1975 and a French consulting firm estimates future growth in demand at seven per cent a year. Eel supply, however, has been unable to keep up with this mushrooming desire. So the market has expanded to the United States, and North Carolina fishermen are cashing in on the high prices that inevitably result from a seller's market.



"It boomed because there was money on the other end," Crow explained.

Charley Bass, of Plymouth, is one of the North Carolina fishermen who has discovered, through Sea Grant, eel fishing. He is an enthusiastic convert.

"It's the most interesting type of fishing I've found," Bass said. "The eel is a crafty creature and it's very satisfying to catch. The most intriguing thing about eeling, though, is the amount of money you can make."

Bass has only been eeling part-time in the spring and fall, but he has already noticed some advantages to eel fishing, besides the comparatively high price. Eel pots are sturdier and require less maintenance than the gill nets he uses a good part of the year, he said. And because eels are caught alive, they do not have to be retrieved during severe weather.

"You can wait to go out until there's better weather conditions," he said, "without danger of spoiling your catch."

Bass fishes out of Mackey's in the Albemarle Sound. And the methods he uses are almost identical to those used by all North Carolina's eel fishermen. First he starts with an eel pot—either a round or square metal trap with a funnel entrance and long rope attached to a buoy. The pots are loaded with bait—menhaden, herring, shrimp head, and other oily scraps are recommended—and tossed flat onto the bottom.

Eels feed at night and will not scavenge rancid food. Most eel fishermen, therefore, try to visit their pots in early morning and late afternoon to collect their catch and refill the bait boot. The wriggling eels are dumped from the pots into garbage cans or tubs full of water and carried back to shore. There they must be kept alive in holding tanks until the dealer arrives with cash in hand. Before being frozen the eels must be kept about five days without food to purge the digestive tracts or the fish will sour when thawed.

North Carolinians can eel fish all year, although the fish are most plentiful in the spring and fall. To produce a steady supply, Sea Grant researchers are experimenting with eel aquaculture. The first pond of aquacultured eels was harvested this summer and an economic feasibility study is underway to test the practicality of eel growing in this state.

Crow believes there is room for expansion in North Carolina's eel industry. Only half the state's coast is fished now and marketing outlets—while sufficient for the present—are still limited.

"The eel industry is in its infancy in North Carolina," Crow said. "The only future is to grow."

And why not? For all the nose-thumbing eel gets at home, it's rumored to be an extremely tasty fish—mild, like flounder, with an easily "influenced" flavor.

So if the plate passes to you, and the host says, "Won't you try some eel?" be brave.

Try some. □

**Johanna Seltz is affiliated with the North Carolina Sea Grant Program.*

Eelfishing is a new and profitable business for some North Carolinians, and three of them are catching elvers (young eels) in a stream, first step in eel aquaculture. Below, eel fisherman Charles Bass cuts his motor and reaches for an eel pot. Three of the much-used round eel pots are shown at right.

New insights for our inland seas

LAKES BUILT OF NUMBERS

BY LOUISE A. PURRETT

POLLUTION of the Great Lakes, one of the nation's most well-known environmental problems, is often seen in terms of noxious chemicals and old tires. There have been serio-comic references to the disadvantages of living downwind of Lake Erie, suggestions that the Detroit River must surely be flammable.

But the situation is much more complex, because some of the pollutants can kill a lake by turning its own ecology against it.

Increases in nutrients such as phosphorus—largely from human sources—have accelerated the natural process of eutrophication (biological productivity) in the lakes. This process, if unchecked, can cause a lake to literally grow itself to death, becoming clogged with malodorous algae until decomposition of organic matter removes oxygen from the water depths and fish and other fauna cannot survive.

To understand how this rampant eutrophication occurs, and plan strategies for stopping it, we need to know the sources and sinks of the nutrients, and how they travel through the lake ecosystem. But the size of the Great Lakes system makes direct measurement impractical, if not impossible.

At NOAA's Great Lakes Environmental Research Laboratory in Ann Arbor, Michigan, scientists are trying to find a simpler way, by building computer models—mathematical miniatures of lake ecosystems. The models, ranging in scope from the effects of a single nutrient to an entire lake ecosystem, allow predictions of future conditions that might result from changes we make now.

Phosphorus is the most troublesome nutrient, and the main target of efforts at preserving the lakes. Dr. Steven C. Chapra of the Ann Arbor laboratory (one of NOAA's Environmental Research Laboratories) has developed a model to simulate the effects of phosphorus, and predict the results of abatement programs.

Chapra's model takes into account three basic sources of phosphorus: domestic, land runoff, and atmospheric. Domestic sources, he explains, include the sewered wastewater from residences, businesses, and institutions. Human waste and detergents are by far the biggest contributors of phosphorus.

The amount of phosphorus that washes into the lakes from the land depends on how the land is used—whether it is agricultural, urban, or forested land—topography, precipitation, soil characteristics, vegetation, animal population, and manipulative practices such as fertilizing. Finally, dust, rainfall, and snow also drop phosphorus into the lakes.

On the other side of the scale, a sizeable fraction of incoming phosphorus is removed by incorporation into lake sediments.

To test the model, Chapra used it to simulate phosphorus inputs and concentrations from the year 1800 to 1970, and compared the results with actual measurements. He fed in the probable conditions of the lakes in 1800, when the main sources of phosphorus were the atmosphere and runoff from forested land, and the model simulated the changes that took place as the population around the lakes grew and the forests gave way to farms and cities. In the end, the 1970 phosphorus levels predicted by the model agreed well with measured values.

The simulation also provided some new insights. It suggested, for example, that there is a physical limitation to water-quality improvement in the Great Lakes. Western Lake Erie, a small basin that collects water—and phosphorus—from a large area of land, has a calculated phosphorus concentration 50 percent higher than the next highest lake. "This suggests that total removal of cultural wastes would never bring western Erie to the levels possible in the other lakes," says Chapra.

Over the past 170 years, the calculations showed, the lakes have suffered two major periods of increased phosphorus loading. In the latter part of the 19th Century, the forested land was cleared for agriculture, causing phosphorus increases in all the lake basins. Then, after about 1945, another major shift in land use around the lakes caused a second jump. Population growth, a resulting increase in sewage, and the introduction of phosphate detergents, had a strong impact, particularly on Lakes Erie, Ontario, and Michigan. He notes that since Huron and Superior were relatively less affected by

Photo: EPA Documerica

the population change, treatment of point sources of pollution—factories or cities—would have little effect on water quality in those lakes.

The experiment also demonstrated that Lake Ontario's health is significantly affected by the health of the lake upstream, Erie. "A coordinated program of waste abatement would be necessary for those two lakes."

Since the model proved to be a fairly reliable simulator of phosphorus input and concentrations, Chapra decided to try it at predicting the success of phosphorus abatement programs. The Great Lakes states and the Canadian province of Ontario have embarked on phosphorus reduction programs that concentrate initially on reducing domestic sources.

It is estimated that about 150 gallons of effluent are poured into the lakes for each inhabitant of the basin. If abatement programs go according to plan, by 1980 the inflow of phosphorus into the lakes would be .46 pound (209 grams) per capita per year. Under such conditions, Chapra found, all the lakes would recover rapidly. All but the western basin of Lake Erie would return to healthy levels of productivity by 1985.

Chapra cautions that this prediction is based on the assumption that phosphorus loss to sediments is a one-way process. For most of the lakes, it is; but once again Erie is the exception. In Erie, phosphorus levels in sediments are already so high that reduction of the amount of phosphorus in the water might cause some of that trapped in sediments to leak back. In addition, the western and central basins of Lake Erie are so shallow that storms can stir up sediment and re-mix phosphorus in the water.

Chapra points out that his model is designed to aid management decisions, and that the computer program is structured so that political or geographic distinctions can be made. "Thus it is relatively easy to develop scenarios of future conditions which ask questions such as 'What would happen if the State of Michigan outlawed detergents, while all other parts of the region did not'? or 'How much of the phosphorus from domestic waste is contributed by people living in counties contiguous with one of the lakes?' "

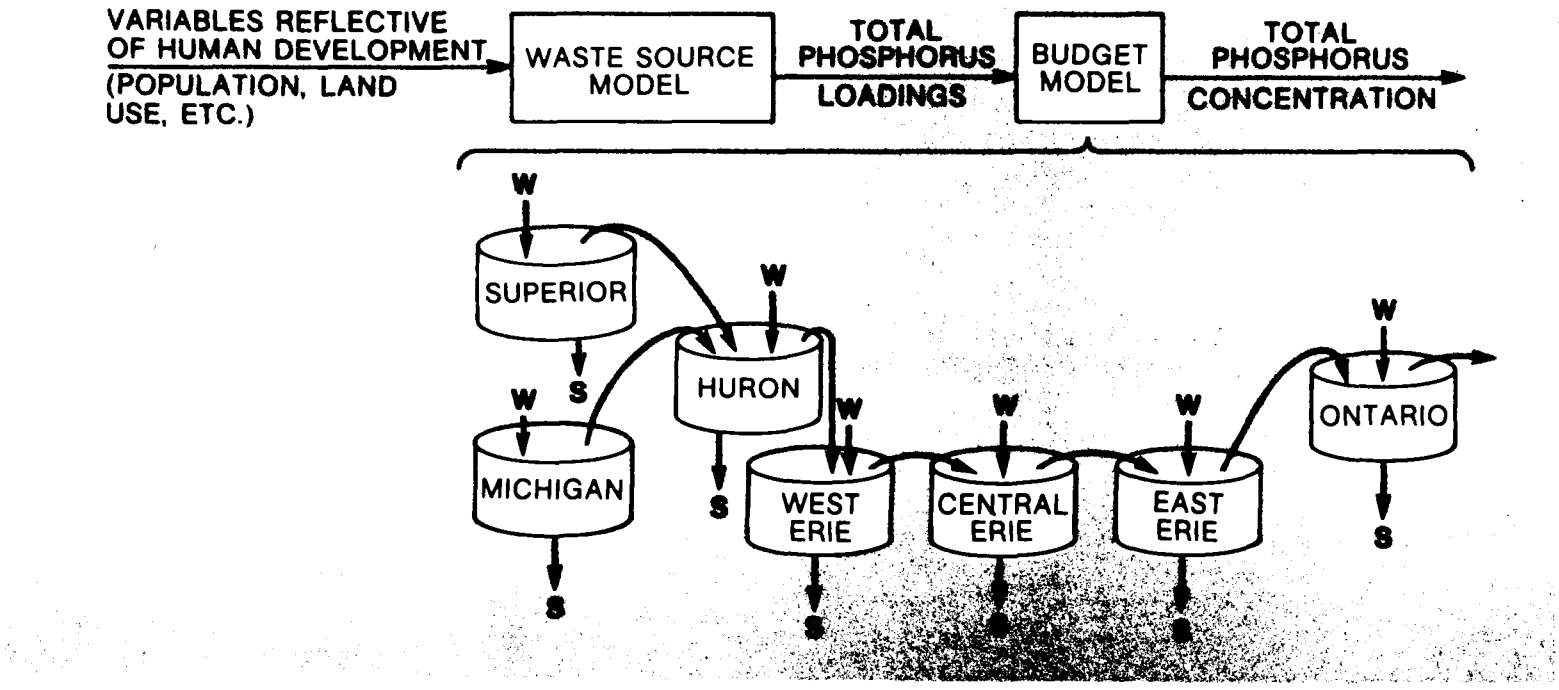
The NOAA researcher is planning some refinements of the model, such as better handling of diffuse sources and addition of sediment-water interactions, that should enhance its usefulness.

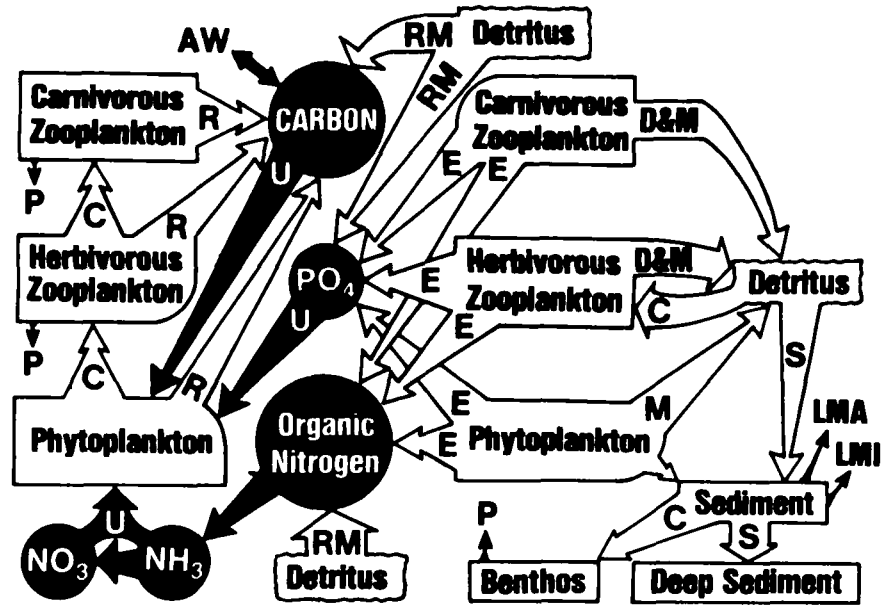
Chapra and another researcher at the laboratory, Dr. Stephen J. Tarapchak, have approached the problem from a slightly different angle. They derived a model that predicts the summer concentration of chlorophyll *a* (an index of biological activity) resulting from phosphorus inputs.

The model showed that there are two main factors determining the amount of phosphorus needed to maintain a given level of productivity: sedimentation; and flushing, the cleansing of the lake basin by water flowing through it.

"At high enough flow rates," the scientists explain, "a lake's ability to tolerate a particular phosphorus loading becomes overwhelmingly dependent on the physical mechanism of flushing." As the flow decreases, however, the in-lake processes that remove phosphorus, such as incorporation into sediments, become more important and eventually predominate.

The phosphorus and chlorophyll *a* models are pieces of a larger ecological puzzle. These specific models, limited as they are to





(Top) A "bucket" diagram shows how phosphorus enters the lakes from wastes (W), is removed from them through sediments (S), and flows from lake to lake through the connecting rivers. (Below) A general ecology model of Lake Ontario simulates the complex interactions of nutrients, phytoplankton, and zooplankton.

a single aspect of the ecosystem, can be generally applied to the other lakes. A broader model dealing with the entire ecosystem of a specific lake—Ontario—is also being developed. The model is a product of the International Field Year for the Great Lakes, an intensive, international study of Lake Ontario and its drainage basin.

The model, devised by Drs. Donald Scavia, Brian J. Eadie, and Andrew Robertson, simulates the life cycles of four types of phytoplankton and five types of zooplankton, and traces the paths of six nutrients through the biological and physical system of the lake. The phytoplankton take up carbon, phosphorus, and two forms of nitrogen, releasing phosphorus and organic nitrogen by respiration. The five types of zooplankton feed on these phytoplankton, in turn excreting or respiring inorganic carbon, phosphorus, and dissolved organic nitrogen, thus completing the nutrient cycle.

The growth rate of phytoplankton depends on available light and temperature, as well as nutrients. Temperature also affects the rate at which zooplankton graze on phytoplankton. These factors, the rates at which zooplankton die or are eaten by animals higher in the food chain, and even the food preferences of the different zooplankton, are included in the model.

Wind and heat from solar radiation are the forces that set the model lake in motion, to generate predictions of temperature profiles, turbulent vertical diffusion, and variations in the thickness of three horizontal layers of the water.

Once the model took shape, the scientists began to ask themselves if it is realistic—does it really behave the way the actual lake does? "Little work has been done to develop robust tests for accuracy in prediction," they comment. The usual way to test such a model is to compare the concentrations of certain variables, such as phosphorus, that are predicted by the model with actual measurements. The trouble with this method, say the Great Lakes researchers, is that it is possible to get the right answers—the realistic concentrations—with the wrong methods. So in addition to the usual tests, they decided to verify the processes simulated by the model.

Primary production, the initial formation of organic matter—carbon—from inorganic, is the foundation of the food web. The model simulation shows primary production rates varying between .01 and 1.2 grams of carbon per square meter per day. This compares with measured values ranging between .15 and 1.85.

Sedimentation, in which fine materials such as zooplankton and their remains sink through the water to become part of a blanket on the lake floor, is another important process. The model shows that tiny living zooplankton cells sink at a rate of .004 to 2.9 meters per day, depending on the species. This is well within the range measured. It also appears that dead cells sink much faster than live ones.

As for the actual concentrations, the researchers found that the model performed well in predicting carbon, nitrogen, and phosphorus. It reproduced the spring and fall peaks, as well as the mid-summer low levels, in carbon from phytoplankton and zooplank-

Photo: EPA Documenica

ton populations. Nutrient levels started to decline in late spring, and continued depleted throughout summer. But as the individuals born in the spring population boom of phytoplankton started to die off, their remains replenished the supply of inorganic nitrogen.

The model also reveals the pattern of succession, the sequence in which different life forms dominate a niche in the ecosystem, one taking over as another declines. Among phytoplankton, large forms tend to succeed smaller ones, followed by herbivorous zooplankton and, at the top of the food chain, carnivorous zooplankton, which feed on other zooplankton.

By manipulating various aspects of the model Lake Ontario, the researchers were able to gain some insights into how important these quantities were in the ecological scheme of things. For example, when Scavia, Eadie and Robertson removed the process of vertical diffusion of phytoplankton, detritus, and nutrients in the water, they found that at certain times of the year this process is the main supplier of phosphorus to the lake's upper levels. Elimination of sedimentation reduced the amount of carbon in the bottom waters by 65 percent, a deficiency that would cause the death of bottom-dwelling animals.

A five-degree-Celsius year-round temperature increase would cause the spring "bloom" of phytoplankton to occur earlier—in late April instead of mid-May. This in turn causes a shift of the zooplankton maximum from early August to mid-June.

Scavia, Eadie, and Robertson's model simulates a specific ecosystem—Lake Ontario. Can it be applied to the other Great Lakes? The three scientists simplified the model slightly and tested it by feeding in conditions on the other lakes, and comparing the predictions with all the records of actual measurements they could find.

At first, they simply fed in physical data for Superior, Huron, Michigan, and the three Erie basins. The model responded with predictions of phytoplankton levels in all four lakes that were generally lower than the measurements suggest. It also predicted that concentrations of zooplankton would decrease sharply throughout the year, a pattern also contrary to what is known.

The discrepancies, the researchers surmised, might be due to differences in nutrient levels among the lakes. Nutrient levels are an important factor in determining the dominant species of phytoplankton, which, in turn, affects the zooplankton community. The researchers then tried to see if simple recalibrations of the model for the differing nutrient conditions in each lake would produce more realistic simulations—for example, taking into account mathematically the implications of low nutrient levels in Lake Superior, which have probably favored the dominance of species adapted to nutrient-poor waters.

This time, the model matched the measurements quite well, at least for the upper lakes—Superior, Huron, and Michigan. Each of these lakes is at a different stage of the eutrophication process. But since the model had to be recalibrated for each lake, or eutrophic state, it cannot be used to simulate the process in a lake. It would have to be constantly recalibrated. As eutrophication proceeds, and nutrient levels change, species better adapted to the new conditions would replace the old populations. For an ecology model to be truly general, the scientists conclude, it should be able to simulate this natural selection. Recalibration would occur automatically.

The mechanisms governing succession, however, are not well understood, and must be studied. In some lakes, especially shallow ones, the physical and chemical interactions between sediment and water can greatly affect the life forms.

The model also failed to simulate the central and western basins of Lake Erie because it does not take into account some of the physical processes occurring there, processes that are less important in the other lakes.

Each new model, by its failures as well as its successes, reveals something about the relative importance of the various processes and components of the lake ecosystems. As scientists learn more about what goes on in the lakes, these models will be refined, coming closer and closer to reality. Already they are providing new insights into the internal workings of the lakes. Eventually, they will be routine tools for planning how best to interact with our inland seas. □

What's new on the Great River of the West?

SALMON Is King Again

BY GERALD D. HILL, JR.

The Columbia River Basin is a place of mind-boggling size. Embracing parts of Oregon, Washington, Idaho, Montana, Wyoming, Utah and Nevada, plus another 39,000 miles in British Columbia, it drains an area larger than all of France. It is the nursery of a magnificent wild resource—four species of Pacific salmon and the seagoing rainbow trout, which come from its rich upstream spawning beds.

They have been an integral, vital part of life in the Great Northwest as long as man has been there. Lewis and Clark found their numbers almost inconceivable, so plentiful that they simply drifted ashore for the Indians to collect and dry against the future.

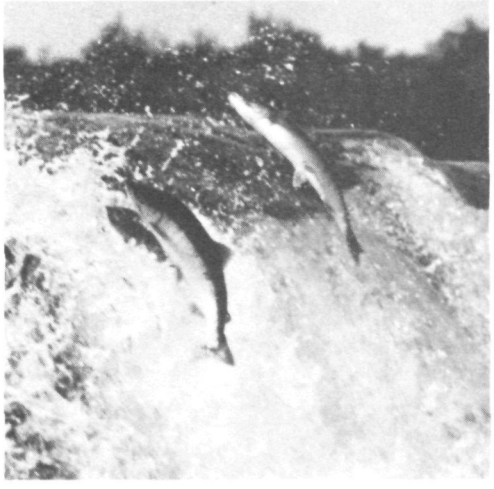
It may have been not much different as recently as 1911, when fishermen took almost 50 million pounds. But that was before man began to use the Columbia in earnest, and in the process to threaten the very existence of the fish with his stream-blocking technology. Less than half a century later, the catch had been cut to less than one-fifth of the 1911 figure.

Happily, the salmon today is making a phenomenal comeback; by 1960 it had risen to more than 30 million pounds, and scientists believe the Columbia ultimately will again send 50 million pounds a year into America's kitchens. This comback is without question one of the finest conservation success stories of all time. (And for every dollar it cost, incidentally, there has been a return of three dollars or more.)

How did the Pacific salmon's troubles begin? Because the salmon, for reasons unknown to man, is a compulsive homebody.

After a lifetime of two to six years, and thousands of miles of travel through streams, rivers and the global sea, he is driven to return, usually in agony, often literally in tatters, to the precise gravel bar where he first saw life, there to reproduce and die.

The largest of the four species is the chinook, which weighs about 20 pounds, although some weigh over 100. Others are the sockeye (or blueback), the silver (or coho), the chum, and the steelhead trout. The life cycle begins with a lazy drift downstream to the sea—about a year. In the ocean environment, adulthood comes quickly; they range from southern California



to the Bering Straits, as far west as Kamchatka and as far south as Japan.

And then it is time to go home, often as far as 800 miles inland. As the salmon reaches fresh water, an awesome change occurs; its pituitary gland produces, in a few weeks, an aging process equal to 30 years of human lifetime. Everything deterioriates except the heart. The fish does not eat. He is on an obsessive journey, swimming at five or six miles an hour, fighting the rush of downstream currents, eluding predators, leaping ten or a dozen feet up waterfalls and other obstacles. In a splendid mystery, he finds his birthplace. Then the female digs a nest in the gravel with her tail and lays the eggs; the male fertilizes them; the gravel settles over the eggs; and the salmon die.

According to Dr. Fred Cleaver, Director of the Portland, Oregon office of the Columbia River Fisheries Development Program, deterioration of spawning grounds actually began in the early half of the 19th century. The first settlers blocked streams to divert the flow for irrigation and to provide power for flour and lumber mills. Hydroelectric plants began to obstruct streams to salmon in the 1880's. This decade saw passage closed to adult salmon in the rich Spokane River and nearly destroyed runs in the Willamette River.

In parts of the Columbia River basins, especially in the upper reaches of the Snake River, salmon have been blocked to a large extent by the construction of dams on the river. Many of the little fish were killed as they began their migration to the sea when they passed through the turbines.

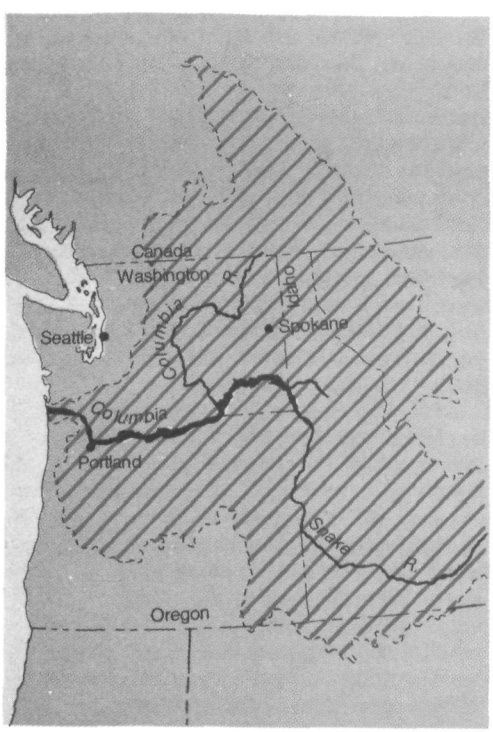
River blockages continued at an accelerated pace until about 1970. More recently urbanization, agriculture and channeling have destroyed the smaller streams that once produced coho and chum salmon. Even without any fishing at all, the capability of the Columbia River environment to produce salmon and steelhead would have collapsed. Minor damage prior to 1880 became serious by 1910, the most important factor by 1930, and sheer disaster to natural propagation, particularly in the upper Columbia and Snake Rivers by the 1960's.

This declining yield spawned the beginning of the Columbia River Fisheries Development Program.

"The Program started with a joint effort of the state fish and game departments in Oregon, Washington, and Idaho with the Fish and Wildlife Service to develop fully the salmon resource as compensation for damages created by Federal water projects in the past," says L. Edward Perry who was in charge of the Portland office until 1968. "The proposal became a serious matter when Congress amended in 1946 an Act of May 11, 1938, to permit closer cooperation with state agencies, using their facilities and services for developing the salmon resources in the Columbia Basin. This is known as the Mitchell Act. The earlier law of 1938 pertained to the construction of hatcheries and the study of problems in the Columbia Basin with the use of revenue obtained from lease of commercial fishing rights on government property at the mouth of the Columbia River."

The proposed development program evolved from the stream surveys conducted throughout the Columbia Basin in the early 1940's. As a result, plans were made to improve the natural habitat by removing log jams and opening up more streams to the fish, by screening irrigation ditches so the small ones heading to sea would not go into the ditches and die, and by building fish ladders around barriers to natural streams, waterfalls and dams that were impossible for the fish to circumvent. However, the primary role and responsibility of the program

Photos: Gerald D. Hill, Jr.



A portion of Willamette Falls, above, that forms a natural barrier to fish migration to the upper Willamette River Basin. The Columbia River Basin covers an area of approximately 259,000 Square miles.

was to restore the declining anadromous fish stocks that were lost due to water developments such as dams, irrigation, and hydroelectric power producers throughout the basin.

The first appropriation was made in fiscal year 1949 in the budget of the Corps of Engineers. It amounted to approximately one million dollars and was transferred to the Fish and Wildlife Service. The Corps of Engineers continued to include the Columbia River Program in its budget until 1958 when it became a part of the Department of the Interior budget. The program was transferred to the Department of Commerce in 1970.

"The major emphasis of the CRFDP has been directed toward the construction and operation of hatcheries," says Dr. Cleaver. "Twenty-one stations are funded by NMFS. Eight of these hatcheries are operated for NMFS by the state of Washington, seven by Oregon and six by the U.S. Fish & Wildlife Service."

In 1975, the 21 program hatcheries produced 110 million chinook fingerlings weighing 1,210,000 pounds; 22.6 million coho fingerlings weighing 1,389,000 pounds; and 2.2 million steelhead weighing 298,218 pounds.

The hatchery rearing program was given a boost in 1976 when extra funds were provided which will increase the production by approximately 1.5 million fish and 100,000 pounds of fingerlings above the 1975 program.

One of the hatcheries funded by the National Marine Fisheries Service is the Little White Salmon River hatchery, located in Washington about 55 miles up the Columbia River from Portland. Jack Bodle, a big, rugged man who loves the outdoors, manages both Little White Salmon and another, Willard, located about five miles up the river.

He is a graduate of the University of Minnesota and has worked for the U.S. Fish and Wildlife Service for about 13 years, seven of them as the manager of the Little White Salmon hatchery.

He explained the spawning process during a recent visit to Little White Salmon River.

"We are just winding up with this run of fish and only have about 500 here now," he said. "At times as many as 5,000 return to the hatchery. These fish were released about three years ago, have been to sea and now have returned. Some will return to the sandbars in the river right at the entrance to the fishway that comes into the hatchery. They were hatched on the bar and won't come into the hatchery only a few more yards up the river, nor will the ones that came from the hatchery stop on the sandbar," he said.

When the fish are ready to spawn, only hours before they would die, they are moved through concrete ditches into an area where

they are anesthetized and killed. The females are split open and the eggs put into a bucket. The eggs are then fertilized with sperm from the male and transferred to the hatchery, where they are kept in trays with 50-degree running water passing through them.

"We keep them in the tray for about 50 to 60 days," says Bodle, "and then they are placed in the ponds where they will stay for 4–18 months and grow large enough to survive the migration to the sea."

Based on the number of smolts (fish ready to go to the sea) produced in 1975 and past records of survival, Dr. Cleaver predicts that over two million fish yielding over 18 million pounds of fish will result from the rearing programs in CRFDP hatcheries.

"The catch predictions are for NMFS-funded hatcheries only and do not include production from State, Corps of Engineers and power company-sponsored rearing facilities," says Dr. Cleaver. "We cannot make predictions for stations outside of NMFS funding, as we have no data on the success of their rearing programs. These include seven upriver hatcheries that have less favorable survival of fish they release."

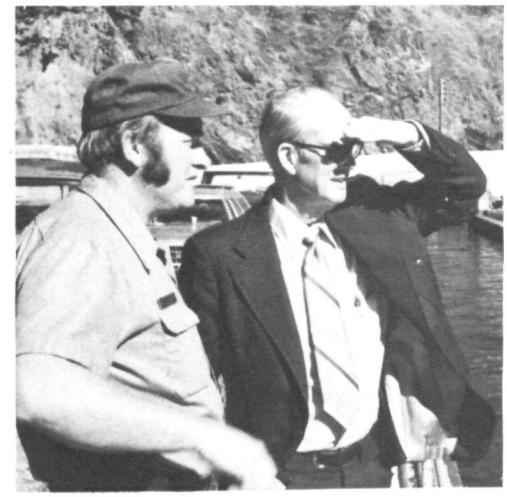
"Each of the four State fisheries agencies—Washington Department of Fisheries, Washington Department of Game, Oregon Department of Fisheries and Wildlife, and Idaho Department of Fish and Game—and one Federal agency, the U.S. Fish and Wildlife Service, operate salmon and steelhead trout production facilities within the Columbia Basin. Funding of the hatcheries, however, is more broadly based and often draws from other public or private sources such as the Corps of Engineers, NMFS and hydroelectric companies. For example, total expenditures for publicly operated salmon and steelhead hatcheries in the Columbia Basin in 1974 was $6,452,000; of this amount the States provided 8.1 percent, public utilities provided 17.9 percent, and the Federal government provided 74 percent. NMFS provided 41.6 percent, Corps of Engineers 23.2 percent and the FWS 9.2 percent.

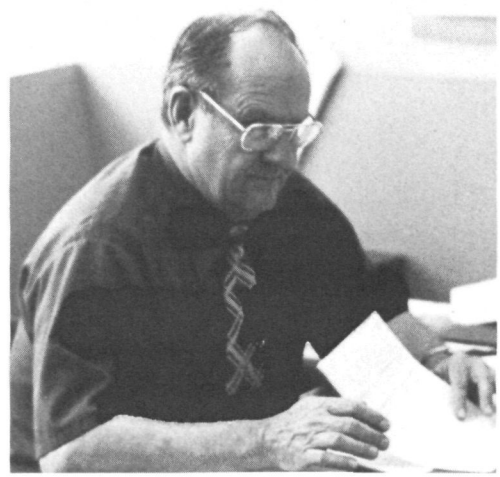
"We are very much involved in areas other than hatcheries," says Dick Pressey, assistant program director for the Columbia River program. "We have been instrumental in the design and installation of over 550 fish screens in the basin as well as the construction of more than 85 fishways."

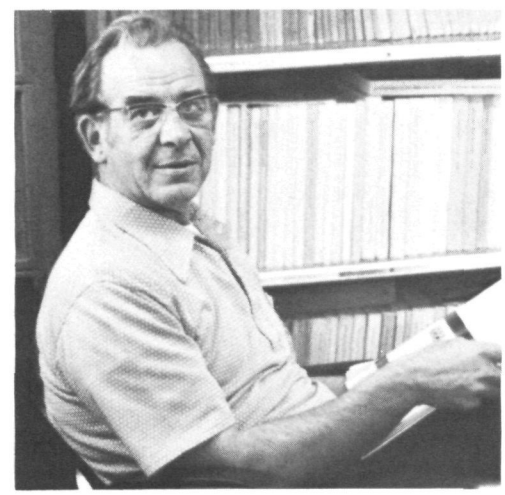
Fish screens are operated to prevent young migratory fish from entering deadend waterways when they head for the sea. "These water diversions are mainly for agriculture. State laws now require all irrigation ditches and other water diversions to be screened, but there is nothing in the law to require farmers to screen the old ditches, most of which were built in the 1930's," said Pressey.

The screens are large drum-like affairs placed at the entrance to a water diversion so that the small fish will not enter the area and become lost. They rotate slowly, dispersing the moss and other debris and permitting a free flow of water.

Recently a large multi-drummed fish screen funded by NMFS was completed and placed in operation by the Idaho Department of Fish and Game, on a large water diversion from the Salmon River near Challis, Idaho. In the past many thousands of young salmon were lost by entering this diversion. In the first month of operation over 100,000 young salmon were safely bypassed back to the river at this screen site.







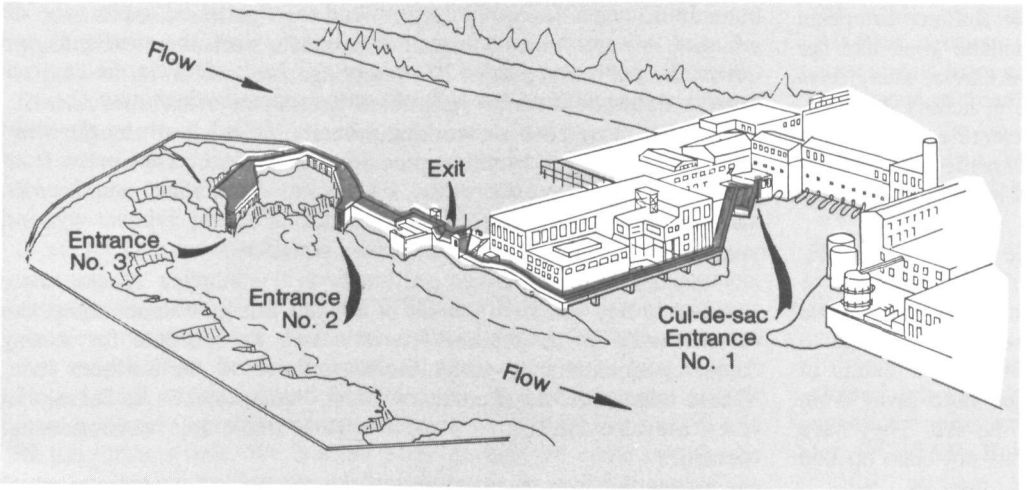
Linda Karlik, top left, Oregon Dept. of Fish and Game monitors video-tapes of fish in the Willamette Falls Fishway. Jack Bodle (l.) and Fred Cleaver, top right, at the Little White Salmon River Hatchery. Dick Pressey, lower left, and Chuck Wagner, lower right, of the NMFS Portland office.

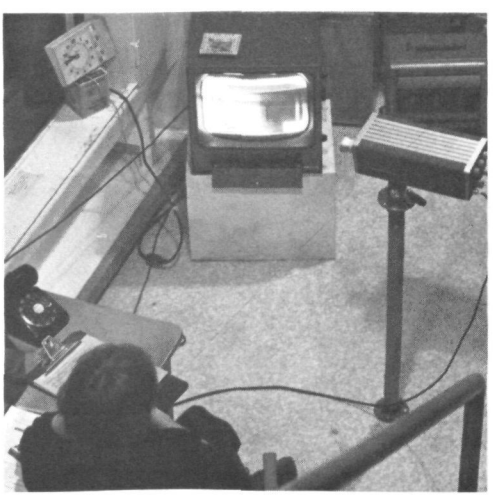
"The Mitchell Act directed the Secretary of Commerce to construct and install devices in the Columbia River basin which would permit the migratory fish to move easily over obstructions to their spawning grounds", says Charles Wagner, an engineer who works in the Fish Facilities Section of the Portland office.

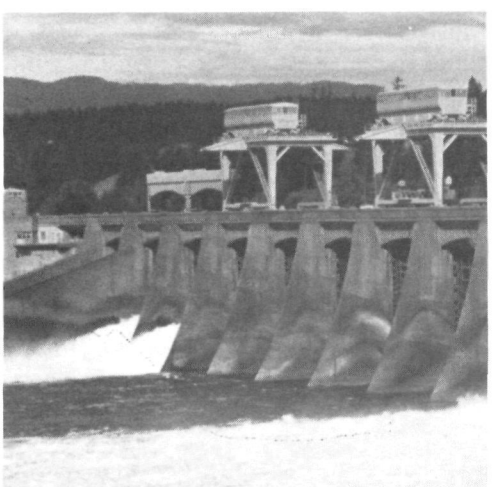
The primary responsibility of this section is to assist in developing functional designs for fish protective facilities at Federal or Federally funded water development projects and at projects licensed by the Federal Power Commission. The section is concerned primarily with projects in the Columbia River Basin but frequently aids in designing fish facilities for projects throughout the country.

"We assist in developing design criteria for fish ladders, fish collection systems, and by-passes that are required to safely pass adult and juvenile anadromous fish over dams and other obstructions," says Wagner. "We design fish screens that are required to prevent juvenile salmonids and other fish from entering water diversions such as irrigation canals and pumping plants and design fish collection, holding and transportation facilities at dams and fish hatcheries. We also inspect these facilities during construction and after completion to be sure they are constructed as planned and operate satisfactorily," says Wagner.

Providing fishways to pass fish up over dams, operating bypass facilities at dams to divert small fish around the turbines and installing fish screens to prevent fish from entering water diversions do not resolve all of the fish protection problems arising from water resource development in the Columbia Basin. The changes in the riverflows resulting from the operation of dams for power production, irrigation, and flood control can have serious impacts on adult and juvenile salmon populations unless efforts are made to protect these fish during critical flow periods. Wagner serves on a special committee established in 1975 to coordinate the operation of dams in the Columbia Basin to provide the best survival conditions possible for juvenile and adult salmonids during their migration to and from the ocean. The staff







Willamette Falls, top, showing entrances to the fish ladder. TV equipment monitors fish passing the fish-counting window 24 hours a day. Water flowing through the spillways of Bonneville Dam.

has also been participating in planning studies to identify and evaluate the impacts of proposed future development of the Columbia River for power and irrigation on the fishery resource and to determine what type of operational restraints may be required at hydroelectric and irrigation projects.

Now, 86 fishways are being operated within the Columbia River Basin in Idaho (2), Washington (56), and Oregon (28). More than 100 logjams and other obstructions were removed from tributary streams, opening to fish many miles of new rearing and spawning areas.

New fish runs have developed above most of the obstructions that were removed or falls provided with fishways. Most notable of these is the sizable spring chinook run that uses the area above Shipperd Falls on the Wind River in Washington. This run was started by releasing hatchery fish above the falls. In some years, the run now totals 10,000 fish.

The largest fishway funded by the Service is at Willamette Falls, about 10 miles south of Portland at Oregon City. In 1975, it was a superhighway for 65,000 fish.

The falls, horseshoe-shaped and adjacent to a paper mill, have been a historic barrier to the upstream passage of fall migrating fish. Because of this natural barrier, a large part of the vast Willamette River system was not available to fall chinook and coho for spawning.

Repeated attempts were made from 1882 to open the river at all times of the year, but only with limited success. A fishway was first constructed in 1904; despite revamping over the years, it failed to provide reliable passage upstream.

"The new fishway was started in 1967," says Wagner. "It took about four years to build at a cost of approximately $3.6 million, and is approximately one-half mile long. It is unusual not only for its size but also because it is covered. It was built that way because there are times during the year when the river flows completely over the fishway."

Construction of the total fishway required the excavation of approximately 10,000 cubic yards of material, mostly rock and the placement of approximately 21,000 cubic yards of concrete. It consists of three entrances and ladders that merge into one central passage, a control section and an exit to the waters above the falls.

Counting facilities have been designed into the upper end of the fishway to provide information on the number and species of fish that move through the fishway. They have an underwater window and automatic TV video equipment which records the fish as they pass by the window. As the fish move by the window they are recorded automatically, to be played back at a more convenient time for counting. Individual video pictures can be studied to record marked fish, obtain size and definitely determine the species.

"Gas bubbles and passing through the dam turbines are two other problems that are affecting the number of small fish in the Columbia River that reach the ocean," said Dr. Cleaver.

"At times when the flow of the river is high, it is necessary to permit some of the water behind the dam to flow over the spillways rather than going through the turbines," says Cleaver. "When this happens the water becomes supersaturated with atmospheric gases which are lethal to the small fish. To combat this, the Corps of Engineers has installed spillway deflectors at most of its dams and the problem is coming under control. These deflectors are concrete sills placed near the base of the spillway to direct the flow of the water horizontally into the stilling basin at the bottom of the dam. The lateral deflection of the water prevents deep plunging action where air entrapment takes place."

Two means are used to prevent the small fish from going through the turbines of the dams. One is to transport the fish by truck from above the dams to the lower Columbia where they have free passage to the ocean. The National Marine Fisheries Service, conducting this experiment since 1970, has found that during low flow years, when most of the water and fish pass through the turbines, the benefits are great.

The fish are raised in the hatcheries above the dams, released in the ponds in the river, removed from the river, transported by truck hundreds of miles downstream past all of the dams and released. Right on schedule three to four years later, those hatchery-raised fish appear at the hatchery after swimming upstream through hundreds of miles of water they bypassed when they were transported by truck. Hauling eliminates losses at turbines, from gas super-saturation and from delays as the fish pass the eight dams between the Snake River tributaries and the ocean.

To combat the problem of the small fish going through the turbines, screens that divert the small fish through safe passages have been installed and have increased the survival rate considerably.

The stocks native to the lower part of the Basin have increased sharply in the past 15 years, while those of the upper part of the Basin have continued to decline. The increases have come mainly from hatchery production; The declines are due either to direct or secondary effects of dams.

Since the Columbia Basin has the capacity, through artificial propagation, to produce additional fish over replacement level authorized by the Mitchell Act, the future of the program could include increased production above the required mitigation level. If this occurs, man will have been able not only to protect, but also to restore some of the conditions of the natural environment. □

RUSSELL McMillan is the only trace of the summer campaign in Kotzebue, and in a day or two he will be gone like the others, back southward across the Arctic Circle, away from the harsh hint of winter that has begun to move in across the steel-colored waters of the Sound. He is part of a scientific army in the field, and shares his colleagues' preoccupation with life and environment. He, and they, have been drawn northward by an uncommonly mobilizing term: *oil*.

Oil has drawn another multitude of people to the northland. They live the harsh life of the oil camps in Deadhorse and Prudhoe Bay. They have driven a pipeline large enough to ride a motorcycle through from the North Slope down through the Brooks Range to Fairbanks and Big Delta, and across two more jagged bands of mountains to a terminus at Valdez, just a narrow fjord away from the deep channels of Prince William Sound, and the sea. They have opened the Arctic as that roadless, barren land has not been opened before.

But, given the search for greater independence in energy production, North Slope oil is not enough. These searchers for petroleum must look beyond the relatively shallow wells now producing, to the deeper waters and deeper wells of the outer continental shelf.

To the rest of Alaska.

In a unique and ambitious prelude to offshore oil exploration off Alaska, a legion of environmental scientists work the shelflands and intertidal pools and rugged littorals of this land; studying the environmental consequences—or lack of consequences—which may occur.

They move to their working grounds, pulled north by the short Alaskan summer or by the winter deadliness of ice. They come from Seattle, Bellingham, Corvallis, Fairbanks, Anchorage, and Juneau, Berkeley and Boulder, and the other Federal laboratory and university towns and industries across America.

Instead of the eternity one needs to contemplate Alaska, there are barely five years. In pursuit of national energy independence, the Department of the Interior has advanced its schedule for leasing outer continental shelf tracts, including those off the northern state. These tracts are the Bureau of Land Management's to lease, but they are also BLM's to protect against intolerable environmental penalties.

In Alaska, the tracts holding some promise of oil cover much of the continental shelf: the wide platform along the northern rim of the Gulf of Alaska, the narrow shelf along the seismically violent Aleutian Trench, the broad, biologically wealthy Bering Sea, the ice-dominated coastal domains of the Chukchi and Beaufort Seas. Until now, none of these had been studied systematically, and such information as there is diminishes sharply as one moves north. This

The first great environmental investigation of the Far North is under way

Report from Alaska

BY CARL A. POSEY

is the difficult setting in which OCSEAP, the Outer Continental Shelf Environmental Assessment Program, conducts the baseline effort in Alaska. It is managed for BLM by NOAA's Environmental Research Laboratories, where the strategy of mounting such a broad investigation began a sudden evolution three years ago.

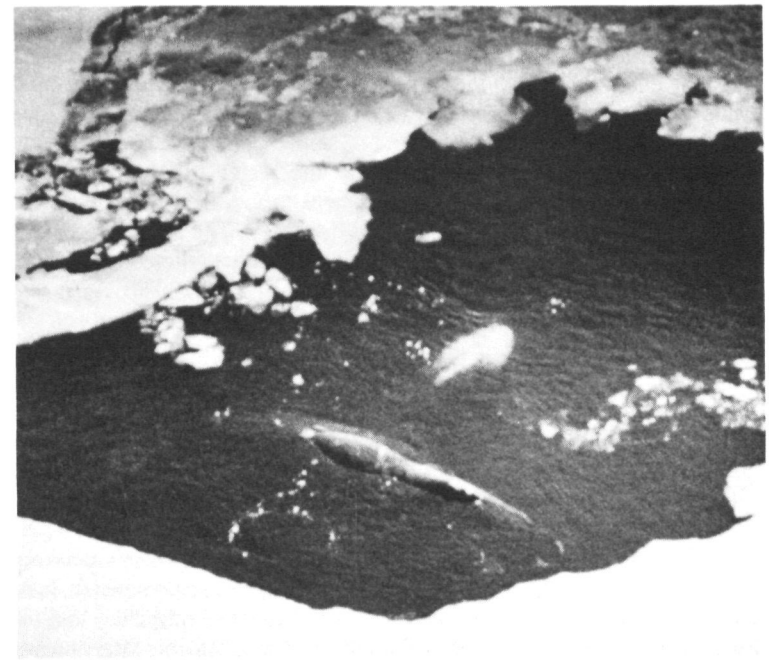
"This program didn't appear gradually," says Dr. Rudolf Engelmann, OCSEAP director. "It came up as quickly as the term, 'energy independence,' and it had no predecessor projects on which to model such an investigation. The work itself is mostly done under contract by scientists in universities and other federal agencies, although there are a number of NOAA projects too. Our first year we were running more than a hundred contracts, covering subjects that ranged from seismic hazards to Gulf currents to bird counts. Now I think we've learned how to approach environmental assessment programs—programs intended to show us the environment and its life forms whole. We learned early on that we could not, in the time allotted to us, identify every consumer in every strand of the oceanic food web, or mark every species, or study every habitat. We have had to settle for a reconnaissance of unprecedented scope, in which we identify what is *crucial* in terms of species, ecosystems, habitats, and relate those elements to the probable impacts oil development will bring."

It is reconnaissance, but reconnaissance on the grand scale. And yet, while the program is large in every sense, it is dwarfed by the Alaskan setting, reduced finally to a pair of scientists digging crustaceans from a northern beach, to Russell McMillan taking a last look seaward from Kotzebue—a program of innumerable vignettes.

There are no roads to Barrow, and the ice permits a seaward approach only a few weeks of the year. Access to this settlement at the very top of North America is from the air, so that the buildings and Will Rogers-Wiley Post Memorial Airport seem to materialize out of the dusky tundra and gleaming ponds and ice-dotted northern ocean. Beyond the village, the land narrows and hooks to a literal land's end in the Beaufort Sea.

Three miles north of Barrow village is the Naval Arctic Research Laboratory, a small enclave of yellow quonsets and an H-shaped lab-with-quarters facility and a small airport—a center of action for most science done in the Arctic, including science done for OCSEAP. But one seldom hears that acronym. People call it "OCS" up here. In 1976 there was more OCS work at NARL, as the lab is called, than anything else.

The year meant a lot to the entire Arctic side of the OCS effort. At the University of Alaska's Geophysical Institute in Fairbanks, David Kennedy, the logistics specialist for the OCS Arctic Project Office, tells why. "Last year things looked bleak," he says, referring to 1975, when the ice never moved away from the Beaufort coast.



Variety of wildlife in Bering Sea is indicated by seals resting on ice floes (left) and bowhead whale in "lead" or opening between ice sheets. Below, Alaska's huge continental shelf is shown in black on this NOS map.

"We didn't have the right kind of equipment, the ice didn't go out, morale was bad. This season is a kind of reward for what went wrong last year. With a little cooperation from the ice, it's come around nicely." Kennedy is an Arctic veteran, a former Air Force C-130 pilot with four years' flying into DEW-line sites and the Greenland ice cap. "Nothing else prepares you for work up here."

Kennedy and the other OCS project office people in Fairbanks are University of Alaska employees working under contract to the OCSEAP office in Boulder. NARL is a mixed Navy contract, with the University of Alaska providing administrative and logistics support, and the International Telephone and Telegraph Corporation—ITT—providing facilities and maintenance.

* * * *

Dr. Peter Connors' group is at NARL from the University of California's Bodega Marine Laboratory, studying the shorebirds that breed and summer here, and winter along the California coast. Connors and two colleagues have taken the Honda three-wheelers, fat-tired motor-tricycles that can negotiate the gravel banks and dunes of Point Barrow, out toward the hook of Point Barrow itself, setting up along a shallow lagoon that is quiet beneath a glowing cathedral of Barrow fog. They've been studying Arctic terns, flocks of which still probe the almost waveless sea for food. Today Connors is working with red phalaropes, pretty grey-white birds of great equanimity. The red phalarope breeds around the pole, Connors says, and is one of the species which are more than ordinarily vulnerable to the effects of spilled oil. The juveniles we see will eventually find their way to the waters off California and Chile. "They're very nice little guys," he says. A moment later one of the birds swims into the imaginary circle beneath Connors' hoop net and he lets it drop, then races to the water to disentangle the trapped bird, which he then weighs, measures, and marks. When he releases them they settle on the water nearby. "The adult birds have already flown. We want to see how long these juveniles stay up here before they head south." A pause, a look around. "These are just about all of the phalaropes in this set. A spill would wipe out the Barrow crop."

Birds are key indicator species in this environmental study. They feed (and supply nutrients in the form of droppings) at various intervals along the food chain, not just at the top or at the base, and they are highly visible—when something begins killing birds, you can see it. OCSEAP investigators have been taking the full avian measure of Alaska's coast and offshore waters.

The Bodega lab group is one string of twos and threes working out of NARL. Another group from the Alaska Department of Fish and Game is counting pack-ice birds, studying the migratory use of Arctic lagoons and lakes. They've had six crews up this year, crews that back-packed and camped around the coast and off-shore islands.

Off to the southwest, below the Bering Strait, the NOAA ship Surveyor's whaleboats and helicopter take ornithologists to the rookeries of King and Sledge Islands, and Bluff Point. Observers study birds from every OCS ship, and the dozens of intertidal parties do some bird work while they count the tiny life forms along the mean low water line.

In Anchorage, a broader view emerges from long, low flights by U.S. Fish and Wildlife Service observers aboard the Office of Aircraft Services' (an Interior Department airplane pool) "Aleutian Goose."

"We fly survey lines in areas that seem to be crucial for the time of year we're surveying" explains Craig Harrison, the wildlife biologist who leads the project. "We have a standard hundred-meter transect width, flown about forty meters off the water. If there's more than a 20-knot wind or seas rough from passing weather, we stand down." The long flights and the long tape recordings cut by the observers ultimately become maps of total birds, where they are, which are critical species. "We can categorize about ninety-nine percent of the birds we see." This information in turn is formatted for computer, and further analyses are run, including special work on high-interest or endangered species. "Seabird colonies are catalogued," Harrison says, "but at a fixed place. Usually if we can show a rock or an island our work has some weight. It's more difficult to show a patch of ocean, which, for many species, *is* the real habitat."

Irresistibly, the sense of the program loops around, linking the work with phalaropes at Barrow to the work of Surveyor, the flights of the orange-and-white amphibian, the tiny bird camps along the Arctic beaches.

* * * *

Dr. David Mason, part of the Western Washington State College group, is not flying today, but waits for the fog to lift because he plans a Zodiak sortie down the coast. The Western Washington teams, which include those finishing at Kotzebue, are one of the exceptions that characterize the OCS work here. The program solicited participation by requests for proposals, so much of the Arctic research naturally flowed into veteran Arctic hands. The group from Bellingham is an exception, and has developed something of a reputation for successfully ignoring the problems of working above the Arctic Circle. Mason, who has previous polar experience, describes their season. "We've mainly been doing intertidal studies, to get baseline estimates of what organisms live in the zone that would be most heavily impacted by oil.

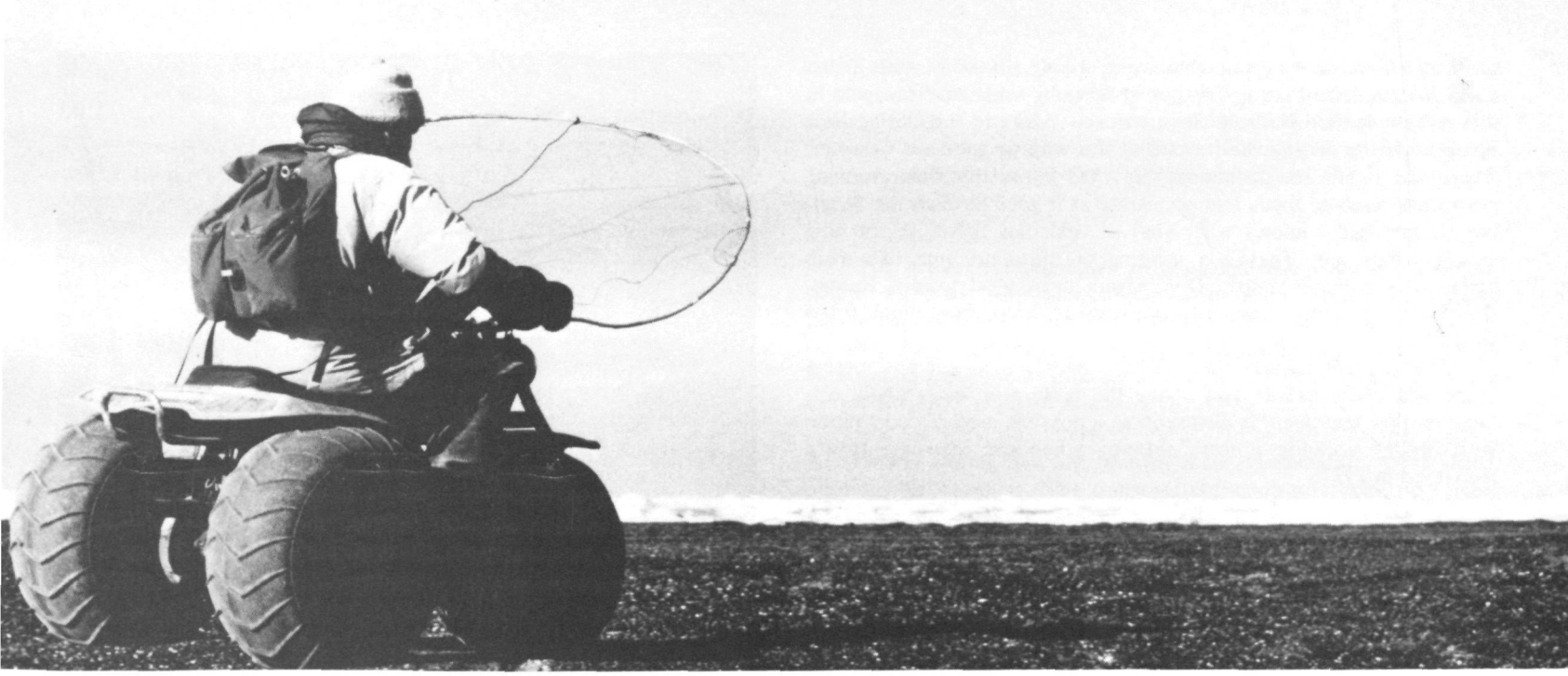
"At the same time, we've been doing a more general kind of survey from the air, flying most of the Arctic coast of Alaska at a hundred feet or so, to get a general idea of what lives from the intertidal zone to the storm surge line, which can be hundreds of meters inland of the beach."

Among Mason's strong impressions is one of resilient organisms. "We may have made too much of the fragility of the Arctic ecosystem," he says. "We've found more inhabitants along the beaches than we expected, because the beaches take such a beating from storm waves and ice through the year. Things that can survive here have to be cosmopolitan, like seagulls and cockroaches of lower latitudes. They can come in, live, and split before conditions become intolerable. They're opportunists. They have to be able to take their moment when it comes."

Now the glow outside the NARL building increases; the ceiling lifts a few tens of feet off the ground, and everyone begins mustering around trucks for a ride to the airport. The 180 carries two ornithologists back to their tent on Barter Island, the Twin Otter takes an ITT mechanic to a DEW line site at Oliktok, the single Otter, called "Dactyl," flies some intertidal experts out past Point Hope, the C-117 (the "Super DC3" of the late 1940's) flies another remote-sensing mission.

Remote sensing, as used by OCS projects here, means building bridges to larger worlds, placing measurements taken in an Arctic neighborhood into regional and continental contexts. The NARL C-117 is working partly for NOAA's Atmospheric Physics and Chemistry Laboratory, using Dr. Peter Kuhn's ubiquitous infrared radiometer system to measure ice age and thickness. The rest of the mission is for the Corps of Engineers' Cold Regions Research and Engineering Laboratory, or CRREL, measuring the low but rugged relief across pack ice with a laser profilometer. Terry Tucker, of the CRREL team, explains how the profilometer data fit with another CRREL project. "Last year we installed two radar sites on offshore islands down by Deadhorse, and then put seven transducers out on the ice. This gives us data on ice movement, which last year was much less than we expected. The profilometer gives us terrain roughness data, which we'll combine with the radar information to develop models of ridge-building."

Remote sensing pervades the OCS effort. At the Geophysical Institute in Fairbanks, Dr. Alfred Belon has become a point of confluence for a broad variety of data bits and images, which he is helping the other scientists turn into useful tools for the OCS studies. "We use infrared and visible images from the NOAA polar-orbiting satellites," he says, "and images from LANDSAT, which



Dr. Peter Connors of the University of California's Bodega Marine Laboratory speeds along gravel hook of Point Barrow, armed with bird-trapping net. Dr. Connors' group is studying phalaropes, terns, and other birds to determine how human activities affect their populations; they mark the birds after trapping, then release them to the natural environment.

looks at four spectral bands in the visible spectrum. We also get aerial photography, some from the Geological Survey, some from the NASA, Electra and U–2 and any opportunities—when the NOAA Buffalo photographed the Shelikof Strait we got some of that.

"Satellite data show sea ice mammal habitats, although you can't see the animals themselves, and pressure ridges and the dynamic changes in the ice pack with the changing seasons. We want to bring these techniques into the world of environmental research."

* * * *

Satellite images of the Beaufort sea coast, received in the short summer at Barrow, would show the ice offshore, pushed there by the winds so that a band of open water about twenty miles wide opens between the pack and the coast. This thin band of water becomes the ocean for OCS oceanographers, who had slim pickings in 1975, and who in 1976 were impatient to return to sea. So they are out on what platforms they can find, taking their physical, chemical, and biological looks at a world usually hidden beneath the ice.

A hundred miles east of Barrow the Geological Survey boat Karluk is pulling permafrost cores from the sea floor, and trying to get some handle on the unfamiliar hazard of ice-gouging from sonar scans of the rough footprints ice makes across the bottom. USGS people, and colleagues in universities, are more or less majoring in hazards. In the quintessential earthquake country of the northern Gulf of Alaska, the emphasis is on seismic hazard, and tsunamis, unstable sediments, vulcanism, and such other difficulties as nature can present an offshore platform. But up here, the hazards have to do with ice, and Karluk is in slow but steady pursuit of them.

She is more or less accompanied by one of the unlikeliest of oceanographic research vessels, the all-aluminum warping tug renamed Alumiak, after her conversion to science. She lies low in the water off the point at Oliktok, at 22 by 85 feet configured like an outsized tennis court. Alumiak displaces 67 tons, and draws only two feet of water.

A party has flown down to the DEW-line station runway with an ITT mechanic from NARL to repair some hydraulics on the ship, which is in her Beaufort Sea shakedown. Jack Mellor, executive officer at NARL, is along, feeling a more than casual interest in the craft. Now, looking across a windy, white-capped sea toward Alumiak, which has launched a Zodiak toward land, he explains how she came to be.

"We needed a large oceanographic research platform up here. We had an LCM for a while, but she had a wooden hull and just couldn't operate in the Beaufort. Then we heard about this warping tug, which seemed a reasonable design, and the conversion didn't look terribly expensive. The OCS people said they'd like to pursue it. So we worked up a modification that would make her useful to oceanographers and had the changes made. She's only just begun work, and so far looks very promising."

The modifications include the addition of a charthouse and a small wet lab, and berthing space, to make the vessel more than a day boat. Navigation and communications systems are replete. A bow A-frame can handle six tons, and a two-ton hydraulic A-frame with an outboard platform and oceanographic winch permits conventional instrument casts from the starboard side. Now, in the shallow Beaufort off Oliktok, she carries people who are looking through the transient opening to the sea, taking bottom grabs and water samples, bits and denizens of the littoral, bird observations . . . whatever can be grasped in the short seasons, from such a ship.

* * * *

In the presence of some detail of this project, there is always a sense of work proceeding somewhere else, of intentions strung across great distances. A group on the beach at Oliktok. To the east, perhaps twenty miles north of Deadhorse, the fog has ridden a south wind seaward, and the Coast Guard icebreaker Glacier moves her tough hull delicately through the turquoise mush and shrunken bergs along the fringes of the pack. Marine mammal specialists mark seals this day, benthos scientists scratch at the seafloor beneath the ice for samples, others lower sediment grabs and density instruments through the shattered ice, probing a world a human never sees.

Two hundred miles to the west, the NOAA ship Discoverer hovers on the Chukchi Sea, while oceanographers build a current-meter string alongside to drop into this equipment-eating environment, where it must measure the movement of water beneath the ice—movement no one has measured before. Robert Charnell, a physical oceanographer at NOAA's Pacific Marine Environmental Laboratory in Seattle, explains the benefits, and the difficulties. "We

have so little data to go on that we're taking a kind of stab in the dark. We want to take a first cut at learning what the transport in this current system is, from St. Lawrence Island in the Bering Sea, up through the Bering Strait, and all the way up into the Chukchi. There are significant questions here. We know the water moving northward tends to focus and accelerate as it goes through the Strait, but no one really knows what kind of velocities there are, or how seasonal they are. There's a splitting of the water into two main currents as it moves north. One stream turns west toward Russia, the rest turns toward the east. We want to know how much flows which way."

The current meter study, which uses single current meters suspended about twenty feet above the bottom in water about one hundred fifty feet deep, is also seen as a possible area of cooperation with Soviet oceanographers, perhaps when the instruments are recovered in 1977.

"We have the meters deep because of the ice," Charnell explains. "The problem is that while you have relatively thin new ice in the pack, some of the old ice in the form of large chunks gets caught in the new ice. So you have a thin layer over the whole surface with these big ice blocks extending in some cases almost to the bottom. The Canadians put out nearly 20 current meter stations in the Beaufort Sea a while back and when they tried to recover them they were able to find pieces of three, they were ground up so badly.

"In March we'll be taking helicopters out on the ice near our current-meter stations, poke holes through the ice, and take some density measurements with portable CTD [conductivity-temperature-depth] instruments. This will help us tell whether water movement near the current meter is representative of water motion near the surface."

As the current meter string slips toward the hundred-fifty-foot contour of the Chukchi, Surveyor, to the south, launches a whaleboat in which College of the Atlantic ornithologists steer around the sheer puffin and murre rookeries of Bluff Point, while biologists from the Auke Bay fisheries laboratory dive for subtidal samples. From the trampoline-like platform on the ship's afterdeck, NOAA's Bell 206 clatters out and back, ferrying scientists to their lonely work.

And even then, the NOAA ship Miller Freeman, churns northward from Seattle, her great trawls and gill nets poised to sample the rich Bering, the smaller treasures of Norton Sound.

And then, the University of Alaska's Acona works the waters of Lower Cook Inlet, and Moana Wave, from the University of Hawaii, explores Prince William Sound.

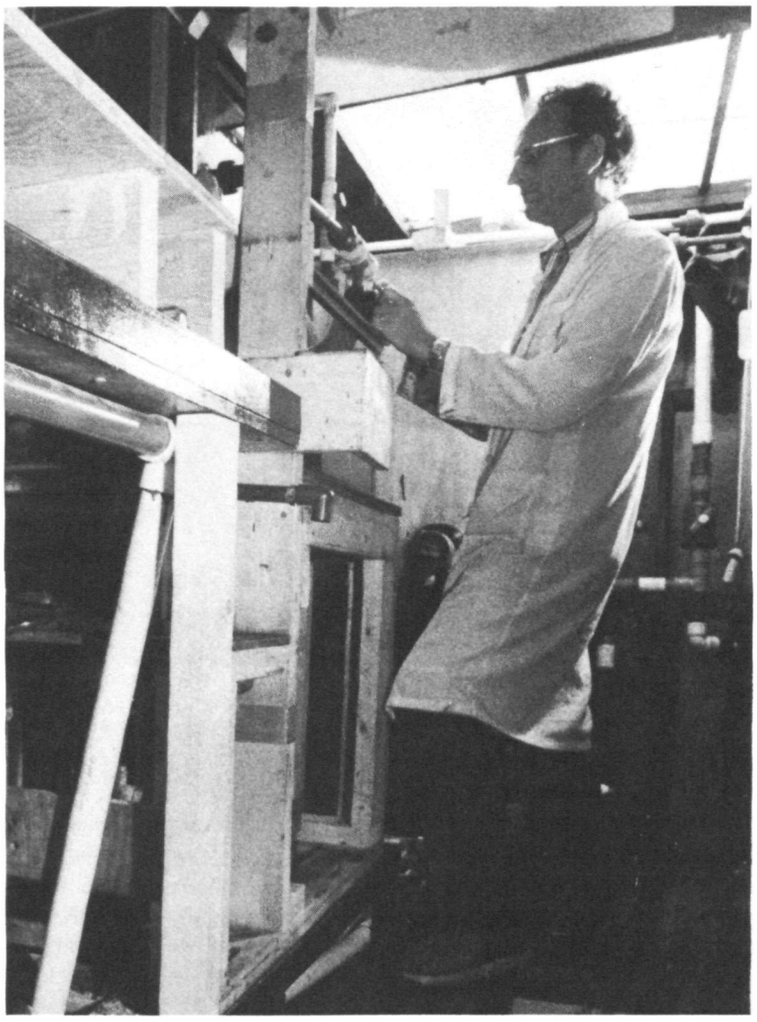
* * * *

The sun takes the short season with it; the narrow gap between shore and ice mends quickly in the winter cold. Barrow disappears in snow and cold fog, and ice, the true ruler of this northern world, regains its kingdom.

Winter reveals the scientific love affairs with ice, the ice habits, the possibility of being hooked by ice, charmed by it, unable ever after to look away. Dr. Gunter Weller, who directs the Arctic portion of the OCS work from the University of Alaska's Geophysical Institute in Fairbanks, talks about ice, and oil, and how one never quite finishes with this frozen world.

"You have that strange substance called sea ice here, which makes environmental assessment in the Arctic completely different from such work anywhere else. It makes life difficult for us. Later on it will make life difficult for the oil developers.

"The difficulty of ice work is legend, of course. But it isn't just that it's cold and you have frozen fingers and work that takes five minutes in Miami takes an hour on the ice. It's also that you're on a very thin veneer spread over a deep ocean. It buckles and moves around. Floes split down the middle of your camp, runways are severed. In the Arctic, you have terrible conditions for aircraft. And you're isolated.



Dr. William Roubal of NMFS Seattle adjusts flow of Prudhoe Bay crude oil into aquarium tanks in Mukilteo, Alaska, to see how various marine species react to varying levels of hydrocarbons (above). In Seattle, NMFS scientist Dr. Donald Malins examines output of mass spectrometer used to measure trace quantities of hydrocarbons in water, sediment, and organism samples.

"I suppose you have to be a little bit crazy to do it. But you get hooked on it, and go a little crazier from year to year."

Weller sees formidable problems connected with drawing oil from the Arctic outer continental shelf. "No technology exists to develop Arctic oil offshore of the 20-foot contour, where you're still working down through shore-fast ice, not pack ice. People talk about monopods and gravity structures, but these haven't been developed.

"And you have scenarios of well blowouts under the ice. For example, the Canadian assessment shows that a drill-ship blowout coming at the end of summer would make it impossible to seal that hole. The ice comes in, the well keeps pouring oil into the marine environment, and it does this all winter long. Then, if you have ice conditions like we did in 1975, the ice doesn't move offshore in summer, and you have another full year of continuous blowout from this one well. The pollution would be incredible."

Ice pervades the OCS work as it does the Beaufort. There are studies of ice gouging, ice dynamics, ice chemistry and composition, ice motion, ice climatology, as recorded in the logbooks of 19th century whalers and revenue cutters.

Downstairs from the Arctic OCS project office at the Institute, Dr. Lewis Shapiro has a fair share of these under his wing. He has been "in ice" about three years. "I don't know just how it began," he says. "You'd sit down and begin talking to somebody in another discipline and find you had ice in common. Ice is the dominant, defining feature of the Arctic. It ties environments together.

"I'm a geologist, and I got interested in ice when I was working in rock deformation. I moved to glaciology, and then got into sea ice.

"It's an unusual sort of material. You're always dealing with it close to its melting point, where any crystalline material presents special problems. We're trying to measure its properties *in situ*, to reduce the changes caused by handling the sample." He holds up a steel envelope about the size of an attache case. "These are flatjacks. We load them with compressed nitrogen, they expand and stress the ice. We measure what the ice is doing with strain gages."

Shapiro notes that ice doesn't just change properties with temperature, but that it changes in structure from the top of the ice to the bottom of the ice sheet.

"At the surface the crystals are fine and randomly oriented. Then as you go through the sheet they become oriented, and larger, so that the bottom is essentially a large single crystal. In a meter or two you've gone from one material to a completely different one."

Most interesting, he feels, is the special relationship of native animals and humans with sea ice. "Eskimos really know the ice. Not in a purely observational way, but the processes involved. They know about capillary action and how it changes the frost table. They're very careful observers. Eskimos see subtleties in the ice we don't. Sometimes I think if a good Eskimo hunter with a Ph.D in mechanical engineering came along, the rest of us could go home."

Shapiro is also working with Dr. John Burns of the Alaska Department of Fish and Game to try to view ice more or less from the perspective of the animals who use sea ice as breeding ground, dormitory, nursery, and transportation.

"Over the years," he explains, "biologists have realized there's an identifiable pattern for some marine mammals. Some animals are associated with certain areas of ice at certain times of the year. Ringed seals den up mainly on landfast ice. That's their critical habitat. Spotted seals seem to prefer small ice cakes. Walrus like it where the ice is breaking up, and their young are born during the spring migration, and ride the ice north. Whales follow the leads that tend to open at certain times. Ice dominates all these life cycles.

"My point is, these animals *classify* ice somehow. How do they do that? And how do we identify the same features in satellite images?"

In Seattle, marine mammal scientists from NOAA's Northwest and Alaska Fisheries Center prepare to put out two field stations.

"One will be at Barrow, the other at Point Hope," says Dr. Howard Braham. "They'll be ice camps eight to ten miles off the coast along the leads. We'll hike out or take snow machines. We'll photograph bowheads when they migrate up the leads, and the seals, from late April to early June. Marine Mammals Division personnel will also be doing some work with the native harvest of bowheads. It's very difficult terrain, but . . . very attractive."

* * * *

The project factors down to pairs and trios, doing the natural historian's lonely work along the Alaskan beach, aboard ships out in the Bering and Chukchi and Gulf, while ornithologists like the Drurys continue their lifetime career censusing Bering Sea rookeries, and the Hunts endure the cloudy inhospitality of the Pribilof rookeries, and the Connorses mark phalaropes and Arctic terns.

And as they do, intertidal parties from ships in the Gulf of Alaska and Bering Sea are running their transects along that hard, interminable shoreline. The transects are made to survey tidal lines, where sampling boxes perhaps a quarter of a square meter in area mark the little world to be picked clean of its plant and animal inhabitants.

The Miller Freeman draws whole marine civilizations from Norton Sound, and biologists in her labs probe the captured creatures' stomachs, health, weight—biological shorthand for the vital signs of an ecosystem.

Farther north, biologists aboard Discoverer take a Zodiak to the edge of the advancing ice pack, to sample microscopic plants and animals that bloom there, and where larger creatures come to feed.

The study goes down and down, from trophic level to trophic level, from seagulls and murres and shearwaters to salmon, crabs, the flinching bivalves on a coastal rock, the northern microorganisms. . . .

Dr. Herbert Bruce leads the OCS work in the Gulf of Alaska and Bering Sea. His Juneau office is the southern corollary of the Fairbanks Arctic group, but it is larger, housed in Juneau's federal building, the largest structure in this tiny capital city. A few miles west of here is the Auke Bay Fisheries Laboratory, where Bruce, an oceanographer, served as deputy director. He has spent his share of time working on fisheries and oceanographic problems.

"In the Bering and Gulf," he says, "we're improving very significantly on the data base used for understanding the distributions and interrelations of important commercial and recreational species, and also improving our understanding of ecologically important life forms, such as forage fishes. We're beginning to identify critical life stages and critical habitats, which, if severely impacted by OCS oil and gas activities, could cause major ecological damage and even doom certain important populations, like salmon.

"I don't regard petroleum development as an inevitable enemy. I'm confident that if we do our work properly the petroleum industry will be able to carry out its OCS development activities so as to avoid widespread ecological damage. In my opinion, the technological capability is there. It's mostly a matter of applying it with full understanding on the part of both industry and government that all necessary measures will be taken to protect the marine environment and its life forms."

As the Fairbanks office is mainly linked to aviation, the Juneau office is pre-eminently a ship-scheduling activity, and this makes it both larger and more inward looking. Where Fairbanks looks principally toward contractors, Juneau is largely concerned with tapping resources within NOAA, mainly in the form of ships.

In fact, the ships from the Pacific Marine Center in Seattle loom large here, if in a land this large anything can be said to loom at all. The Discoverer, Surveyor, and Miller Freeman are so-called "energy ships," liberated with money allocated to the pursuit of energy independence from the mothballed spell in which they slumbered.

Nearly ten years ago, when Discoverer first came on the line, the accent was on the broad spectrum of her capabilities, the environmental studies she would be able to do. Now she works along the ice edge, scientists aboard conduct marine mammal

studies, take physical oceanographic data, look at zooplankton and microorganisms, and send divers down into the cold ocean for sediment cores from under the ice. In Alaska, this incomparable ship has come into her own, doing work today she was designed to do a decade ago.

* * * *

"One of the things we have to be able to do here," Bruce notes, "is understand how much perturbation the marine environment can undergo before unacceptable or irreversible ecological damage occurs. So we need to know what important ecological elements are most vulnerable to probable impact, what their sensitivities to oil pollution are. We also need to know the existing concentrations and distribution patterns of hydrocarbons and trace heavy metals in the environment. Only with that information will we be able to predict with any degree of reliability the probable effects of hydrocarbons introduced through spills and blowouts, and from smaller, chronic inputs. And then we should be able to develop a reliable and practical monitoring program through which the ecological welfare of the Alaskan outer continental shelf can be determined during the lifetime of oil and gas production there."

At the University of Alaska's Institute of Marine Sciences, a mineshaft-shaped modern structure next door to the Geophysical Institute houses bright new laboratories with supergraphicked walls. In those cheerful surroundings, scientists are pursuing the millionths and billionths used to express the quantities of hydrocarbons and trace metals one finds in an environment still largely untouched by humankind.

Dr. David Burrell has the heavy metals side of this work. "Heavy metals are the only natural water pollutants known to have resulted in human fatalities," he says. "But they cannot exist in high concentrations in sea water. There are too many efficient ways of removing them, so they're rare in solution. Mostly they go into sediments. Our concern is that petroleum drilling could release metals from this sedimentary reservoir. Petroleum development also means more metals in the environment. We get vanadium and nickel in crude oil, and a lot of water comes up with the oil that also carries metals. The platforms with their paint, corrosion, and so forth add metals. So do drilling muds."

Burrell and his coworkers at Alaska have been applying the analytical state of the art to measure the small quantities of copper, cadmium, lead, mercury, nickel, vanadium in water samples, in sediments, and in some animals. "There's no ideal way to make these measurements. The quantities are very small, of the order of fractional parts per billion in the water, and of parts per million in the sediments. Measuring such quantities is an area of research itself. We're really at the frontier."

This frontier threads through the OCS study. Upstairs from Burrell's lab is Dr. David Shaw's. Concern there is with the organic, hard-to-quantify values of hydrocarbons as they exist in the Alaskan environment today—baseline hydrocarbons—and as they are added by such events as a tanker aground and leaking JP-4 into Cook Inlet.

The frontier runs down to Seattle, too, where Dr. Joel Cline at NOAA's Pacific Marine Environmental Laboratory is tracing light hydrocarbons (like methane) through Alaskan marine ecosystems. In the evolving lab facility at Sand Point, a hydrocarbon measuring system has been fielded that, if it does not given them the precision available in a fixed lab ashore, permits them to run chemical reconnaissances of the northern sea, filling a huge blank page labeled "Ocean Chemistry."

The NOAA National Analytical Facility, part of the Northwest and Alaska Fisheries Center's Environmental Conservation Division, is directed by Dr. Donald Malins, who, like Burrell, echoes Britain in his speech. The facility has sprung from work begun at the Center several years ago. It got started in mid-1976 with equipment money from the Environmental Protection Agency, and now runs hydrocarbon measurements for both the OCS physiological programs and NOAA's marine ecosystem study in Puget Sound.

The work—the actual analyses—is, like the hydrocarbon work in Fairbanks, state-of-the-art. "We have at our disposal the most advanced, sophisticated instrumentation for determining levels of hydrocarbons at the nanogram level," he says, referring to their ability to find one part of hydrocarbon in an billion parts of something else, working with a one-gram sample. A column chromatograph lets them isolate total hydrocarbons, which are then sorted into individual hydrocarbon molecules on a gas chromatograph. Then their absolute structure is determined by analysis with the mass spectrometer.

"The facility has been located in our Environmental Conservation Division because physiological studies here complement the analytical work. That is, we also want to determine what the hydrocarbons do to marine environments, organisms, and ecosystems." Malins and his colleagues have set up experiments in aquaria at the Manchester aquaculture facility across Puget Sound, and up at Mukilteo, where a large truck-trailer holds aquaria into which toxic aromatic hydrocarbons—at the moment, those contained in Prudhoe Bay crude—can be added in varying quantities.

"We're working with salmonids, flatfish, and shrimp. We find that crustacean larvae may be of particular importance in setting acceptable hydrocarbon levels. Spot shrimp larvae, for example, are killed in a day or two by about ten parts per billion of naphthalene.

"Salmonids in low-level exposures—of the order of parts per million—tend to concentrate aromatic hydrocarbons in some tissues, but they get rid of them when they're moved to clean water. We are attempting to pinpoint whether any major changes in life processes occur.

"But further work is badly needed. Some organisms, like salmon, transform hydrocarbons into other compounds. Research on aromatic hydrocarbons suggests that such metabolic products can cause tissue and other damage. So our problem deepens here. We have to be concerned with metabolically produced molecules that may be more toxic than the parent hydrocarbons themselves."

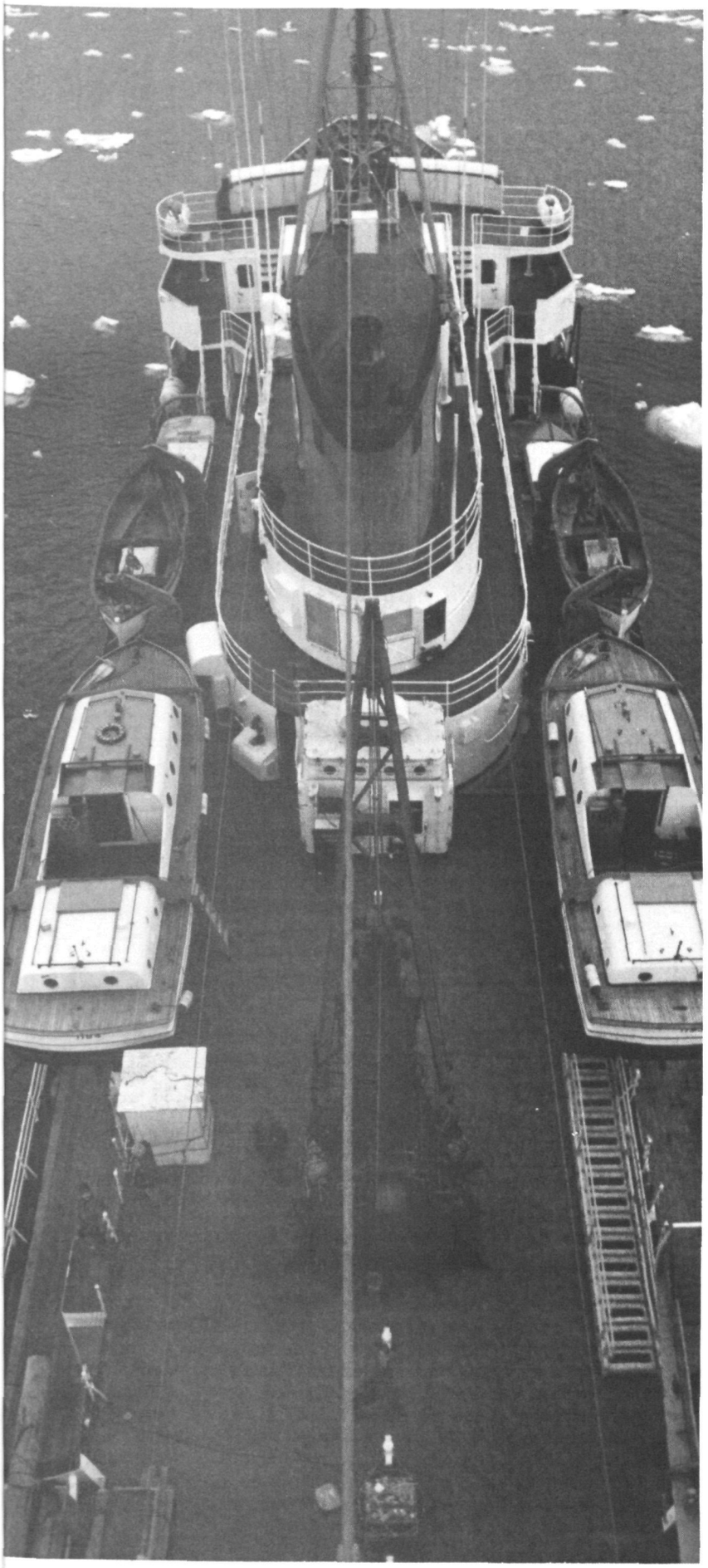
* * * *

Oil presents difficult problems everywhere it connects with the marine environment. In the converted apartment building where the Pacific Marine Environmental Laboratory has some of its offices, an unusual modeling effort is trying to make those problems less difficult. Dr. Jerry Galt is applying the art of simulating natural processes numerically to solving immediate problems. "We're using models," Galt says, "to help interpolate between points of observation, and to improve communications. You can design models that let a highly specialized group—say, physical oceanographers—talk to groups with other specialties. Models also let you go beyond your data base to investigate situations you have not been able to observe."

One of the unusual qualities of the Seattle models is that they are applied in almost a tactical sense, bringing immensely complicated instruments into the hands of people at the front lines. To see how this tactical support works, when it works well, and why observations and modelling are two faces of one coin, one finds an excellent example in the gyre near Kayak Island.

In mid-1976, the first lease sale areas in the northeastern Gulf of Alaska were announced by the Department of the Interior. Even as they were being announced, however, Galt and his colleagues had begun scrutinizing data for an area west of Kayak Island, where the Copper River flows into the Gulf. LANDSAT imagery showed sediment plumes from the Copper River moving in a large circular pattern—a gyre. At the same time, data from a string of current meters set out in the Gulf showed what appeared to be a segment from a current following the curves of the bathymetry. The question then was to relate observations made directly, by current meters, to the circulation patterns inferred by the remote imagery.

"What you do," Galt explains, "is use the model to explore the possibilities. We had this conventional view of currents there, but the model let us ask questions like, "what would the currents be like if we took out the Copper River, or Kayak Island? The model



NOAA ship Surveyor: looking down from mainmast as she sailed the Bering Sea in late spring cruise.

indicated we had a counterclockwise gyre that would carry any contaminants back up into the Copper River delta and Prince William Sound."

Based on this evidence, Interior withdrew sixteen tracts in the area swept by the gyre—an expensive decision to base on a model. The gyre itself was not observed directly until late last summer, when satellite-reporting drifters moved through a pattern that virtually traced the model's view of circulation there. "Naturally," Galt says, "I was glad to see those tracks."

One change the Kayak Island events brought has been a closer day-to-day working relationship between Galt and people who use his model results in the Interior Department. But he is conscious of being driven a little by the lease schedule. "We're set up sort of like a flying circus. We've been working very hard on the Gulf. Now we're focusing on Kodiak. Each time we move farther north our information base deteriorates a little more. Around ice, there isn't even an agreed-upon way to write equations."

Nor is much known about equation-writing when oil is on the water.

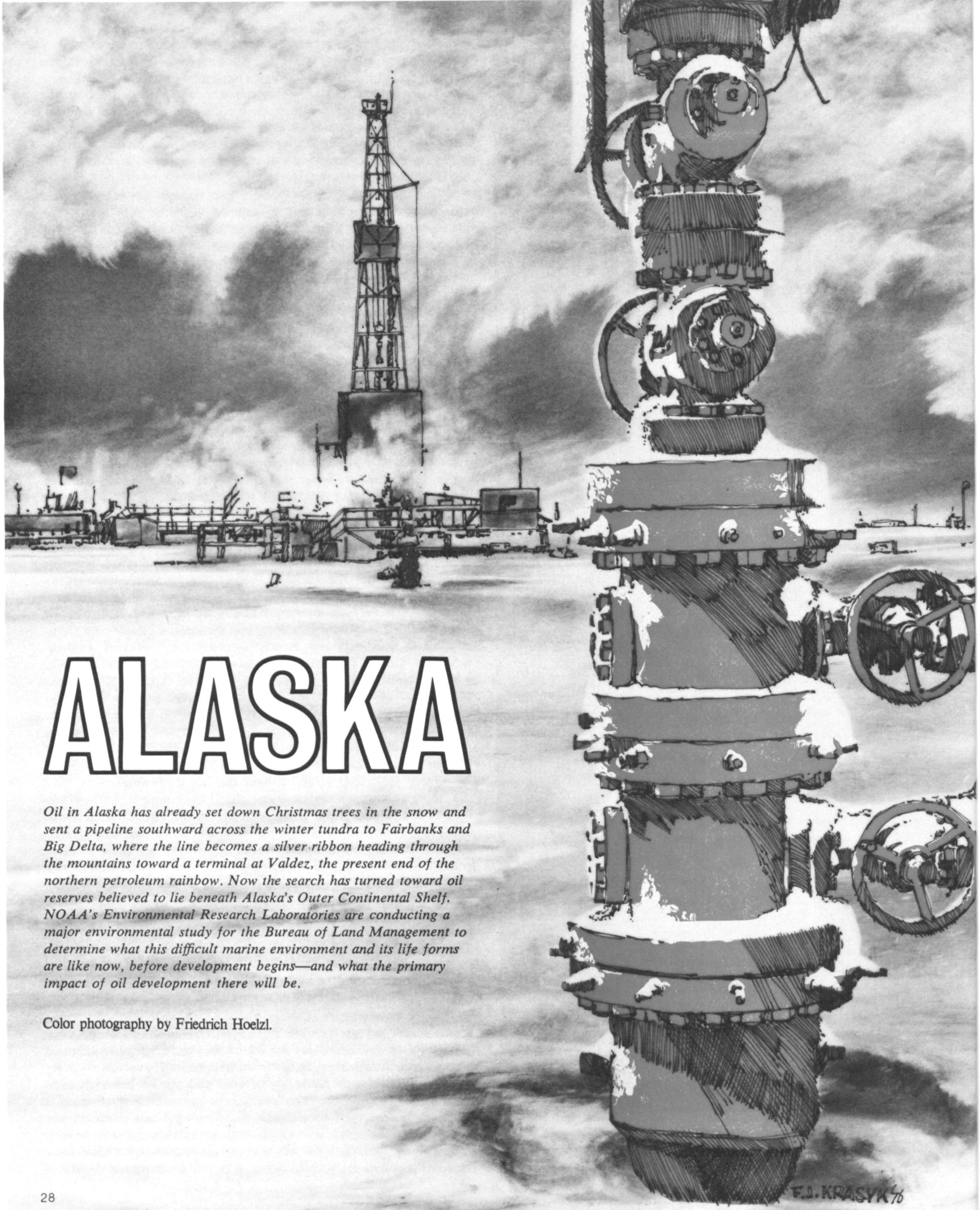
"Oil does smooth troubled waters," Galt says, "to the extent it tends to knock down capillary wave action. But it also picks up that capillary wave energy, so that the slick is able to move through the water. It floats on top of the water, while the water is involved in all kinds of small-scale divergences and convergences. So you don't just have a big pool of oil, but streaks and feathers. We don't understand the mechanism by which oil propels itself, we don't know how to parameterize the way water moves oil around. And there are lots of chemical questions we don't know how to answer.

"We need to look at oil in the environment."

That need could be the motto of what is called SOR (for Spilled Oil Research) teams, a freeform, fast-response organization that has evolved between NOAA and the Coast Guard. The object is to get spill specialists to the scene as soon after an accidental spill as possible, to take the detailed data scientists need to understand how oil behaves in the sea—how it weathers, how it emulsifies, when it turns to Vaseline, why it sometimes disappears. The spills, catastrophic in ecological and economic terms, are "spills of opportunity" for the SOR teams. Short of a controlled, deliberate spill, which scientists believe is needed to assess the impact of oil in the cold water off Alaska, the SOR teams may provide the most efficient avenue to improved understanding of oil and environment. It is also another set of vignettes, of pairs or trios of investigators staging out of Seattle, Anchorage, Key Largo, their bags packed for sudden flights into remote corners of the marine world.

There are many voices around this work. Perhaps, they may say, there's too much emphasis on oil and environment. Perhaps too little is said of the gravel island problem in the Arctic. What about doing more in terms of glaciers, or that species of bird not covered by reconnaissance? The science is too applied—or too basic. Is there enough on the building of coastal roads and the emplacement of rigs offshore? The work is shaped and reshaped by the voices. A chorus calls from within the Federal government, another from the state, from the sponsoring Bureau of Land Management, from the users of this new knowledge, from environmentalists, Eskimos, oil people. The staffs in Boulder, Juneau, and Fairbanks hear inner voices of their own. Institutions mature as campaign fades into campaign. Changes come. New lease schedules help ease the constraints of time upon the program. The broad-brush of offshore reconnaissance begins to give way to a more focused examination of critical ecosystems, and the greater urgency and complexity of possible impacts along the enormous littoral of Alaska. Like the compound whose impact it assesses, the program is organic. It evolves.

And still, it is an anthology of twos and threes, poised here to trawl a cold ocean for its life forms, here to track the findings of a myriad species, then to monitor the flowing ocean beneath the juggernaut of ice. Everywhere, this huge undertaking reduces to men and women looking seaward, saying their seasonal hello, their seasonal goodbye, to the wild places along the shorelines of Alaska. □

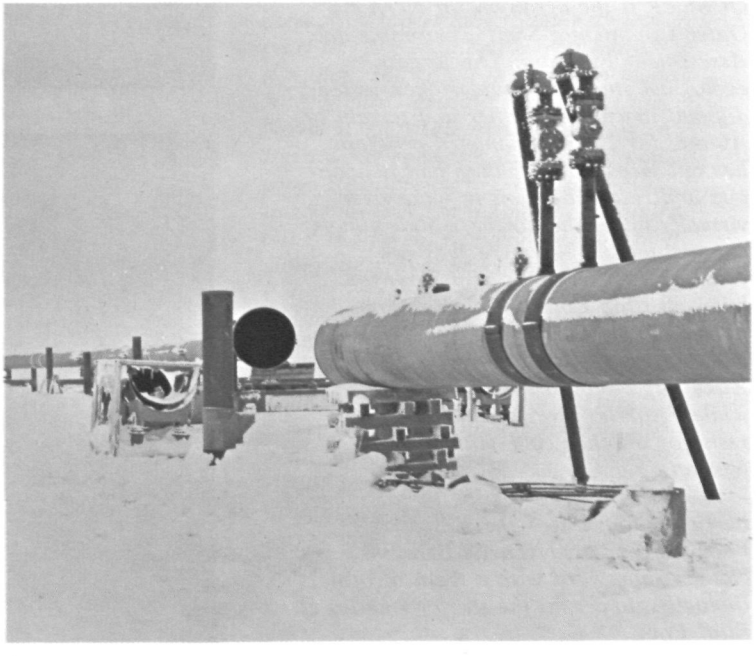


ALASKA

Oil in Alaska has already set down Christmas trees in the snow and sent a pipeline southward across the winter tundra to Fairbanks and Big Delta, where the line becomes a silver ribbon heading through the mountains toward a terminal at Valdez, the present end of the northern petroleum rainbow. Now the search has turned toward oil reserves believed to lie beneath Alaska's Outer Continental Shelf. NOAA's Environmental Research Laboratories are conducting a major environmental study for the Bureau of Land Management to determine what this difficult marine environment and its life forms are like now, before development begins—and what the primary impact of oil development there will be.

Color photography by Friedrich Hoelzl.

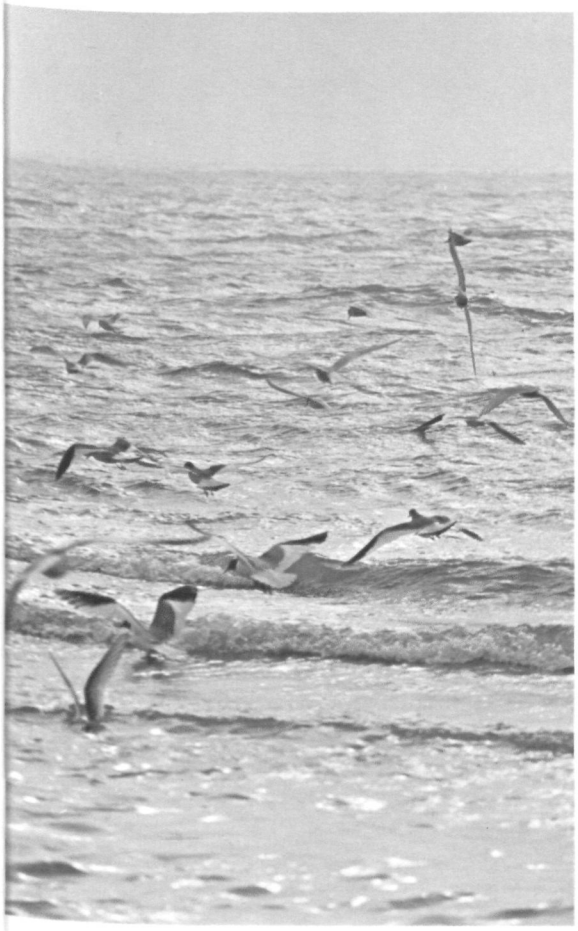
Alyeska pipeline
FLUOR
ALASKA
INC.
prime contractor for
Valdez
Terminal
FOSS

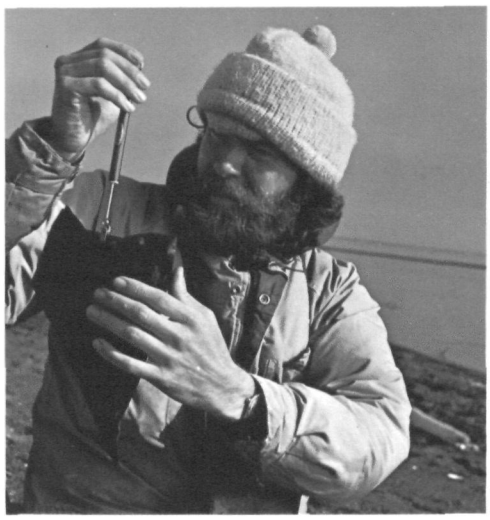


OCSEAP is the acronym for NOAA's Outer Continental Shelf Environmental Assessment Program. The largest ecological study ever undertaken in the difficult maritime weather and terrain of Alaska, the NOAA-managed program has put ships and airplanes and helicopters and research teams at work over virtually all of the northern state's huge continental shelf—where they are dwarfed, like NOAA's ship Surveyor lying off Bluff Point, in Norton Sound.

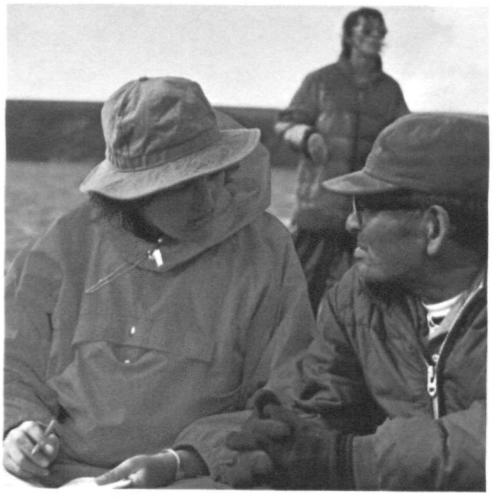
Near Point Darby, NOAA divers hand benthic samples to Surveyor crewmen for Auke Bay biologist Joyce Gnagy to sort, while Fisheries diver-scientist Lou Barr rests for another cold plunge into Norton Sound.

A small coworker of the larger hurricane-hunters of the Research Facilities Center, NOAA's Bell 206 clatters shoreward with a team of ornithologists, to census the steep rookeries at Bluff Point.



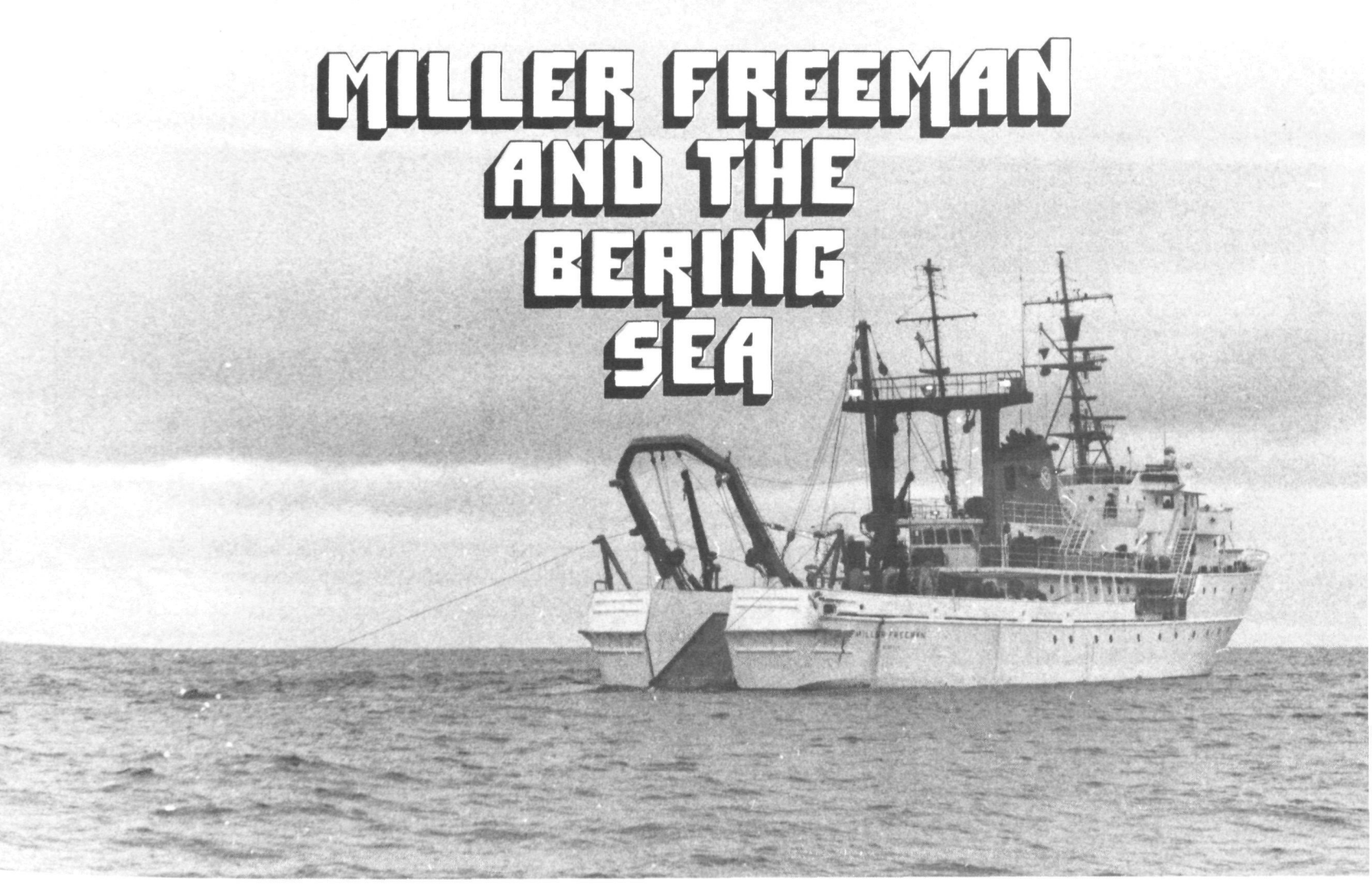


The Top of the World is what Point Barrow calls itself, and it is as far north as North America goes. There, scientists sampling life and currents and water chemistry beneath the persistent ice pack use the ice itself as a research vessel, dropping instruments down through hard-sawn holes from locations accessible only by helicopter, the new bushcraft of the north. In the chill Arctic summer, these researchers take to unlikely research craft like the modified warping tug, Alumiak, shown on the horizon behind Jack Mellor, executive officer at the Naval Arctic Research Laboratory in Barrow, as he tugs a Zodiac through some Beaufort surf. The birds have left the ponds that dot the northern tundra, but some juvenile phalaropes still feed along the gravel beach at Barrow. Dr. Peter Connors of the University of California's Bodega Marine Laboratory catches them to get their size and weight, and marks them to see how long into the gathering autumn they stay before returning to shorelines farther south. While the phalaropes endure research, Arctic terns feed on the tiny life illuminated in the prisms of breaking waves near Barrow.



Fish, Fish Come, Come

MILLER FREEMAN AND THE BERING SEA



THE NOAA ship Miller Freeman, one of the best-equipped fisheries research ships in the world, has never been busier, given the combined requirements of the outer continental shelf study and extended jurisdiction fisheries needs. Reactivated a little over two years ago as an "energy ship," the Freeman begins her fourth major cruise in northern waters this month. John Elverum shipped aboard the Freeman as a fisherman on her 1975–1976 Bering Sea expedition, where he took these photographs, and provided this description of the multidisciplinary work this ship is doing in the northern ocean.

". . . Arriving on location in the Bering Sea we engaged in trawling operations until late October. Then the ship was involved in buoy retrievals and deployments for measuring tidal action and gathering current data, and then the research centered on primary productivity studies and plankton tows.

"The trawling operations were divided into three separate legs, each with their own team of scientists. Chief scientists for the three sections included Ron Wolotira, Dick Bakkala and Ken Waldron, all biological oceanographers with the Northwest and Alaska Fisheries Center.

"To accomplish this task and gather the desired data the Eastern Bering Sea was pockmarked with trawl sites. The location and frequency of these sites was dependent on two variables: one dealt with the known areas of high marine-life concentrations; the second concerned potential oil-drilling areas. Consequently the lowest number of stations occurred north of Nunivak Island where there was one station per 400 square miles and the highest concentration was located just north of the Alaskan Peninsula and the Aleutian Islands where there was approximately one station per 175 square miles.

"Because of the immensity of the area and the large number of trawl sites (564) two west coast charter boats, the fishing vessels, Pat San Marie and the Anna Marie were also engaged for the fishing operations. The attempt was made to make all three ships' operations as identical as possible, in terms of the equipment used and operating procedures. Each vessel employed an eastern trawl with 112-foot headrope, 83-foot footrope and 41.8 inch diameter floats on the headrope. Aside from using identical equipment each ship fished only during daylight hours and each set was limited to a half hour.

"During the second leg of trawling the three vessels spent five days conducting comparative trawling operations, working several stations simultaneously to determine the effectiveness of each boat relative to each other. This was necessary so that data obtained from each vessel could be combined into a single data base without bias due to possible differences in fishing powers between the vessels. Although some differences in catch size were noted (due in part to the length of time the gear actually remained on the sea floor) the three boats were fishing about the same and reaping comparable results.

"Although there were typical days for the crew of the Freeman—days when the operation went like clockwork, the gear retrieved smoothly and the catch processed quickly—it would be impossible to say there was an average catch.

"Along the shelf brake arms a single set often reaped several tons of fish, while in other areas, notably northwest of Bristol Bay where a cold-water tongue existed, there would scarcely be enough to fill a couple of buckets. But if the catches weren't consistent in terms of quantity or variety, the actual processing of the fish and shellfish remained fairly uniform throughout the trip.

◀ *Alaska's food web—land and sea—is the focus both of scientific research and of survival economics (facing page). The remains of caribou drying on racks in Kotzebue and urgent "messages" to fish on fishing net floats contrast with scientific work of Alaska Department of Fish and Game researcher Kate Tate, probing salmon consumption on the Kuzitrin River near coastal town of Teller.*

"Once the catch was brought aboard, the processing began by dumping the haul onto a sorting table on deck. In many instances the catch was too large (over 2,500 pounds) to fit on the table and when this occurred it was split before placement. This was done by placing the catch into a sampling bin from which a representative sample was taken for processing.

"Weather was also a factor in the processing, with blowing spray and a rocking deck often making scientific work difficult, if not outright dangerous. On such occasions the catch was lowered through a hatch in the deck and the work was performed in duplicate labs below.

"Once in place fisheries personnel, working in tandem with NOAA crew members, descended on the sorting area and fish, crabs, and snails began to fill the sampling baskets.

"After the catch was sorted into species, a random subsample was taken for study. The size of this subsample varied with the individual varieties. High priority fish for the project included pollock, yellowfin sole, rock sole, flathead sole, halibut, Pacific ocean perch and sablefish.

"A subsample of 300 to 400 for pollock and 150 to 200 fish of other species was the general rule of thumb, but usually there were only three or four species in a single haul in sufficient quantity to gather accurate biological data.

"The information collected from the individual fish species consisted of length-weight relationships, maturity, and sex ratios. The sex of the fish was determined by dissecting and examining the reproductive organs and the length-weight data was gathered by weighing the sample as a whole and then measuring and counting the individual fish.

"By making a small incision behind the head of each fish and extracting the small otilith disk (ear bone), biologists were also able to determine the exact age of each of the samples. Analyzed under a microscope, these disks are read in a manner similar to the reading of the rings of a tree.

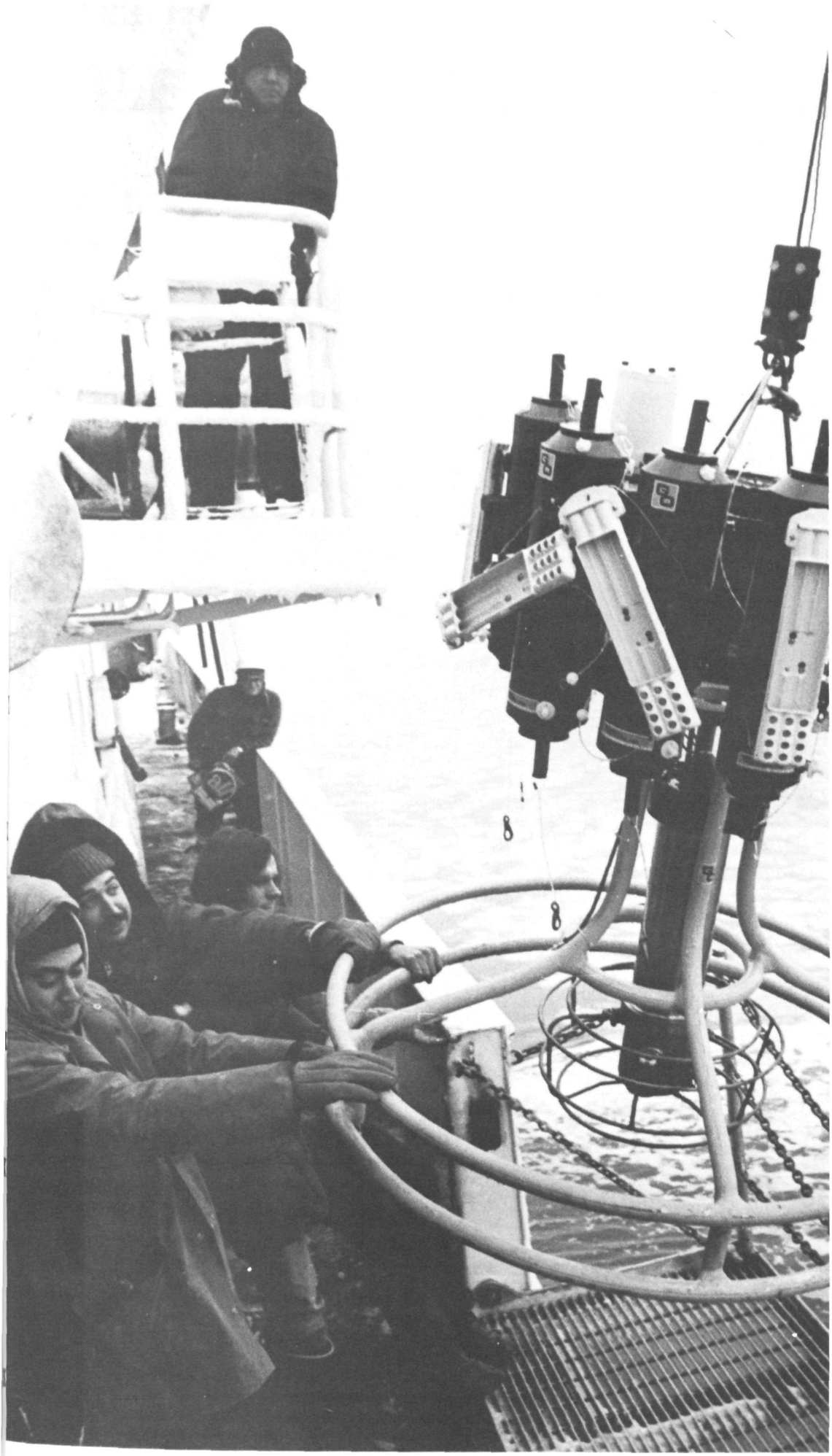
"The sampling procedure for crabs differed from that of bottom fish in that whenever possible the entire catch was processed. The two major crab species, King and tanner, were first separated after which scientists set to work recording the number, sex, size, shell condition, egg color and in some instances weight and claw size.

"With respect to crab operation one of the highlights of the trawling occurred when a 7,000-pound haul of King crab was brought aboard. It was utilized in several ways—the most enjoyable being the delicious crab meals served by the galley.

"Indeed a large number of crabs and fish were steamed, frozen, salted, and filleted by various members of the crew for what was termed 'palatibility studies.

"The difficulty of identifying snail species in the field resulted in the collecting of random samples of these shellfish for later analysis. If the snail catch was under 25 pounds, one bag was collected; if under 100 pounds, two bags were collected and if over 100 pounds three bags were stored away.

In laboratories aboard the Miller Freeman NOAA research technicians Tom Hilton monitors profile drawn by signals from the Conductivity Temperature Depth (CTD) casts, while University of Alaska researcher Mrs. J. Roberts measures phytoplankton sample to determine amount of fall productivity in Bering Sea. On deck, technicians launch string of sub-surface current meters and buoy.



Winch operator Clarence "Whitey" Tondell on icy upper deck brings in CTD-water sampler, being pulled aboard by (from left) Lt. Cdr. Warren Taguchi, Tom Hilton, and chief scientist David Brickell of the University of Alaska. Above right, plants and animals brought up from the frigid waters.

"To give some idea of the scope and magnitude of the trawl operations the crew and scientific personnel aboard the three vessels completed 654 hauls, took length measurements on 180,834 fish, recorded length weight data on 5,898 fish, removed 7,427 otoliths and collected carapace measurements on 81,270 crabs.

"Aside from these programs, the Freeman's scientific personnel were also engaged in collecting samples and data for a number of independent studies for various universities and institutions. These studies ranged from gathering data on fish diseases to the removal of fish stomachs for content analysis.

"While all these projects were underway, bird and mammal sightings were recorded, vanveen bottom samples were taken, weather data was collected and expendable bathythermograph casts, measuring the temperature of the water with depth, were conducted at each of the trawl sites.

"Five buoys were placed in strategic locations throughout the Bering Sea and four old buoys were retrieved. Each of these subsurface buoys had a current meter and current vane attached to it, and the information they gathered (current velocity and direction) was stored internally on magnetic tape. The buoys have a life span of approximately six to eight months, depending on the frequency of activation.

"Throughout the trawling and buoy deployment phases, Conductivity Temperature Cast (CTD's) were taken at specified stations. The CTD equipment, mounted on a Rossette Multi-bottle sampler, is used for temperature recordings and water sample collections. Scientists aboard the Freeman also probed the primary productivity—the base of the biologically abundant Bering's food chain—to determine how life and ice interacted in this northern sea." □

And now, IOCARIBE:

Caribbean Cooperation: It Works

BY HARRIS B. STEWART*

IN 1965, on a small French island off Brittany, the Hydrographer of the Royal Netherlands Navy and the Director of the Netherlands Institute for Sea Research generated an idea that blossomed beyond their wildest imaginings.

Two years later, it was adopted as an official program for international cooperation by UNESCO's Intergovernmental Oceanographic Commission.

They called it CICAR—for the Cooperative Investigation of the Caribbean and Adjacent Regions.

Last July, after seven years of work at sea in which 40 research vessels from ten nations participated, CICAR came to an end with a multi-national symposium at Caracas, Venezuela, with more than 100 technical papers presented. These were but the tip of the iceberg; several hundred other papers and reports have been issued, and more will emerge as the last of the field data are analyzed.

How well did CICAR work? Does it deserve to live on in some permutation? For that matter, what was it intended to accomplish? The objectives of the program were spelled out at a Mexico City meeting of the International Coordination Group for CICAR:

—to contribute to the development of marine research in the CICAR region;

—to insure the maximum participation of coastal countries in the region;

—to achieve a better scientific understanding of the region;

—to carry out, rapidly and effectively, certain particular projects of research with well-defined scientific and economic objectives; and

—to establish the basis for further international coordination in the CICAR area.

CICAR provided the occasion for the first official U.S. delegation to be sent to Cuba in recent years, when in 1972 the Havana CICAR meeting included this group, posing at the José Marti airport, (l. to r.), John Bruchs, NMFS; Harris Stewart, AOML; Robert Molinari, AOML; Bernard Zetler, AOML; and John Antoine, Texas A&M University.

All but the second were accomplished successfully, and even that might have been a success had the objective been instead: "maximum *possible* participation of coastal countries". Of the countries in the region, only Colombia, Cuba, Mexico, Venezuela, and the United States were able to field ships, although the Netherlands, France, United Kingdom, Federal Republic of Germany, and the USSR all sent one or more ships from outside the area. Guatemala, Jamaica, Brazil, Panama, and Trinidad and Tobago participated to varying degrees, from having their scientists work on ships of other countries to just showing up at meetings. Except for Cuba, Jamaica, and Trinidad, none of the Caribbean island nations was able to participate, and none of the Central American countries between Mexico and Colombia contributed to the program. In essence, CICAR was the United States, the Soviet Union, Mexico, the Netherlands, the United Kingdom, Colombia and Venezuela, in decreasing order of their degree of participation.

CICAR contributed significantly to the development of marine research in the region, and this is particularly true of Mexico, Colombia, Venezuela, and Trinidad and Tobago. Each of these countries was able to use its participation in CICAR to obtain stronger governmental support for marine research.

The U.S. was a major contributor to CICAR, with the following sea-going groups involved: NOAA (AOML and the Southeast Fisheries Center of NMFS), Geological Survey, Navy, Coast Guard, Woods Hole Oceanographic Institution, University of Rhode Island, Lamont-Doherty Geological Observatory of Colombia University, Duke University, Florida State University System, University of Miami, Texas A&M University, and the University of Puerto Rico. In

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**Dr. Stewart, Director of NOAA's Atlantic Oceanographic and Meteorological Laboratories in Miami, has been for seven years the U.S. National Coordinator for CICAR and has just been appointed as the U.S. Associate for IOCARIBE. He was Chief Scientist on the NOAA-CARIB Expedition in 1972, and has been Chairman of the U.S. Delegations to CICAR meetings in Mexico City, Havana, Port of Spain, Cartagena, and Caracas. He was also the Chairman of the Steering Committee for the July 1976 CICAR-II Symposium and is Editor-in-Chief of the Proceedings of these meetings.*

addition, scientists from numerous other U.S. and Caribbean institutions rode U.S. research vessels during the program. Education and training of Caribbean scientists was an essential element of CICAR, and NOAA assisted by having people at NODC for training in the operation of data centers and by running the two-month NOAA-Carib Expedition.

CICAR did indeed achieve a better scientific understanding of the region. Although most of the participating groups from the U.S. and elsewhere were "doing their own thing" rather than working cooperatively on a comprehensive scientific program that somehow never materialized, a tremendous amount of new knowledge was developed. The United States, for example, has published a "Preliminary Bibliography of Published Results of Marine Research by U.S. Scientists in the CICAR Area, 1968–1974" which contains over 400 references. The Soviet Union has a series of publications on the work of its vessels in the CICAR program, and other countries have published CICAR bibliographies (notably the Netherlands, Trinidad and Tobago, and the United Kingdom).

Scientific results presented at the CICAR-II Symposium in Caracas covered a broad spectrum, but representative results in physical oceanography included studies of the circulation in the Cayman Sea, the Gulf of Mexico Loop Current, the physical oceanography of the Cariaco Trench, circulation through the passages between the Atlantic and the Caribbean Sea, effects of upwelling, tides in the Caribbean and Gulf of Mexico, and the coastal circulation off Surinam.

A broad range of chemical results dealt with gypsum-organic interactions, the relationship of nutrients to the Amazon River outflow, sources and movements of suspended materials, contamination in coastal lagoons, dissolved carbohydrates off Venezuela, dissolved silica, radionuclides and trace elements in plankton, and salinity structure in the Venezuelan Basin.

Marine geological and geophysical results included the development of a tectonic map of the Caribbean Sea and new knowledge of the complex fault systems of the region, of the nepheloid layer, of sedimentation, of the complex geophysics of the island arc system, of the origin of the Old Bahama Channel, of marine terraces, and calcium carbonate deposition in the Gulf of Mexico.

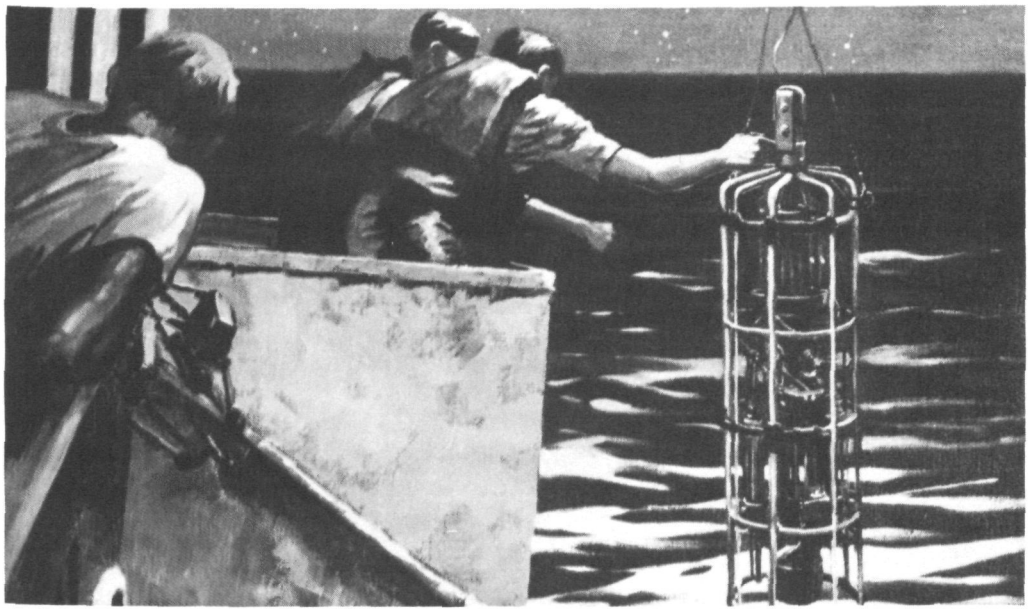
In the area of sea-air interaction, CICAR resulted in the development of a thermodynamic model for mean monthly sea surface temperature predictions, a better understanding of the role of the atmospheric boundary layer in sea-air interaction processes in the tropics, the development of a climatic heat budget for the Gulf of Mexico, and a much better understanding of the air-sea interactions during squalls and deep convection and of the response of the tropical ocean to meteorological forcing functions.

In marine biology, results ran the gamut from the zonation of fan corals and the biology of Caribbean turtle grass to the dynamics of phytoplankton in an upwelling area, the ecology and toxicity of sponges, and the systematics and distribution of diatoms and dinoflagellates to studies of Caribbean zooplankton, the search for cancer-specific marine antibiotics, studies of the macro-fauna of the area, and new knowledge of coral reefs, the ecology of coastal lagoons, and the regional distributions of the benthic organisms.

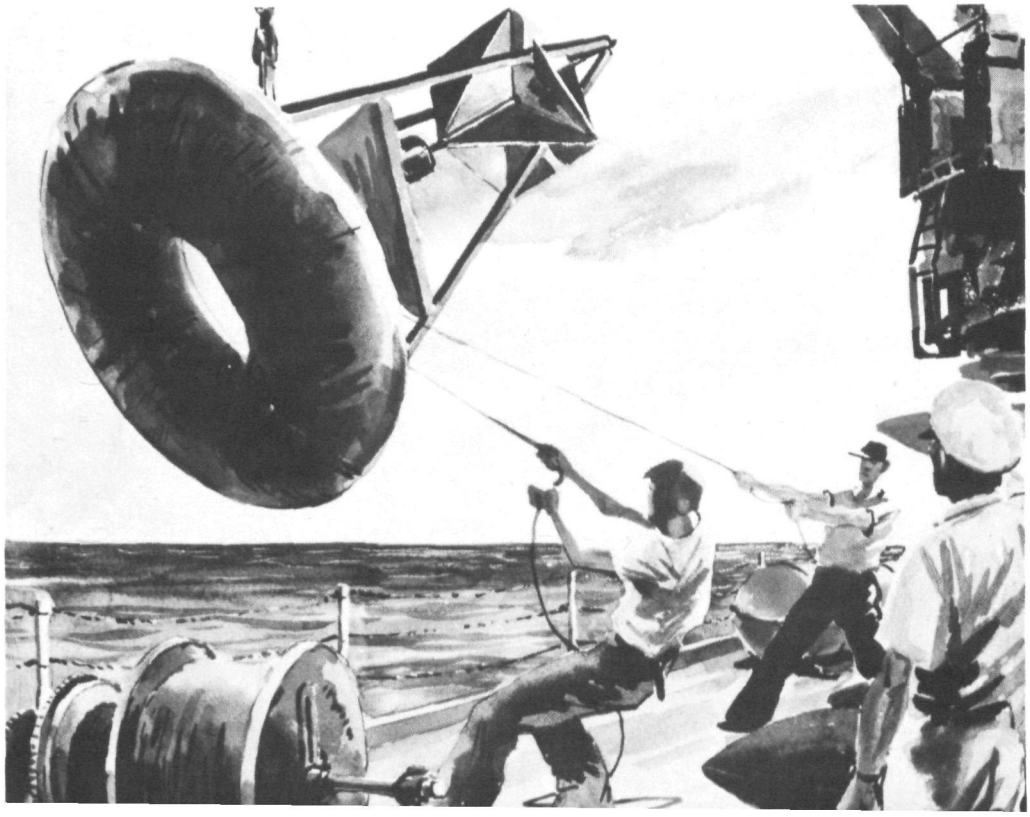
In fisheries, CICAR developed new knowledge of shrimp migrations, porgy distribution and migration in the Gulf of Mexico, spawning conditions of fishes in the northeastern Caribbean, potential fish production from coralline shelves, the ecology of juvenile grunts, the distribution of larval lobster recruitment and dispersal as revealed by a surface drift model, the fish fauna of Cuban artificial reefs, the relationship of scarlet prawns to a bottom oil deposit, aquaculture of the sea mussel and the queen conch, the Jamaican spiney lobster, snapper and grouper resources in the region, scallops and mussels, and even an interesting method for inducing spawning and reproduction in molluscs artificially.

The abstracts of the more than 100 papers covering these subjects were published and made available to participants at the Caracas meetings, and the full papers are now in the final stages of preparation for publication by the Inter-governmental Oceanographic Commission of UNESCO and by the Food and Agriculture Organization, both of the United Nations.

The carrying out of specific research projects with well-defined objectives was designed to cover two of CICAR's major



Action paintings by Jack Coggins, done aboard NOAA ship Discoverer during 1968 CICAR work off Barbados.



aspects: the CICAR standard sections and the CICAR survey months. These were a series of lines of oceanographic observing stations criss-crossing the Caribbean, the Gulf of Mexico, and certain of the inter-island passes. Every ship working in the area was encouraged to make its observations at these standard stations on these pre-set profiles. Fortunately, many of them did. In addition, several periods were set when every ship that could be made available made observations at the same time—or as nearly at the same time as possible. These were the CICAR Survey Months; probably the best scientific results from CICAR came from these two projects. One of the basic tenets of international cooperation is that it should be limited to those activities that cannot be carried out without such cooperation; these are really the only two CICAR activities that met this criterion. The results, developed primarily by Dr. Robert Molinari of AOML, comprise one of the major scientific results of the CICAR program. His compilation of the work of all the ships that had occupied standard sections during survey months gained immediacy when the Bureau of Land Management needed information to help predict where currents might carry potential oil spills in the Gulf of Mexico. The major relevant work at that time was his, and BLM funded its continuance to a predictive conclusion.

Other than the field work, the major U.S. contribution to CICAR has been by the National Oceanographic Data Center of NOAA's Environmental Data Service. Acting as the CICAR Regional Data Center, NODC has produced bibliographies, data distribution charts, data summaries, on-request data summaries, a Guide to CICAR Data, and has been the willing acceptor of data in all sorts of format from the CICAR participants in spite of their attempt to standardize data submission by developing specific forms, the so-called CICARDI form, for submitting CICAR data. NODC is still trying to get CICAR participants in this country and in others to submit their data to NODC. (An international cooperative effort is no more effective than its ability to exchange data among the participants).

CICAR's field work officially terminated in December of 1975. Both the Intergovernmental Oceanographic Commission, the sponsor of CICAR, and the various countries involved felt that the international cooperative relationships developed during CICAR ought to be continued. The marine scientists in the various Caribbean countries were all talking with each other, the CICAR umbrella facilitated research in the waters of other countries (and restrictions in this area are becoming increasingly bothersome to marine researchers), good science was actually being accomplished by international cooperation that could not have been otherwise done and the CICAR Standard Sections and CICAR Survey Months are the classic examples. Thus it was decided that some mechanism should be established as the basis for future international cooperation and coordination in the Caribbean and its adjacent regions.

Scientific party from several nations poses with officers and Barbados flag aboard the Discoverer during CICAR operations.

Colombian, Venezuelan, and U.S. scientists aboard the Discoverer during the La Guaira to Cartegena leg of NOAA-CARIB, a CICAR training and education cruise in 1972.

The result is that the Intergovernmental Oceanographic Commission has established a CICAR follow-on called the IOC Association for the Caribbean and Adjacent Regions with the acronym IOCARIBE. The first meeting of IOCARIBE was held last July in Caracas, and it was decided that instead of the rather relaxed format of CICAR, IOCARIBE would concentrate on specific projects which would utilize marine science for the benefit of the countries of the Caribbean. The first consideration is that IOCARIBE is to be supported only for six years on a trial basis to see if it can in fact accomplish something worthwhile.

Because the major economic importance of the Caribbean to the nations bordering it is fish, IOCARIBE is concentrating its initial effort on those aspects of marine research that have a significant bearing on fisheries. To this end, a workshop will be convened in 1977 in which physical oceanographers, marine chemists, sedimentologists, marine biologists, and fisheries people will get together to decide what specific projects should be undertaken under IOCARIBE with a view to providing the scientific framework that the Food and Agriculture Organization and others concerned with Caribbean fisheries development need to increase the ability of fishermen within the area to make a livelihood and the people of the area to have a more substantial diet from the sea. This is in sharp contrast to the old CICAR concept of each country "doing its own thing," and the end results should be considerably more applicable to the problems of the area.

The Caribbean is exciting scientifically, as the CICAR participation by United States scientists has indicated. The Caribbean is sensitive politically. IOCARIBE provides a good mechanism for doing good science that will benefit the United States as well as the countries of the region.

That meeting on the Brittany island some eleven years ago spawned a program that has paid off for the IOC, for the Caribbean, for marine science, and for the United States. It is a great game, and NOAA has played a leading role. □

BECAUSE the mail from England was late in 1769, oil deliveries to the northeastern states are made more promptly today.

The Gulf Stream—that wandering "river in the ocean" driven by trade winds in a circular pattern around and around the Atlantic Ocean—caused Benjamin Franklin no small amount of grief, gave Rhode Island skippers a leg-up on their British competitors, and today is saving shipping companies both time and fuel in voyages up and down the East Coast.

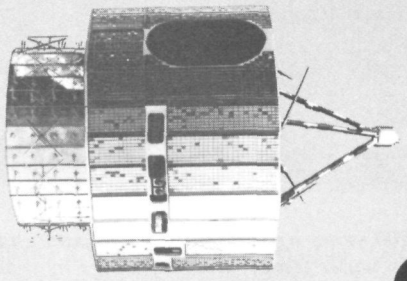
This natural phenomenon, apparently first recognized by fifteenth century mariners from Spain, Italy and Great Britain, only now—500 years later—is being accurately charted and scientifically utilized by seafarers.

NOAA's satellites, operated by the National Environmental Satellite Service, have helped unlock the mystery of the meanderings of the Gulf Stream and made it an aid to navigation.

The first important scientific research on the Gulf Stream was conducted, it is reliably reported, by Benjamin Franklin after he was called on the carpet by the Board of Customs in Boston in 1769. Then Deputy Postmaster General of the British Colonies in North America, Franklin was instructed to explain why British mail packets sailing from Falmouth, England, to New York took up to two weeks longer crossing the Atlantic than did Rhode Island merchant ships carrying supplies from England to the colonies.

One can imagine the consternation of the British Admiralty and other Crown officials

It saves time, money



Seeing Eye Over The Gulf Stream

BY WILLIAM J. BRENNAN

Photo: Leo Touchet, The Photo Circle

that sailors from the colonies were outperforming those representing the ruler of the high seas.

Like any obedient civil servant, Franklin hopped to it to find an explanation. He turned to a cousin, Nantucket whaling captain Timothy Fogler, who told him of the strong northeastern current which ran just south of Nantucket Island; a current whalers rode when outbound, and attempted to avoid returning to their island homes.

Franklin also learned that the Rhode Island merchant captains, too, were well aware of that portion of the Gulf Stream which flows into the mid-Atlantic, where it branches out to become the North Atlantic Current—which in turn splits to bracket the British Isles—and the Canary Current, heading down towards the Canary Islands. By avoiding first the North Atlantic Current, and then the Gulf Stream, on their voyages from England to New England, the Rhode Island skippers could shave as much as two weeks off the trip.

But this was the eighteenth century equivalent of flying by the seat of your pants. There was no scientific documentation of these alleged currents and, worse, the currents never seemed to be at the same relative spot on the ocean's surface on any two consecutive voyages. It is easy to understand why the British, upon receiving Franklin's carefully prepared chart of the breadth and course of the current, were skeptical and dismissed it out of hand.

For some reason—perhaps because of the British dismissal of his effort, or possibly because of his deep scientific curiosity—Franklin throughout his life maintained a deep interest in the Gulf Stream. On subsequent voyages across the Atlantic he made measurements of the current temperature at various points and depths, carefully recording his findings. For nearly 100 years, his efforts stood as the most scientific research on what we know today to be the Gulf Stream.

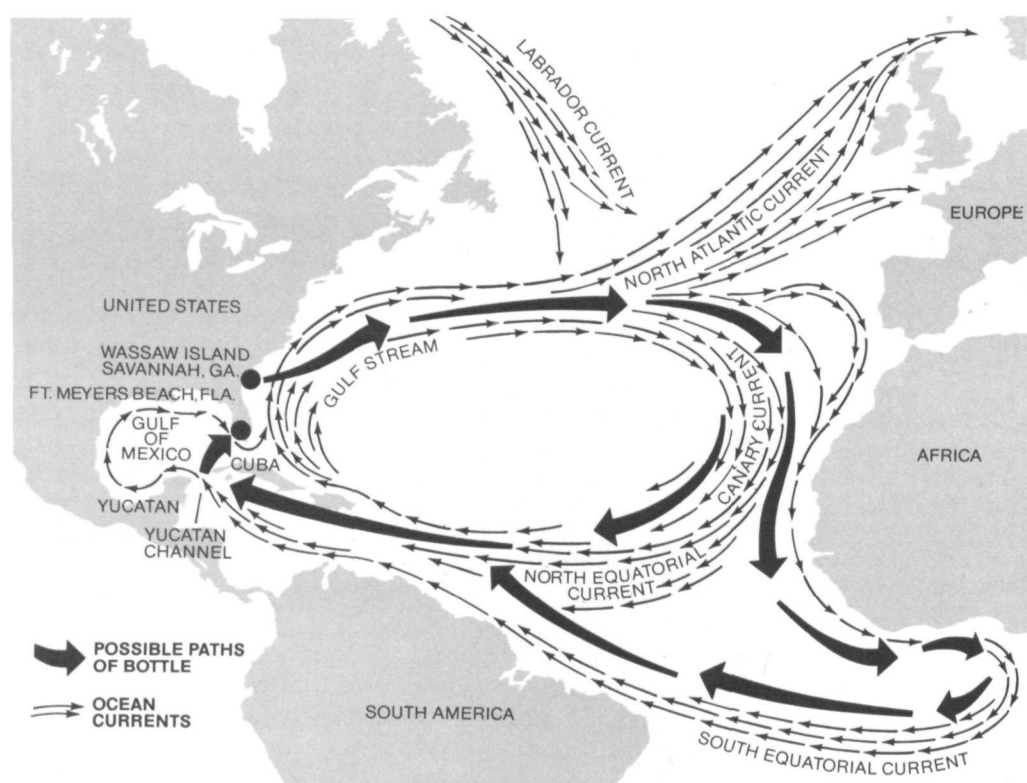
To make his observations, Franklin used a line with a weighted thermometer tied to its end. (It was another line, with a kite at its end, that makes him a familiar figure to every lower grade school child today).

Until the age of the satellite, which enabled scientists actually to see the track of the Gulf Stream, precise knowledge about its exact location at any given time was hard to come by. Considerable research was done, of course, but in effect it was merely an extension of Franklin's pioneering. Temperature variations were recorded, salinity levels taken, types of flora and fauna enumerated, and relationships between the Gulf Stream System and the weather noted.

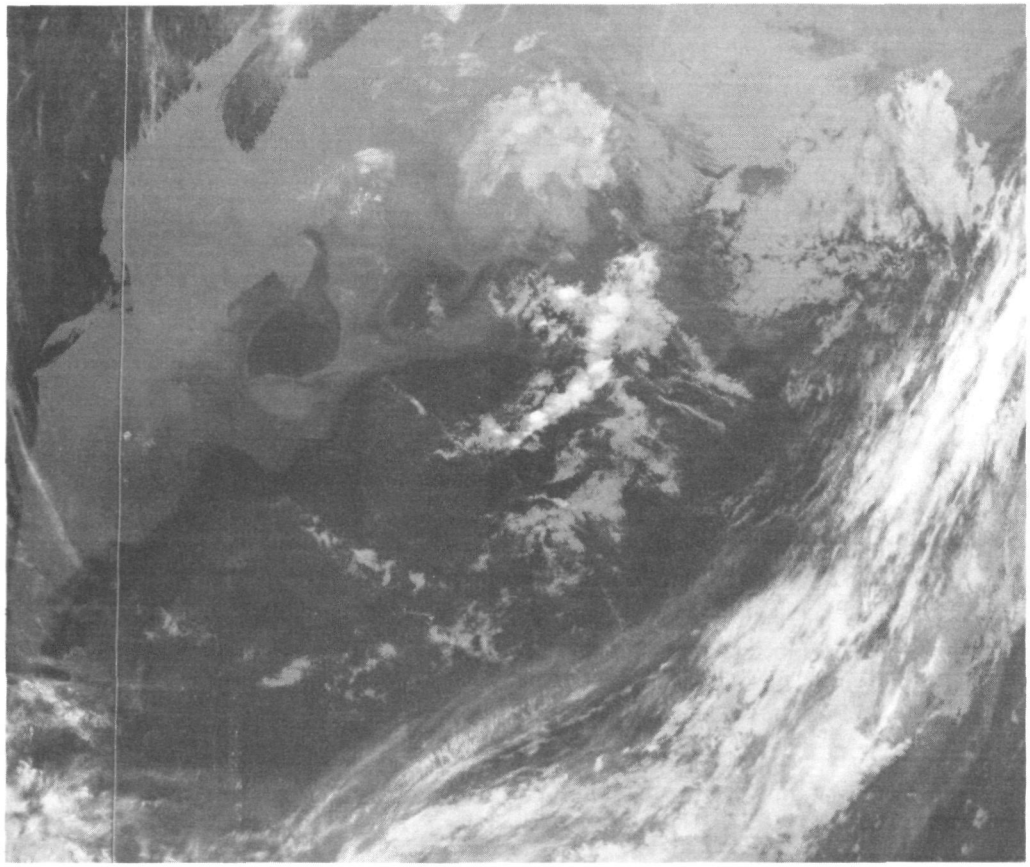
Scientists were well able to determine the tremendous volume of warmed water that was transported. They learned the Gulf Stream's effect upon temperature-vulnerable fish; that its position could vary by as much as 250 miles; and that eddies at least as great as 100 miles in diameter could break off from the Stream, causing unusual currents and affecting the weather. But the ability to predict where the Gulf Stream would be next week—and to take advantage of this for

BENJAMIN FRANKLIN'S MAP OF THE GULF STREAM

BEN FRANKLIN'S GULF STREAM— Some 200 years ago, Benjamin Franklin charted the course of the Gulf Stream, basing his efforts on water temperature readings he made himself during numerous trans-Atlantic trips. His was the first reported scientific research on the Gulf Stream.



Atlantic Currents—This chart, prepared by editors of Surveyor Magazine of the American Bureau of Shipping, illustrates the various major currents in the Atlantic. It also shows the possible route taken by a bottle tossed into the Atlantic at Wassaw Island, Georgia, by Explorer Scouts in 1962 and recovered seven years later on Ft. Meyers Beach, Fla.



Conclusive Evidence—Visual proof of the Gulf Stream's course is offered in this infra-red imagery from the polar-orbiting NOAA-4 satellite. The west side of the Gulf Stream (where its warmest waters meet the cold North Atlantic water) may be clearly seen, the darkest shade representing water of warmer temperature while the abutting light grey is cooler water. Several enormous eddies are visible. Cape Cod and Long Island are in clear relief at the left, as is Nova Scotia at the top of the picture.

shipping purposes—eluded them until NOAA's polar orbiting and geostationary satellites with their infrared, heat sensing instruments gave them a new vantage point.

High-altitude observation of the Gulf Stream has given mariners a new tool in the routing of ships, up and down the Atlantic coast and across the Atlantic, as well.

Cost-conscious shipping companies have been quick to take advantage of the new-found ability to plot precisely where the Gulf Stream is at a given time. The obvious value is in routing, of course, and any number of oil tankers out of Puerto Rico or Gulf of Mexico ports hope to find the fast-flowing waters near the inner-wall of the Gulf Stream to give them added speed on their voyages to New York or New England terminals. Similarly, by avoiding the currents southbound, vessels make better time and utilize less fuel.

Studies have shown that fuel savings (measured by propellor revolutions per minute) and speed can both be increased if the master of a northbound vessel seeks out the swiftest waters of the Gulf Stream, usually found some 12 to 25 miles east of the west wall of the Stream. One ship in these waters obtained a speed of 19.3 knots at 71.6 revolutions per minute. When the vessel went west of the west wall, out of the Gulf Stream, its speed decreased to 16.2 knots but propellor revolutions had to be increased to 79.1 per minute. The Gulf Stream accounted for at least 3.1 knots difference in speed and a 10 percent difference in propellor revolutions and accompanying fuel consumption.

Finding the Gulf Stream on northbound trips up the coast has become an "almost automatic" part of navigation for captains of Exxon Company, U.S.A. tankers, according to a company spokesman. "Captains I've talked with all seem pretty happy to get to port sooner," he commented. And masters of the seven tankers operated by Sabine Towing and Transportation Co., Inc., routinely tune in on radio broadcasts plotting the location of the Gulf Stream's west wall in the hope that this can aid them.

Bendix Field Engineering Corporation makes sophisticated use of Gulf Stream information provided by NOAA's satellites. A company staffed by meteorologists/oceanographers and licensed ships officers, Bendix provides comprehensive weather advisory services to more than 40 worldwide shipping firms sailing the North Atlantic. Masters of Bendix client companies' ships are given pre-departure briefings on dominating weather conditions, including Gulf Stream locations. After departure, en route to Europe, for example, the masters are given twice-daily updates on weather by single side-band radio broadcasts.

But Bendix puts Gulf Stream data to work for its clients another way. Using the monthly National Weather Service publication "gulfstream,"—an "historic" compilation of Gulf Stream locations—Bendix conducts a post-mortem on the performance of clients' ships, making sure the vessels' operating efficiencies are satisfactory. If a vessel takes eight hours longer than normal to cover a given route, is this partly because of bad weather, adverse currents, or some operating problem? By eliminating bad weather and obstructive Gulf Stream currents as factors, the consulting service can advise ship owners to take a close look at their ship, or its captain.

Infrared imagery from NOAA's GOES–1 and the polar-orbiting satellites clearly show the course of the Gulf Stream, unless overhead clouds obscure it from the satellite's view. The infrared sensors aboard the spacecraft record the differing water temperatures and this information is transmitted to computers at the National Environmental Satellite Service in Suitland, Md. which, by assigning varying shades of grey to different temperatures, provides imagery.

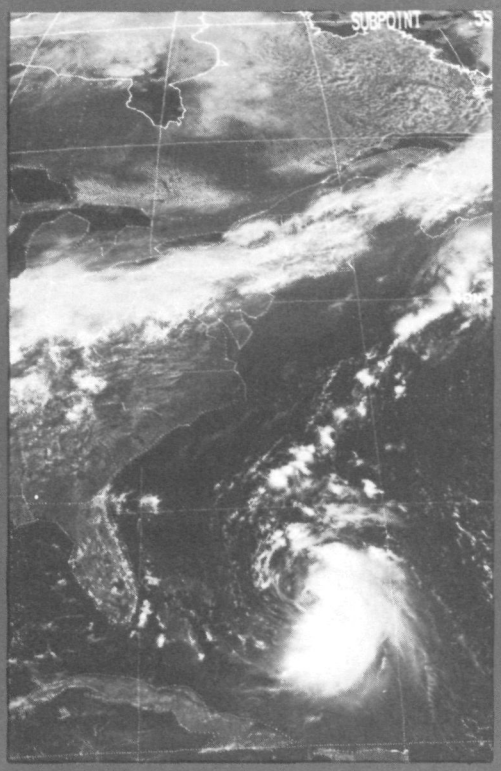
The west wall of the Gulf Stream is clearly visible because of the extreme temperature differential between waters within and outside of that part of the Gulf Stream. As noted, generally the fastest currents are found from 12 to 25 miles east of the west wall.

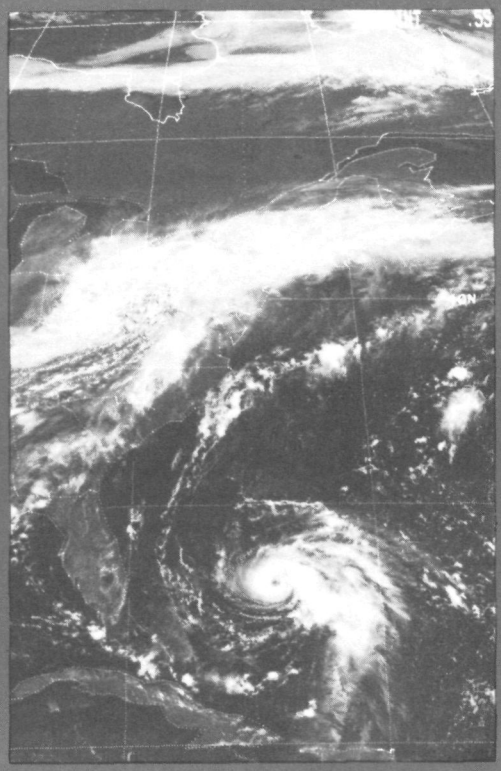
The imagery, as well as Gulf Stream information from the Coast Guard and other sources, is analyzed and plotted by specialists at NESS. Three times a week, on Mondays, Wednesdays and Fridays, they prepare a radio message giving several chart coordinates of the Gulf Stream for Coast Guard inclusion in its Marine Transportation Messages, monitored by ships at sea. Additionally, the same message goes to the Eastern and Southern Region Forecast Offices of the National Weather Service, for use as an aid in weather forecasting.

Commercial shipping is not the only user of the satellite-provided Gulf Stream information. Pleasure craft, particularly those involved in such well-known races as the Newport to Bermuda event, look to the Gulf Stream to give them an edge over the others in the race. This past summer, during the Bicentennial visit to the United States of the Tall Ships, Gulf Stream data was made available for their race from Bermuda to Newport, and for the procession of ships down to New York Harbor which followed the race.

The utilization of the Gulf Stream to the benefit of the human race is only the beginning. NOAA's National Marine Fisheries Service, the Weather Service, and other government and private organizations all have a piece of the action. Perhaps the early 1900's proposal to deflect the Gulf Stream closer to the mainland of North America and thus produce warmer climates was merely a wild-eyed dream. But just as Ben Franklin started something when he dropped a line with a thermometer attached into the Atlantic Ocean, the ability to "see" the meanderings of the Gulf Stream by satellite is the opening of another door. □

THE VIEW FROM SPACE

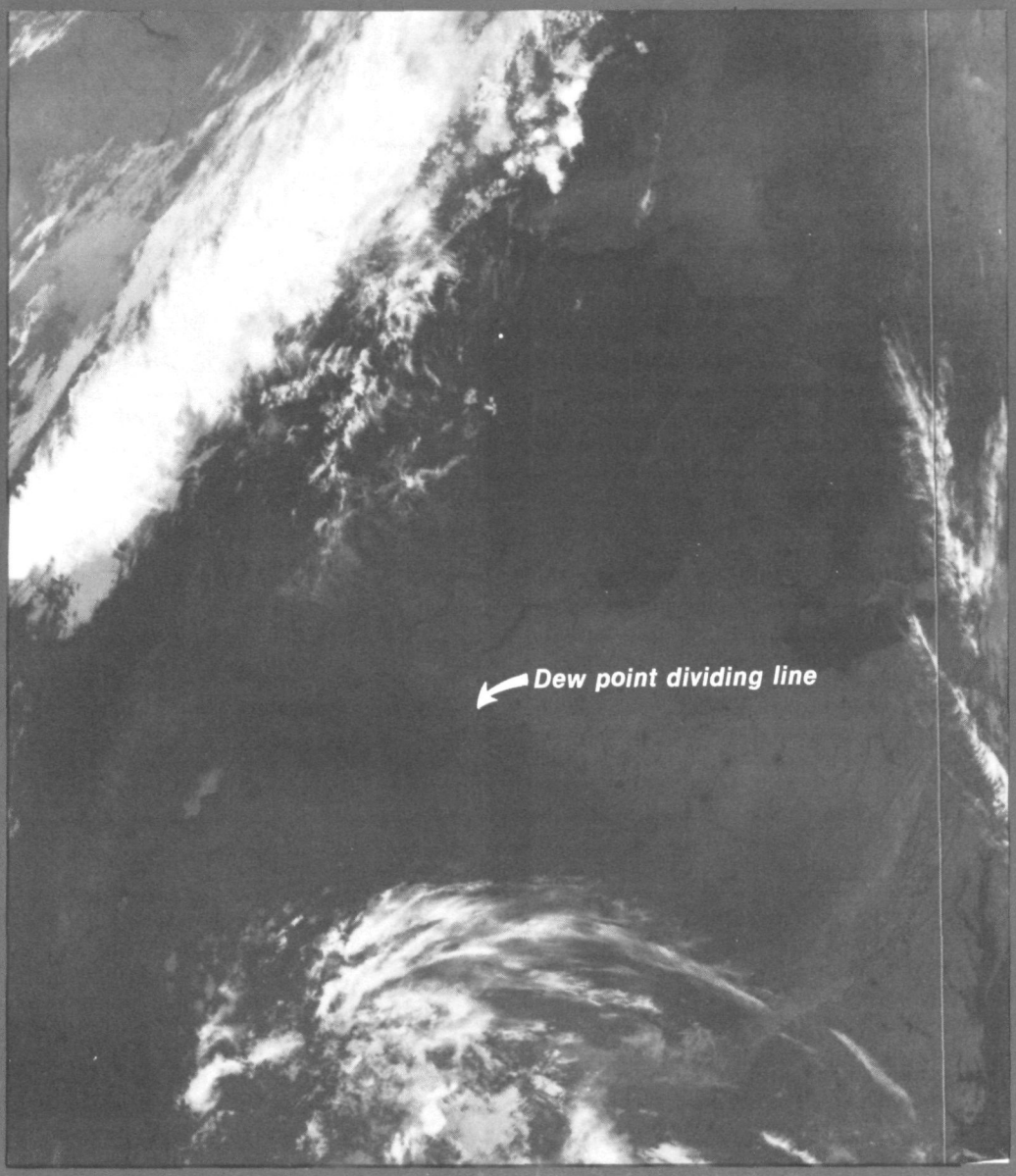


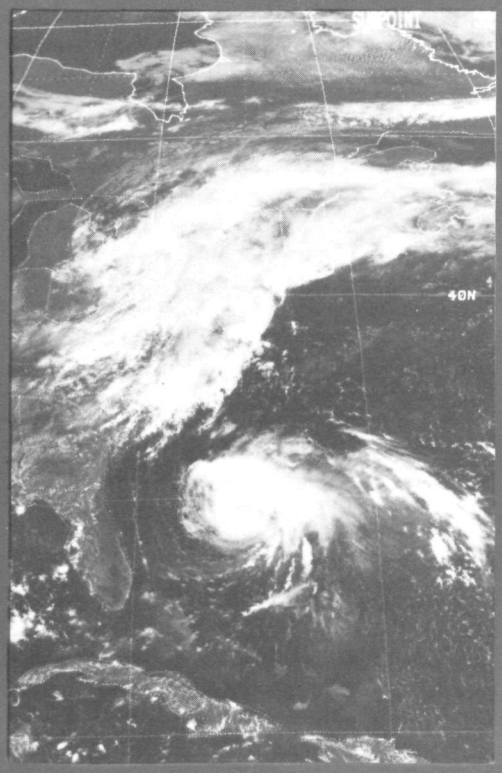


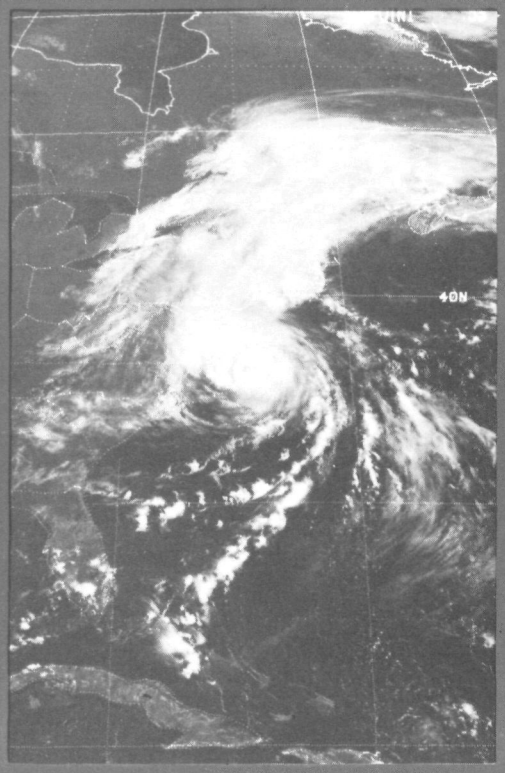
Hurricanes dominated much of the weather news during the summer and early fall of 1976; interrupting Atlantic coast vacations for many beach-goers, skidding past New York City and into Long Island, and taking more than a hundred lives in Baja California. The best that can be said about hurricanes is that no longer can they take the American public by surprise. NOAA's geostationary satellite system makes sure of that, "seeing" these vicious storms almost at the moment of their birth and tracking them throughout their life span. Most of the accompanying photographs illustrate the capabilities of satellites in observing hurricanes, typhoons and tropical storms.

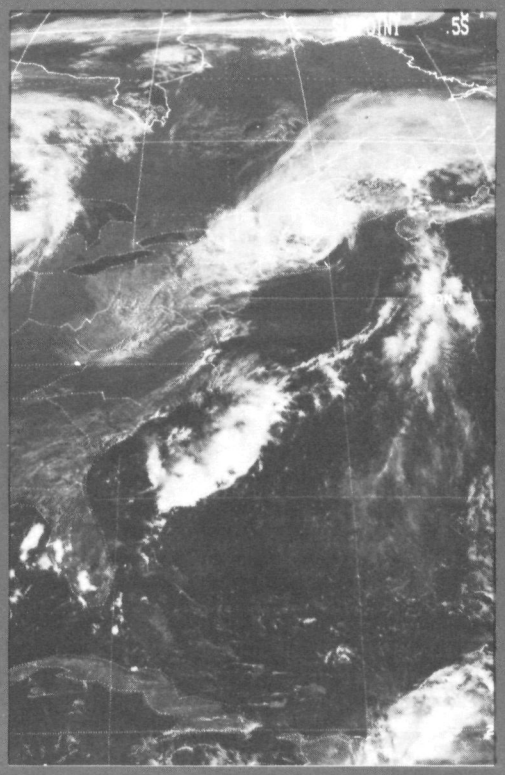
A HURRICANE'S LIFE–the five pictures above show the birth, life, and death of Hurricane Belle as seen by the GOES satellite. From left, on August 6 Belle was named when the former tropical storm reached hurricane proportions; 24 hours later the eye is fully developed; on August 8 Belle is headed north; the next day the storm is off Virginia, threatening New York; during the night Belle ripped into Long Island and by 1 p.m. (DST) on August 10 was dying over New England.

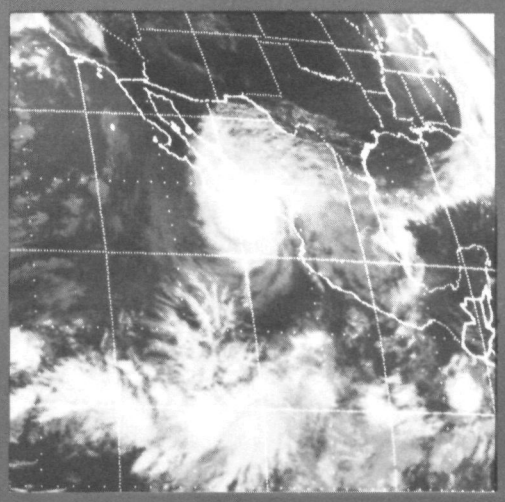
A FIRST FOR NOAA?—The September 8 picture at right from polar-orbiting NOAA–5 may be the first time ever that the humidity variance in abutting air masses could be visually determined. Low dew points (low humidity) in the area around and south of the Great Lakes let earth temperatures there cool to a greater degree than that area further south covered by an extremely moist air mass. The infrared sensor shows the earth beneath the moist air mass to be warmer, and thus darker in image coloration. Weather maps showed dew point differences of as much as 20 degrees for selected stations on opposite sides of the dividing line, an unusual occurrence.

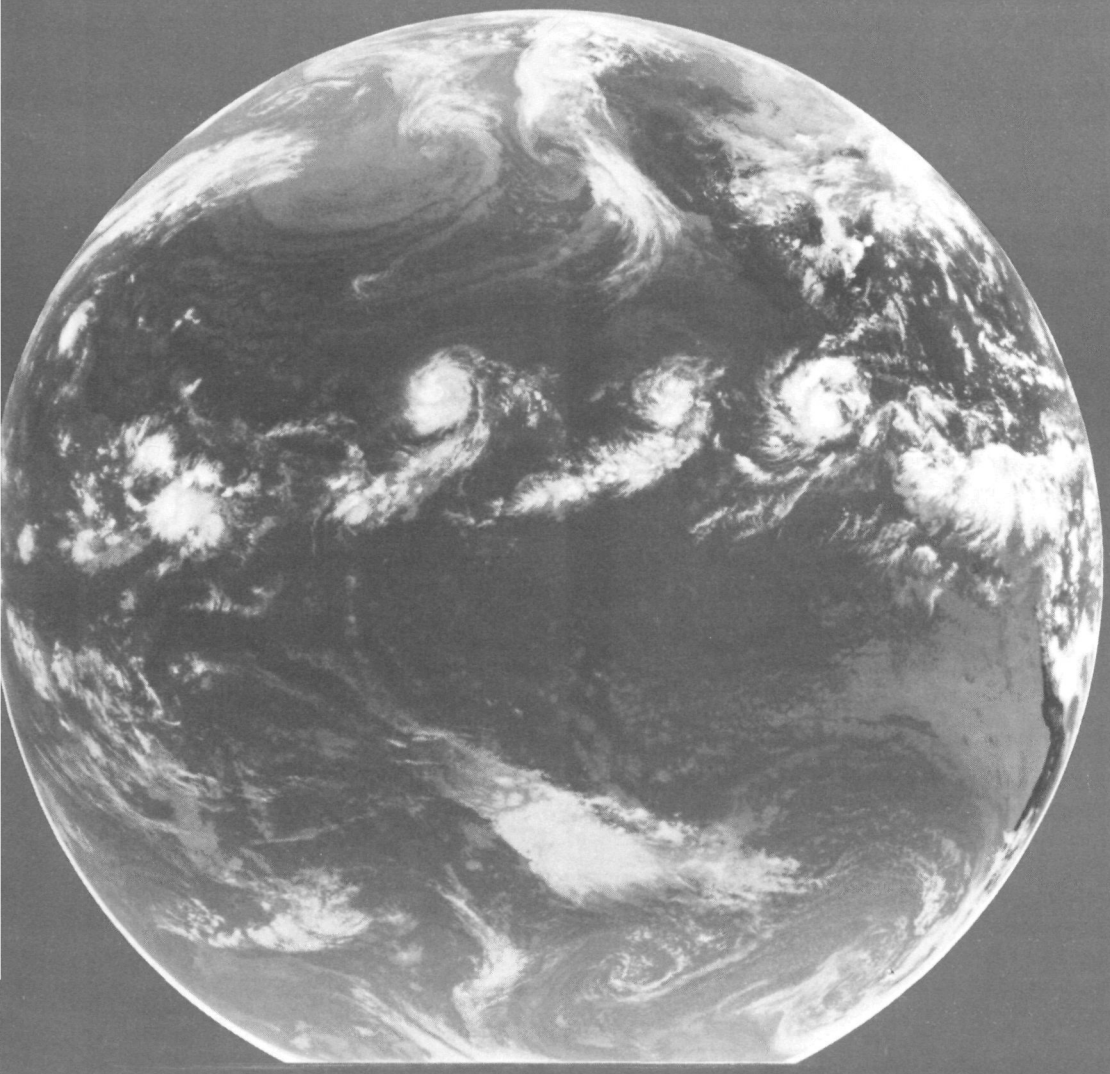












Lined up in perfect order between Hawaii and Central America on September 26th are three Pacific storms (left): Hurricane Kate on the left, just southeast of the Hawaiian Islands; a tropical depression in the center which never reached hurricane force; and, Tropical Depression #19, south of Baja California. Four days later, TD #19 had become Hurricane Liza (above) and within hours smashed into LaPaz, causing millions of dollars in damage and killing more than 100 persons.

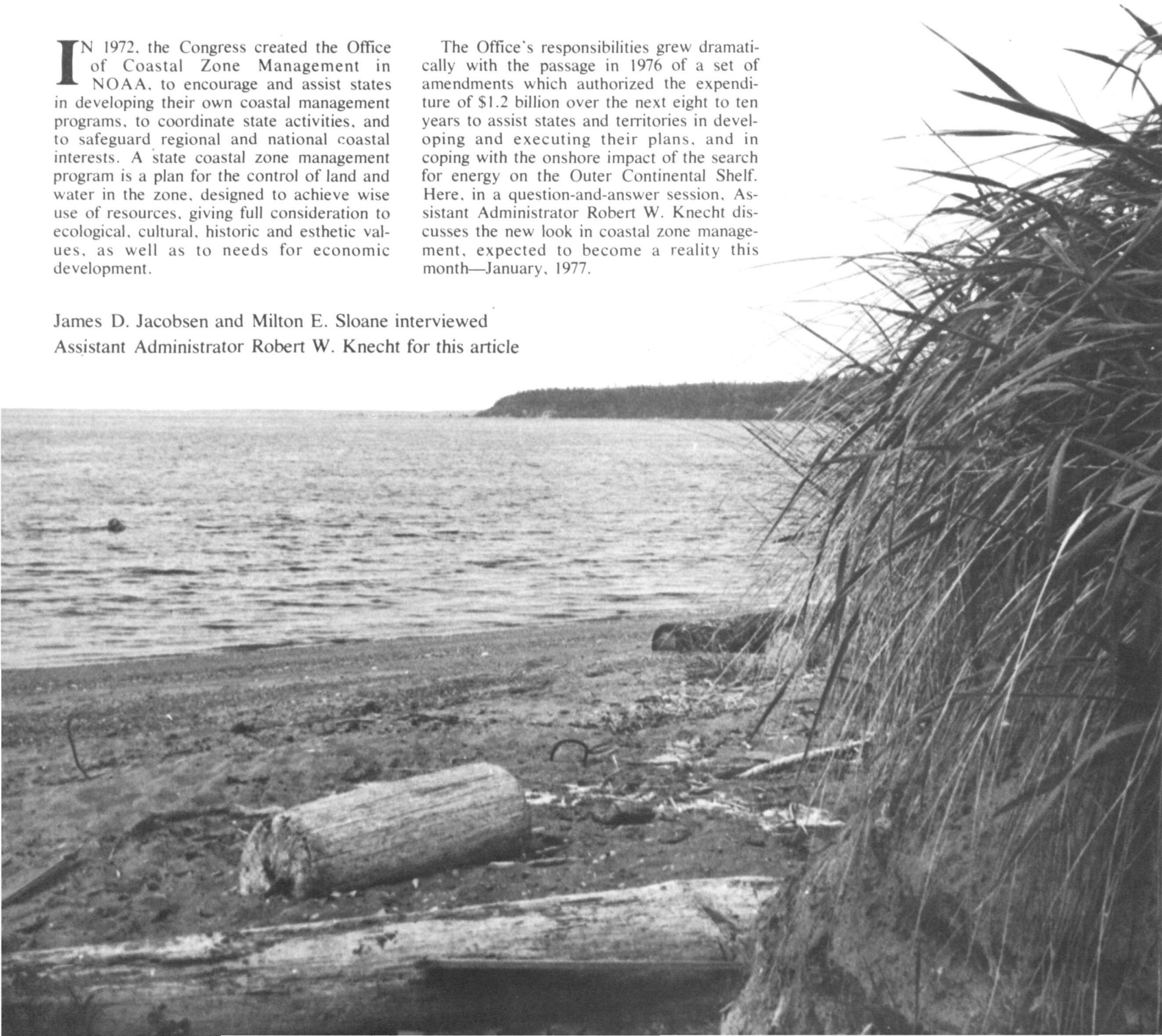
Stronger state incentives and energy impact funds

COASTAL ZONE MANAGEMENT IN 1977

IN 1972, the Congress created the Office of Coastal Zone Management in NOAA, to encourage and assist states in developing their own coastal management programs, to coordinate state activities, and to safeguard regional and national coastal interests. A state coastal zone management program is a plan for the control of land and water in the zone, designed to achieve wise use of resources, giving full consideration to ecological, cultural, historic and esthetic values, as well as to needs for economic development.

The Office's responsibilities grew dramatically with the passage in 1976 of a set of amendments which authorized the expenditure of $1.2 billion over the next eight to ten years to assist states and territories in developing and executing their plans, and in coping with the onshore impact of the search for energy on the Outer Continental Shelf. Here, in a question-and-answer session, Assistant Administrator Robert W. Knecht discusses the new look in coastal zone management, expected to become a reality this month—January, 1977.

James D. Jacobsen and Milton E. Sloane interviewed Assistant Administrator Robert W. Knecht for this article



Q. How do the new amendments modify the original Act?

A. The new amendments have two separate parts. First, they create the Coastal Energy Impact Program, which is a major new thrust for us, and second, the amendments strengthen and extend the provisions of the basic program.

Q. How does the new legislation affect OCZM's basic program mission which is to help states develop an effective coastal management program?

A. Many of the amendments strengthen the basic program and, hence will be very helpful as we work with states in developing good coastal management programs. Specifically, these amendments allow for a fourth and, in some circumstances, a fifth year to develop programs—and in many cases, that additional time will be crucial. The amendments also allow for a higher share of Federal financial assistance, up to 80 percent from $66^2/_3$ percent, and the authorization levels are increased for program development as well as program administration grant funds. Finally, there are a number of new features, which will be helpful to states in a supportive way. For example, grants are now authorized for research and training purposes; for interstate studies such as those concerned with energy, erosion, marine transportation and the like; grants are now available to assist in acquisition of needed access to coastal recreation areas.

Q. How will the "interim approval" process work?

A. Actually, this is an important aspect of the new amendments and has to do with a kind of "halfway house" created between the planning and the operational phases of a state's program. This is called "interim approval." It means that a state has fully completed the overall design of this management program, has completed all of the technical work and made all of the technical decisions with regard to the program, but has failed to complete one or more of the implementing aspects such as new legislation, reorganization, executive orders and so on. So, "interim approval" means that an agreement has been reached between the state and our office that the program described when fully implemented would be approvable and a timetable has been set for the state to close the gaps.

Q. Washington is the only state which has completed development of its program and had it approved by NOAA. What other states do you feel are coming with a program soon?

A. I think we can look forward to approval of segments of certain states in the very near future, for example, the San Francisco Bay Region in California and the Island of Culebra in Puerto Rico. Following shortly thereafter, in mid-1977, I anticipate that we will be considering for final approval the programs from the States of California and Oregon. As you know, the California legislature recently passed coastal zone management legislation and the Oregon voters sustained their current land use and coastal legislation at the polls on November 2.

Q. Once a state has an approved program, does it automatically receive Federal assistance?

A. Federal assistance is awarded to states to administer an approved program on an annual basis provided that the program remains in good standing. Each year, our office is responsible for re-certifying a state's program and ensuring that it is being implemented as it was originally submitted and approved.

Q. Has a state ever been refused participation in the Coastal Zone Management Program?

A. One of the requirements states must meet in order to continue receiving program development grants is to show progress toward development of an eventually approvable program. In addition, states must complete the work they started in each successive grant period. So far, there has been only one case where a state in our view has not yet successfully completed the work it committed itself to, and hence, an additional grant has not been made—and that's the case of Indiana.

Q. The new bill also adds three additional planning requirements to state programs, for beach access, energy facility siting, and shoreline erosion control. Would you explain these?

A. Yes. I think Congress felt that beach access, energy facility siting, and shoreline erosion control are so important that they require specific treatment in state coastal management programs. At present, our office is drafting rules and regulations describing exactly what we will consider as an adequate program in each of these three areas. At a minimum, however, states will have to have a planning process that deals with the problem, for example, of erosion that indicates what kind of guidance it proposes to provide to local communities to deal with local erosion problems, how they plan to approach the problem of setting state policies on erosion, how they would begin to develop mechanisms to deal with erosion problems, and so on.

Q. Shoreline erosion, beach access, and energy facility siting present chronic problems along the coasts. What do you envision as probable solutions?

A. In the case of beach access, for example, the new amendments authorize creation of a grant program to assist states in acquiring improved rights-of-way to beaches and other coastal amenities. I think this will be helpful provided that the Administration and

Congress agree on a satisfactory level of funding. On energy facility siting, I believe that the Coastal Energy Impact Program and the funding assistance available under it will be helpful in resolving potential coastal impacts. With regard to shoreline erosion, I think that once we have a better understanding of the magnitude of the problem, we can do a better job of providing the proper solutions and perhaps federal assistance through new legislation if that proves necessary.

Q. Several other major elements are included in the amendments which also affect the basic program. Would you comment on them?

A. A key element of the new amendments is the tie, for the first time, between state coastal management programs and federal decision-making with regard to the Outer Continental Shelf. The "federal consistency" provision of the basic CZM Act has been explicitly extended to include offshore energy exploration plans, development plans, and production plans that are approved by the Federal government. These OCS plans are now required to be consistent with approved state coastal management programs to the extent that activities included within these plans impact land and water uses in the state in question.

Q. In terms of the basic program, what is your office doing to implement the new amendments?

A. In connection with the energy impact program we are organizing a division to handle the processing of grants, loans, and other kinds of financial assistance. In addition, we are strengthening a number of other parts of the office that will support the Impact Program as well as the other parts of the basic program. For example, our regional coordination network will be substantially strengthened, our grants management operation will be expanded, our legal detachment, part of the NOAA General Counsel's Office, is being doubled and our Federal relations activity will have to be increased.

Q. What is the general reaction so far to the proposed regulations on the expanded Federal consistency provisions under the basic program which have been distributed for public comment?

A. There is an understandable concern with regard to the regulations on both the part of the states and Federal agencies involved in coastal activities. Both sides are concerned that the processes we call for seem to be complex and time consuming. Therefore, we are re-examining our proposal to see if there is a way to simplify it and to speed up the process without short-changing the basic objective. That is, we want to assure that to the maximum extent practicable federal actions support and do not frustrate approved state programs.

Q. What is the effect expected from the new amendments?

A. I have two hopes for the new amendments. The first is that the amendments which strengthen and extend the basic program will provide stronger incentives for successful state participation in the coastal management program; that, in effect, they will accelerate states from planning and preparation into the coastal management process. My second hope is, I would like to see the Coastal Energy Impact Program facilitate expanded domestic energy production. It will especially help coastal communities and coastal states in dealing with rather severe pressures that offshore oil and gas development is going to put upon them.

Q. Do the new amendments provide any new incentives to the states?

A. They provide additional financial assistance as well as encouragement to participate in coastal planning. The new Energy Impact Program especially requires states to be participating in the Federal coastal management program (or a similar program at the state level) in order to receive federal assistance.

Q. Which states will the new legislation affect most?

A. The formula grants portion of the energy impact program will be of most direct and immediate application to the State of Louisiana. The allotment for formula grants depends on oil and gas currently being produced in the Federal Outer Continental Shelf adjacent to the state in question. Since most of the current Federal oil and gas production is adjacent to Louisiana, that state will have the largest allotment. Regarding the credit assistance component of the CEIP, I think it is clear that Alaska will be the most immediate benefactor since so much of the new leasing will be adjacent to that state and much of the early activity at least, will be in that area.

Q. Do the Great Lakes states have as big a stake in the new amendments as do Pacific, Atlantic, and Gulf Coast states?

A. They certainly do with regard to the provisions of the amendments that refer to the basic program, but the energy impact program is somewhat less relevant to those states. However, it should be noted that funds under the impact program are available for planning for all kinds of energy facilities, in the Great Lakes as well as along the ocean shoreline, and a certain limited amount of funding for environmental purposes is also potentially available to them.

Q. How will the basic program relate to other organizations within NOAA, such as the National Marine Fisheries Service for fisheries protection?

A. Recently, the NMFS has gained a very large and important task dealing with extended 200-mile jurisdiction. This brings them very directly into the management of living marine resources over wide ranges of the Outer Continental Shelf. To the extent that our new energy impact program is directly related to the OCS in its oil and gas-related activities, we will have to coordinate closely. I think we can anticipate a closer working relationship between NMFS and OCZM in terms of management of shelf resources.

Q. What part does the Coastal Zone Management Advisory Committee play in forming new regulations or interpreting the present ones—what is its role?

A. The Coastal Zone Management Advisory Committee, as I see it, serves principally in the capacity of advising the management of the coastal zone program, NOAA and the Department of Commerce on key policy issues in this field. This would mean that it should be involved in the review of new proposed rules and regulations and major policy issues that may be confronted in setting up these new activities.

Q. How does the Nation's energy situation relate to Coastal Zone Management?

A. Many of us feel that the quickest way to obtain oil and gas resources from the Outer Continental Shelf is through a cooperative State-Federal approach. That means that the states and their local governments and the Federal government need to be pursuing this important national goal in a fully cooperative and coordinated way. I think the coastal zone management program provides the framework for that coordinated approach.

Q. How will the new Coastal Energy Impact Program affect the national energy supply?

A. If the CEIP works out the way in which Congress intended it to, then it will facilitate access to important national energy resources existing on the Outer Continental Shelf. That is, communities will be assisted in coping with the pressures and problems brought about by OCS activity and, hence, will be better able to bear their portion of the new burdens that may be placed upon them.

Q. What kind of assistance is provided by the Impact Program?

A. The Impact Program provides funding for planning assistance; provides credit assistance in the form of bonds and loan guarantees for needed public facilities such as schools, hospitals, roads, sewer plants, etc., in connection with expanding populations associated with coastal energy activity. The CEIP also will provide repayment grants in those cases where communities are unable to repay loans or bond guarantees because the energy activity doesn't provide revenues as expected. And, finally, the CEIP through the formula grant provision will make available grants to communities and states to deal with unavoidable losses of valuable environmental and recreational resources.

Q. How are funds allocated?

A. The credit assistance in the form of loans and bond guarantees basically will be made available to states based on the estimated number of new jobs that are going to be created in that state as a result of coastal energy activity. On the other hand, the formula grant allotment will be made available to states based on the amount of oil and gas produced from the Outer Continental Shelf, adjacent to that state in the year preceding the year in question. Other factors

in this determination include oil and gas first landed in that State from the Federal Outer Continental Shelf, employment levels in OCS activities, and acreage leased adjacent to the state.

Q. When do you expect first funding will be available for the new program?

A. We have submitted a supplemental funding request for fiscal year 1977 through the Department of Commerce to the Office of Management and Budget. We are hopeful that this supplemental appropriations request will go forward to the Congress together with the regular fiscal year 1978 budget in January 1977. Assuming that this is the case, and assuming expeditious action by the Congress, funds could be available as early as February or March 1977. Shortly thereafter, we anticipate an allotment of these funds to eligible coastal states by March and expect to be in a position to receive applications for specific assistance by May.

Q. Do you set interest rates for loans or loan guarantees?

A. Yes, that is a unique aspect of the new legislation. The Secretary of Commerce will be the only official outside of the Treasury Department to set interest rates on Federal Government loans. Setting these interest rates will be an important aspect of the operation of the program.

Q. What must a State do to become eligible for Federal assistance under the Coastal Energy Impact Program?

A. It must be either receiving a program development grant under Section 305 of our program, receiving a program administration grant under Section 306, or be making satisfactory progress to develop a program meeting the policy and objectives of the Coastal Zone Management Act of 1972.

Q. What happens if, after a state or local community has begun building a project funded with loans or guarantees from the impact program, the anticipated energy facility is cancelled?

A. That's precisely the kind of situation this program is designed to deal with. By providing for repayment assistance, the Federal Government is removing the risk to the State or local jurisdiction of providing new or improved public facilities. If the energy activity and the increased tax revenues it would generate don't materialize, the impact program can provide refinancing, modification of loan terms, or repayment grants to ensure that the project can be completed without fiscal hardship to the state or local government.

Q. What public facilities and services are required as a result of energy activity?

A. The new amendments do not require any specific set of public facilities. Rather they authorize the creation of an assistance package that communities can avail themselves of to meet the facilities they feel they need. So the question of what facilities, the kind of facilities, the size, and so on, is essentially left to the communities in question.

Q. How do you know that states will utilize the money for the stipulated purpose?

A. The rules and regulations which are now in draft form specify the usual safeguards in a program of this type. In addition, the audit requirements are spelled out rather carefully in the new legislation. Furthermore, the states are required to sign, in effect, a contract with us indicating that they will return or repay funds from the formula grant program that are determined after the fact to have been spent incorrectly.

Q. Who determines when Outer Continental Shelf activity affects a state?

A. OCS activity begins affecting a state as soon as the Department of the Interior calls for the nomination of OCS tracts in an area near that state. The specific determination of the "impact areas" relevant to each new OCS activity will be made by OCZM and the states in collaboration. We are very much aware that the areas most impacted by OCS activity are not always the ones closest to the activity, and we don't want to tie ourselves to narrow criteria of "adjacency" in assessing whether an area is potentially affected by new OCS activity.

Q. What are environmental or recreational losses as they apply to the Coastal Energy Impact Program?

A. The formula grant provision of the CEIP is an effort to recognize a modicum of national or Federal responsibility to pay for unavoidable losses of valuable environmental or recreational amenities carried out in the national interest. These losses could come about through loss of a productive wetland; dredging related to oil activity; deterioration of water quality through the multiple and cumulative effects of related oil activity; erosion along channel banks associated with oil-related transportation; loss of coastal recreational lands to oil-related development, and the like.

Q. Does a state define its own seaward boundary as it applies to adjacent states?

A. The legislation calls upon the two states in question to get together and agree on a method for extending the boundary between them through the territorial sea and to the edge of the Outer Continental Shelf. Failing that, the Secretary of Commerce is directed to determine these boundaries. We are in the process of developing a procedure that will encourage states to embark on a bilateral negotiation which, hopefully, will result in the setting of these boundaries within the next year. In order to determine a state's allotment under the formula grant provision, it's necessary to be able to attribute Federal lease sales to an adjacent state. Most boundaries between states have yet to be extended through the territorial sea, to say nothing of the edge of the continental shelf.

Q. How will the U.S. energy impact program compare with the program in Scotland?

A. I'm not aware of any precisely similar program in Scotland in terms of national financial assistance due to impacts, such as our coastal energy impact program. However, a kind of do-it-yourself counterpart to this program was established by the county government in the Shetland Islands several years ago in their dealings with the oil industry and apparently has been working quite satisfactorily. There are, however, a number of lessons that can be learned in the Scottish experience.

Q. Does Canada or any other country have a program such as ours?

A. Not to my knowledge.

Q. What are the steps your office is taking now to implement the new energy impact program?

A. The first step is the development of rules and regulations, which will establish the policies and procedures to operate the new program. We published the first draft of these rules and regulations on Oct. 22 in the Federal Register. In addition, a draft environmental impact statement was also made available to the public in mid-October.

Q. Have you had any reaction to the proposed regulations thus far?

A. There have been quite a number of reactions and a good number of questions raised. Reactions have varied quite a bit. A number of correspondents indicate general satisfaction with the regulations, but make relatively minor suggestions for improvement. Others have major problems with one or more points in the philosophy. However, we are finding that many of the major problems cited have to do with statutory requirements—requirements that we are not in a position to modify. In general, I'm pleased with the degree of interest being shown in the draft regulations and the kinds of responses we're getting.

Q. What ramifications do you see from the new coastal zone amendments?

A. I don't believe the new amendments change the basic direction or purposes of the Coastal Zone Management Act of 1972. The principal objectives of that Act were to provide assistance and encouragement to states in first developing and then implementing comprehensive coastal management programs to meet the particular problems of their shoreline areas. While the coastal zone management program and the supporting legislation has an environmental thrust, clearly the resulting state programs are meant to be balanced and to reflect the need for economic development as well as the urgent need for conservation of coastal resources.

Q. What effect have the new amendments had upon your office and upon the states?

A. The office is expanding as a result of the new program, . . . gearing up for the higher level of activity. We're having to add some additional competence in unfamiliar areas, such as municipal-state financing, public facilities assistance, coastal access, and so on. Similarly, the states will have to develop competence in dealing more precisely with coastal energy-related problems. □

TAKE TWO POUNDS OF FISH AND GIVE IT GLAMOUR

Seafood can be glamorous. All it takes is a little initiative and imagination in preparation of this bountiful resource. Each recipe has a special flavor and can be served with a flair. And just like anything else that can be made glamorous, you need to start with a good base—the fish fillet.

Fish fillets are the most common and easily found cut of seafood. Fish fillets are the tender sides of the fish cut lengthwise away from the backbone, and they are ready to use. There is practically no waste in fish fillets, so you really get your money's worth. Many varieties of fish are plentiful and fillets cut from these fish will be lower in cost than the scarcer species.

So, reel in a couple of pounds of fish fillets for dinner tonight and add your own special touch of glamour.

Fillets New England

2 pounds fish fillets, fresh or frozen
1 cup sliced celery
⅓ cup chopped onions
6 tablespoons butter or margarine
4 cups soft bread cubes (½-inch)
½ cup chopped pecans
1¼ teaspoons salt
1 teaspoon grated orange rind
¼ cup orange juice
Cranberry-Orange Sauce

Thaw frozen fish. Cut fillets into 6 portions. Cook celery and onions in 10-inch fry pan in ¼ cup butter or margarine until tender but not brown. Stir in bread cubes, pecans, ¼ teaspoon salt, orange rind, and orange juice. Turn stuffing into well-greased baking dish, 12 x 8 x 2 inches. Arrange fish in a single layer on stuffing. Melt remaining 2 tablespoons butter or margarine and drizzle over fish. Sprinkle with 1 teaspoon salt. Bake in a moderate oven, 350°F., 25 to 30 minutes or until fish flakes easily when tested with a fork. Serve with Cranberry-Orange Sauce. Makes 6 servings.

Cranberry-Orange Sauce

⅓ cup sugar
2 teaspoons cornstarch
½ cup orange juice
½ cup water
1 cup raw cranberries
2 teaspoons grated orange rind

Combine sugar and cornstarch in 2-quart saucepan and mix. Add orange juice and water; cook, stirring constantly, until mixture comes to a boil. Add cranberries, and cook 5 minutes or until skins on cranberries pop, stirring occasionally. Fold in orange rind. Serve with fish. Makes 1¼ cups sauce.

Fillets Oriental

2 pounds fish fillets, fresh or frozen
⅓ cup cooking oil
1 cup sliced celery
1 cup sliced onions
1 cup sliced mushrooms
1 clove garlic, minced
1 package (10 ounces) frozen green peas or Chinese pea pods, partially defrosted
1½ cups water
2 tablespoons sherry
2 tablespoons cornstarch
1 tablespoon soy sauce
1½ teaspoons salt
½ teaspoon monosodium glutamate
¼ teaspoon powdered ginger
6 servings hot, fluffy rice

Thaw frozen fish. Cut fish into 1-inch pieces. Cook in 3 tablespoons oil in 12-inch fry pan or Chinese wok until firm. Remove fish from pan. Add remaining oil to pan. Add celery, onions, mushrooms, and garlic. Cook and stir until mushrooms are limp. Add peas or pea pods; mix. Combine water, sherry, cornstarch, soy sauce, salt, monosodium glutamate, and ginger; blend well. Add to vegetables and cook, stirring carefully until sauce is thickened and clear. Add fish and cook until fish flakes easily when tested with a fork. Serve over rice. Makes 6 servings.

Fillets Milano

2 pounds fish fillets, fresh or frozen
1½ cups sliced onions
1 clove garlic, minced
¼ cup cooking oil
2 cups sliced zucchini (½-inch)
2 tablespoons flour
1½ teaspoons salt
¼ teaspoon pepper
1 can (1 pound) tomatoes or tomato wedges
1 can (8 ounces) tomato sauce
1 teaspoon basil
4 ounces spaghetti (raw weight), cooked and drained
½ cup shredded Parmesan cheese

Thaw frozen fish. Cut fish into 1-inch pieces. Cook onions and garlic in 2 tablespoons oil in 10-inch fry pan until tender but not brown. Add fish and cook, turning carefully until fish is firm. Remove from pan. Add remaining 2 tablespoons oil to pan. Add zucchini and cook until thoroughly heated. Sprinkle with flour, salt, and pepper; mix well. Add tomatoes, tomato sauce, and basil. Cook until sauce is thickened and zucchini is almost tender, stirring occasionally. Combine with fish, and mix carefully. Layer half of the spaghetti, fish mixture, and cheese in baking dish, 12 x 8 x 2 inches. Repeat layers to use remaining ingredients. Cover with aluminum foil, crimping it tightly to edges of dish. Bake in a moderate oven, 350°F., for 20 minutes. Uncover and continue baking 20 minutes longer or until zucchini is tender and fish flakes easily when tested with a fork. Makes 6 servings.

Fish Stew With Bacon-Cornbread Dumplings

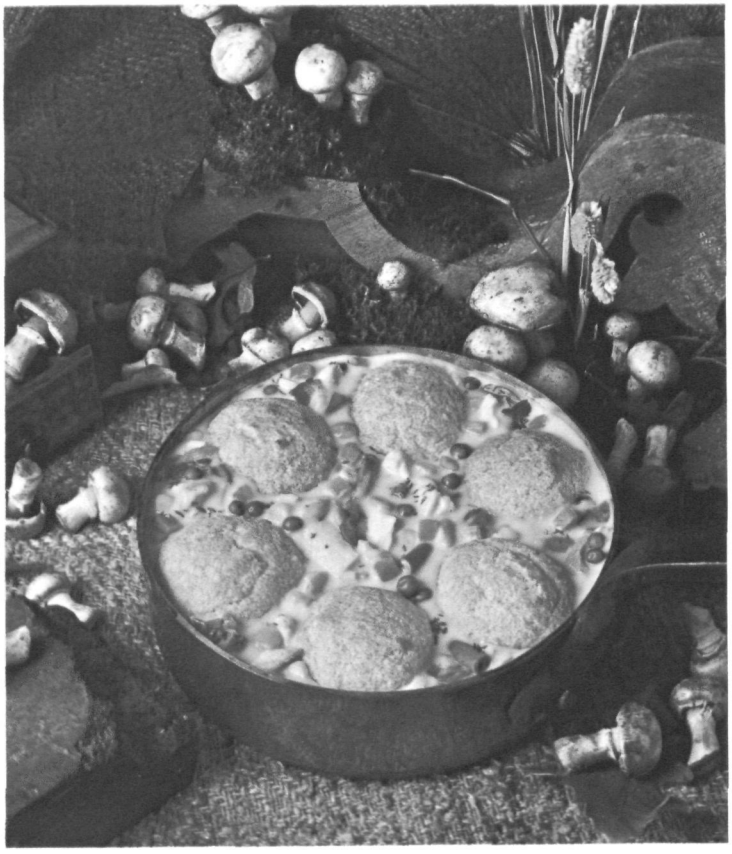
2 pounds fish fillets, fresh or frozen
1½ cups sliced onions
¼ cup butter or margarine
1 package (10 ounces) frozen mixed vegetables, partially defrosted
1 can (4 ounces) sliced mushrooms, undrained
2 cans (10½ ounces each) condensed cream of celery soup
1 cup milk
1 teaspoon salt
½ teaspoon leaf thyme
4 slices bacon, diced
½ package (18 ounces) corn muffin mix
Milk

Thaw frozen fish. Cut fish into 1-inch pieces. Cook onions in butter or margarine until tender but not brown in 6-quart Dutch oven with heat-proof handles, stirring often. Add frozen vegetables and mix. Add mushrooms, soup, milk, salt, and thyme. Heat and stir until hot. Fold in fish. Cover and bake in a hot oven, 400°F., 15 minutes or until hot and bubbly. Fry bacon until crisp; drain on absorbent paper. Prepare muffin mix as directed on package label, reducing milk by half. Stir in crisp bacon lightly, and drop 6 to 8 mounds of batter onto hot fish mixture. Return to oven. Bake 20 minutes or until dumplings are done and fish flakes easily when tested with a fork. Makes 6 to 8 servings.

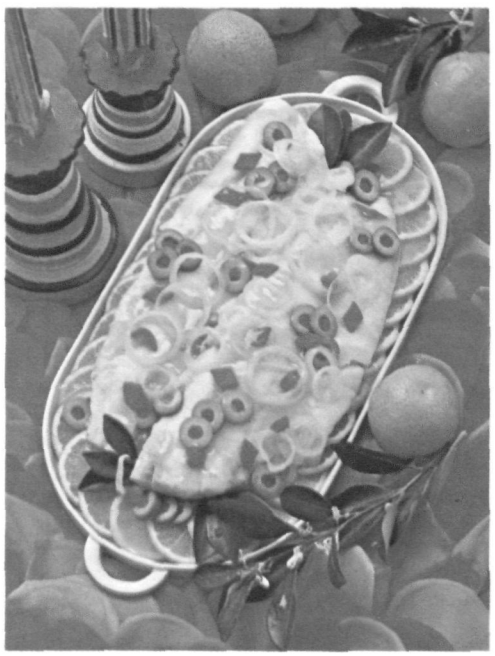
Fillets Amandine

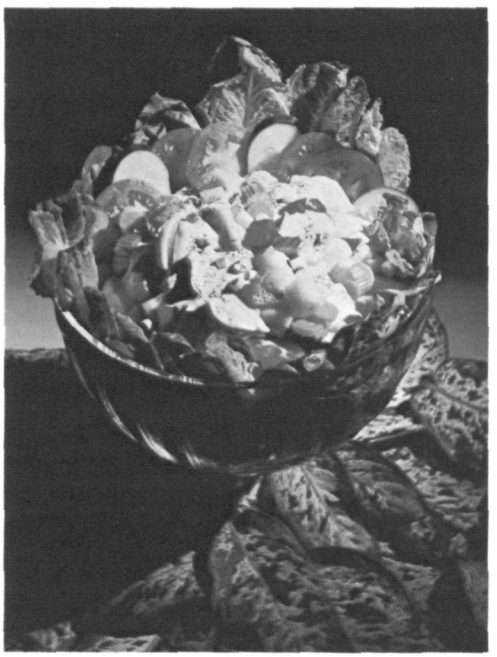
2 pounds fish fillets, fresh or frozen
¼ cup flour
1 teaspoon seasoned salt
1 teaspoon paprika
¼ cup melted butter or margarine
½ cup sliced almonds
2 tablespoons lemon juice
4 to 5 drops liquid hot pepper sauce
1 tablespoon chopped parsley

Thaw frozen fish. Cut fillets into 6 portions. Combine flour, seasoned salt, and paprika; mix well. Roll fish in flour mixture. Place fish in a single layer, skin side down, in a well-greased baking pan, 15 x 10 x 1 inches. Drizzle 2 tablespoons melted butter or margarine over fish. Broil about 4 inches from source of heat 10 to 15 minutes or until fish flakes easily when tested with a fork. While fish is broiling, sauté almonds in remaining butter in fry pan and allow to turn a golden brown, stirring constantly. Remove from heat. Add lemon juice, hot pepper sauce, and parsley; mix. Pour over fish. Serve at once. Makes 6 servings.



Recipes for Fillets Oriental (opposite page), Fillets Milano (top), Fish Stew with bacon-cornbread dumplings (left), and Fillets Amandine (above) appear on previous page.





Fish 'n' Chips

2 pounds fish fillets, fresh or frozen
1½ cups prepared pancake mix
1½ cups milk
¾ teaspoon salt
Hot oil or fat for frying
6 servings favorite French fries
Malt vinegar or tartar sauce, as desired

Thaw frozen fish. Cut fillets into pieces 4 x 1½ x ½ inches. Combine pancake mix, milk, and salt; beat until smooth. Dip fish pieces into batter and place in single layer in fry basket. Fry in deep fat, 350°F., 3 to 4 minutes or until coating on fish is brown and fish flakes easily when tested with a fork. Drain on absorbent paper. Serve with hot French fries. Sprinkle fish with malt vinegar or serve with favorite tartar sauce. Makes 6 servings.

Fillets Yucatan

2 pounds fish fillets, fresh or frozen
2 tablespoons lemon juice
1 teaspoon salt
1 cup sliced onions
¼ cup melted fat or oil
1 tablespoon flour
½ cup sliced stuffed olives
¼ cup diced pimientos (¼-inch)
⅛ teaspoon saffron (optional)
¾ cup orange juice

Thaw frozen fish. Place fillets in a single layer, skin side down, in a well-greased baking dish, 12 x 8 x 2 inches. Sprinkle lemon juice and salt over fish. Cook onions in a 10-inch fry pan in fat or oil until soft but not brown. Blend in flour. Add olives, pimientos, saffron, and orange juice. Cook, stirring constantly, until sauce is thickened. Pour sauce over fish. Bake in a moderate oven, 350°F., 20 to 25 minutes or until fish flakes easily when tested with a fork. Makes 6 servings.

Crunchy Fish Salad

2 pounds fish fillets, fresh or frozen
2 cups boiling water
2 teaspoons salt
1 small onion (1½-inch), sliced
⅓ cup lemon juice
¾ cup commercial herb and garlic dressing
½ cup sliced green onions
2 cups sliced, cooked carrots
2 cups peeled, diced cucumbers (½-inch)
2 tablespoons diced pimiento
2 cups celery, sliced thin diagonally
1 cup dairy sour cream
¼ cup horseradish
1 teaspoon dill weed
⅛ teaspoon white pepper
Crisp salad greens
Cucumber or tomato slices for garnish

Thaw frozen fish. Cut fillets into 1 inch pieces. Place fish pieces in 10-inch fry pan. Add water, 1 teaspoon salt, onion, and ¼ cup lemon juice. Cover and simmer 5 to 10 minutes or until fish flakes easily when tested with a fork. Carefully remove fish from liquid; drain; and place in bowl. Pour half of the herb and garlic dressing over fish. Cover and chill 1 to 2 hours. Combine green onions, carrots, cucumbers, pimiento, celery, and remaining herb and garlic dressing; mix. Cover and chill 1 to 2 hours. Combine sour cream, horseradish, dill weed, pepper, and remaining lemon juice and 1 teaspoon salt. Mix well. Drain fish and vegetables; combine; fold in sour cream mixture gently. Serve on crisp salad greens. Garnish with cucumber or tomato slices or both. Makes about 10 cups, 8 to 10 servings.

NOAA Profile

EAT FISH, AMERICA!

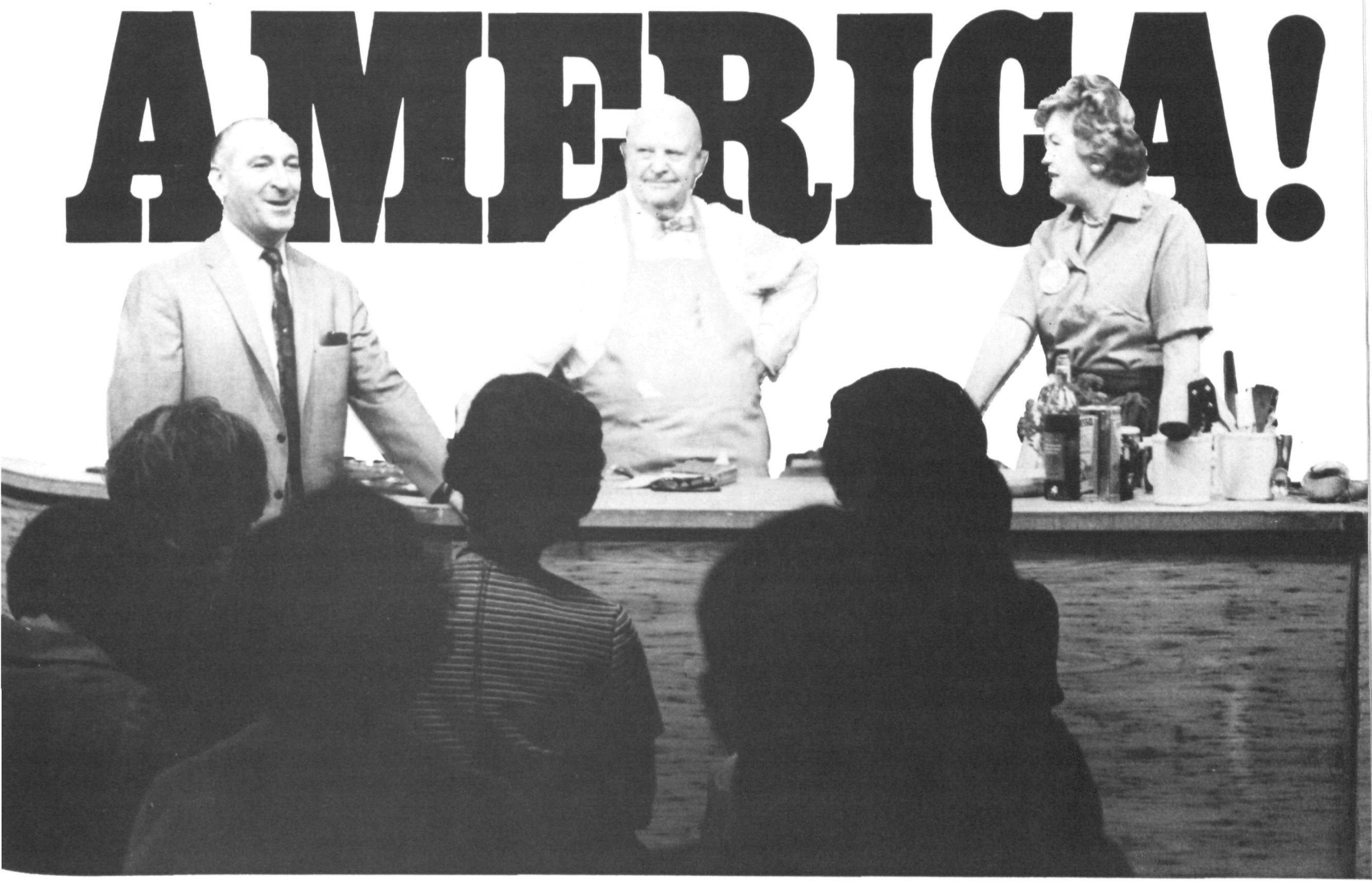


Photo: Robert Brigham

Three experts in food preparation–NMFS' Bob Finley, James Beard, and Julia Child.

BY VALERIE A. ANDERSON

BOB FINLEY had just given three television demonstrations, showing thousands of viewers how to prepare exotic seafood dishes, and he was naturally eager to get his mother's opinion of his performance.

He got it.

"Bob, you're a fraud," she said. "*You don't know how to cook.*"

That was years ago, and he lost no time learning. Today, as head of the National Marine Fisheries Service's National Fisheries Education Center in Chicago, he can—and does—swap skillet-talk with such experts as Julia Child and Jim Beard. He still tests recipes before unleashing them upon the literally millions of consumers his office reaches. Before an NMFS creation leaps up at you in all its vividness from the pages of a newspaper, a magazine or a cookbook, Finley has not only sampled it; he probably has cooked it. Learning to cook once he recognized the need for it was typical of Finley's approach to his job, which may be accurately described as damn-the-torpedoes. Bringing seafood into as many American homes as possible is a goal he pursues with singleminded dedication, and he will happily do whatever it takes to accomplish it.

The job is as big as anybody can make it. In bureaucratese, it is his task to develop and disseminate consumer education information to seafood and allied trade associations, other commercial and recreational fisheries interests, the media, academia, conservation organizations, consumer advocate groups, and anybody else he can reach.

Finley's days (and more nights than he cares to recall) are spent with newspapers, radio and TV stations, in photographers' studios, and groups upon groups, as he develops promotional programs. Bursting with energy, always on the move, carrying his message with staccato good cheer, he chases his dream. He is not as cheerful as he seems; he is, in fact, a restless, not easily satisfied man whose quest for perfection keeps him perpetually looking for new worlds to conquer.

His approach to the complex problems of marketing have earned him enough kudos to satisfy anybody: they include the National Fisheries Institute's Distinguished Service Award; the Blue Pencil for outstanding Federal publications; the Catfish Farmers' Merit Award for Outstanding Service; the restaurant field's Executive Chefs Association and the American Culinary Olympic Teams' awards; Kimberly-Clark Corporation's Mark of Excellence for graphic communications; Man of the Year Awards from the National Fisheries Institute and the Shellfish Institute of North America; and, in 1973, the coveted NOAA Public Service Award.

Fish—and for that matter any body of water—have always attracted him. Born in Allerton, Iowa, just north of the Missouri line, he found fishing in the nearby lake cause enough to play hookey. "I learned every inch of that lake," he remembers,

"every fishing bank, the various places you could catch different kinds of fish. I grew up with that lake, and it became part of me."

The Iowa boy's first exposure to saltwater fisheries, however, came with his Army service in Africa during World War II. "We were always stationed in a coastal area," he says, "and when I had time off, I'd go out with the Arab fishing fleets. Then when we went into Sicily, Italy and finally France, I was still in the Mediterranean. Everywhere I went, I saw seafoods in open air markets, squid on menus, octopus cooked in its own ink, shark dishes. They even took small immature fish and, without cleaning them, deep-fried them in batter." Fascinating, so fascinating in fact, that when he was mustered out the family plan that Bob become a lawyer was abandoned. He entered the School of Fisheries at Oregon State University, attended Iowa State in the summers to learn about fresh-water fish. Before he knew it, he was a marine biologist.

His career began with the Iowa State Conservation Commission, where he did lake studies. He then went to the Interior Department's Bureau of Commercial Fisheries as a statistical agent. In 1950, he took over the publication "Fisheries Statistics of the United States."

Numbers, however, were not lively enough to hold Finley's attention, although he gave color to the publication within the bounds of the nature of the job. "It really wasn't my bag," he said. "I loved people. I needed something more outgoing."

Early in 1958—the year his mother exposed his kitchen ignorance—he became a marketing representative, something more to his liking. He gave demonstrations to schools, supermarkets, restaurants, on TV shows and, in one year, undertook the backbreaking task of 90 such shows.

When the National Fishery Education Center was established in 1961, Finley and a

Top left: Finley receiving the Golden Spoon Award in 1967. At work, he goes over plans for a seafood education program with (from left) Ann Davies, Center Dietician, Rick Guidice, Center Printing Specialist, and Bob Christian, Deputy Director; and reviews a slide presentation. Other of his staff members who make things happen are Majorie Hawk, Carrie Gourlie, and Freddie Nelson.

secretary, starting small, set out to make America conscious of fish as a smashing alternative to meat and poultry. The first step was to freshen up the look of the Bureau's publications. "There's no reason why government materials have to be presented in a dull, unattractive way," he says. Brightness, crispness, and a contemporary feeling are a mark of the Center's publications; they could make an old boot look delectable. One result of the Finley team's touch is that the Center's offerings are getting an impressive share of all U.S. food editor space. Every month, more than 800 U.S. food editors receive the NMFS' latest recipes, accompanied by richly-colored transparencies and covering a wide range, from underutilized species to the traditional favorites. But this is only the tip of the iceberg. Through a variety of approaches, people know more today about fish than ever before, which pleases not only Finley but his boss, Jack Brawner, who bears the jawbreaking title of Chief, Industry and Consumer Services Division, Office of Fisheries Development, NMFS.

"The Center," Brawner says, "provides a vital service to the commercial fishing industry and the consumer alike. It singles out good buys for the housewife as well as providing information on selling, purchasing, handling and nutritional value of seafoods."

Looking ahead, he sees an even more useful role for the Center: "with the advent of the 200-mile fishing limit, the United States will have within its jurisdiction 10 per cent of the world's seafoods. We will have the opportunity to become the world's fore-

Pages from Finley's life--a fourth grader in Allerton, Iowa; a World War II soldier in Tunisia; a vacationing beachgoer in Miami, Fla., 1950. In the shadow of the world's tallest building, the 110-story Sears Tower, Finley relaxes at his home (above left) by cleaning a newly-aquired bronze to add to his antique collection and (above right) mixes his own special Coffee Liqueur.

most fishing capital. The marketing and consumer information from the Center will play a large part in reaching this goal."

As to Finley, Brawner describes him as a can-do professional with a sharp deadline sense, a neat disdain for bureaucratic dawdling, and a unique personality. "He's an innovator," Brawner says. "He's internationally recognized in consumer education, marketing development and the development of educational materials. Private firms ask special assistance from him in developing various types of packaging. This means that millions of consumers are picking up packages designed by Bob Finley."

Getting the word to the housewife—or the institution, or the restaurant—is a carefully planned progression. "We beat the drum in advance of the product," Finley says. "We start an interest program. Then we let the consumer know what NOAA and NMFS are doing to help get that product into her hands. Then it's time to get the product out through the retailers, and to give ideas on how to serve it; costs, characteristics, composition, nutritional value. All these steps lead to one goal—we want people to eat more fish."

The Center's staff is small, tightly-knit, and expert. Robert Christian, Finley's deputy, works with demonstrations, recipes and food photography. Ann Davies is a consumer specialist and nutritionist, working principally with food editors. Rick Giudice labors in consumer education. Carrie Gourlie, the possessor of the world's most delightful Southern accent, is a liaison specialist. Marjorie Hawk and Freddie Nelson support the entire office in the clerical area. Among the Center's highly popular products are its fish charts, depicting U.S. marine life in colorful fashion. The most recent chart, a departure from the rest, is a marine mammal group so spectacular that national magazines are eager to reprint it. The next one will be turtles.

In his spare time, believe it or not, he goes fishing. He has an old house on the Mississippi which he has named "Early Depression", and which he restored with the help of carpentry techniques taught to him as a boy by his father.

His home is an apartment 43 floors above the city of Chicago, where those fortunate enough to be invited to dinner discover that their host is, indeed, a cook.

He likes all fish, but his favorite is salmon steaks Oriental, marinated in a sweet-and-sour sauce, broiled carefully, and served with a delicious variety of side dishes. Salmon, he says, goes well with a great number of things (he favors curried rice with almonds, glazed carrots and Bibb lettuce salad with his own mustard dressing).

Finley has strong opinions on fish cookery, as on many other things, and he is anxious that people treat fish with a certain respect: "don't overdo it; start with fresh or fresh-frozen fish and thaw it properly in the bottom of the refrigerator." And more. The point is, he cares.

Finley makes it look easy, whether he is cooking fish or selling them. But it hasn't always been that way. "I've taken on a lot of jobs I knew nothing about," he says, "and have done the best I can. There are times I lie awake at three in the morning trying to sort out a problem, and I remember my father telling me never to say 'I can't'. And I find that after you get into a project, and research it, and paw and scratch at it, you become comfortable. And then you're not afraid of it any more." □

TEN TELEPHONE POLES AWAY

A Chilling Winter's Tale

BY NANCY PRIDGEON

WHERE were you on the night of December 29, 1972? Chances are you'll have a hard time remembering. Not me. It was one of the longest nights of my life—a night I spent alone, with my car high-centered in a snowdrift, surrounded by a blizzard that swept the Colorado high prairie as though it would never tire.

That I'm here to tell about it is because I remembered the NOAA Winter Storm Safety Rules. I saw them for the first time when I worked at the ESSA Research Laboratories in Boulder, Colo. They made sense, so I put most of them into practice.

One of the rules—"Stay in your vehicle"—I'd never had a reason to test. It sounded right, even easy. But when the time came to use it, it was more difficult to follow than I'd ever dreamed.

I considered myself an experienced snow-and-ice driver. Sudden winter storms are part of the zest of Colorado living. When I left Boulder, I took a job about 100 miles away and moved to an isolated ranch on the Colorado prairie—rolling short-grass-and-sand country where ranchers counted their land by sections. (A section of land is 640 acres or one square mile.)

On the round-trip to work each weekday, I observed the commonsense rules of over-the-road winter travel: Chains in the car trunk, along with a jack that I could manage under unfavorable conditions. A shovel for digging out. And as full a tank of gas as possible—not only for use if extra fuel were needed for freeing a stuck vehicle, but also for the weight.

Some drivers put sandbags or concrete blocks in the trunk. But I did what many had found useful—I carried two mounted tires and wheels equipped with tire chains. Changing a tire in blizzard conditions is sometimes easier than trying to fasten cold, heavy tire chains in place.

8:00 p.m. The weather threatened to dump more snow atop that already fallen the past few weeks. It hadn't started to snow yet. After work, I shopped at the supermarket for the long weekend ahead. The wind in the parking lot was strong, but I thought I could beat the storm. I only had 15 miles to go.

In good weather, the trip to town and back was a delightful drive through range land populated by scattered clumps of cattle, a herd of antelope, an occasional coyote or falcon hunting jackrabbits. What I didn't know that night was that a ground blizzard—strong winds blowing across existing snow on the ground, piling it into drifts and windrows—had been blowing across the area all afternoon. I heard the Traveler's and Stockmen's Advisories when I switched on the car radio. But I knew the area well. I wanted to get home.

8:30 p.m. Five miles east of the city, I picked up a light, steady snow. The lights in the village I passed through were blurred. The road was still dry. Just past the houses, the snow was blowing steadily from the north. It looked like a translucent sheet lying just above the road at ground level. Another mile or so and the road was glare ice.

Cars were driving slowly now, in both directions on the two-way road. I was annoyed that there were so many. A couple more miles and I could turn off the main road. I hoped the cars behind me could stop when I made the left turn.

9:00 p.m. I made the turn and started north into the wind. Two miles of paved road, three miles of gravel road, and I'd be home. Ignoring the fingers of snow grasping the edges of the road, I kept on. The piles of snow were no more than six or eight inches deep, easily negotiable by the car I was driving. The sideroad was usually deserted, so I thought it strange when I passed three or four cars coming toward me. I turned west on the gravel road.

For the first mile, the drifts were a couple of feet deep on the right side of the road. I escaped them by driving on the left side. The drifting was patchy—snow drifts alternating with several yards of road cleared by the wind.

A strong gust swirled snow around the car, blinding me. I braked immediately, but it was too late. I didn't see the hood-high snowbank stretched from one side of the road to the other. The car

Illustration: Lou Nolan

plowed ahead a foot or so before it high-centered—rode up the snow bank until the weight of the car compacted the snow and it sank, suspended as surely as if I had driven it up on a rack.

Except, I didn't know that, at first. I thought all I had to do was to free the car, turn around, and drive home by a second, longer route. The car's motor was still running. It seemed no damage had been done.

For the next two hours, I concentrated on getting out of the snowbank. The car's rear wheels spun helplessly. I shoved newspapers under them. I even sacrificed an old woolen jacket. I shoveled snow from around the rear wheels. The blizzard persisted in filling up the holes, but I thought I was making progress. I pulled my stocking cap over my ears and wound my muffler around my chin. From time to time, I got back in the car out of the biting wind.

Next, I tried jacking up the car. The chained and mounted wheels were ready. But try as I might, I could only get the car up so far—not enough to get the wheels off the ground. It was much later before I figured out I was trying to lift the entire car with a fulcrum point somewhere around the front end—a feat I could never have completed without a much taller jack.

Angrily, I wished someone would come along to help. The car headlights were still on and I worried about being stalled on the wrong side of the road. Suddenly I knew. There wasn't going to be another car. Not that night. And I was very tired.

11:00 p.m. I fought back the panic as I got back in the car to think about the situation. On a clear day, I could have seen my barn, in full view upon a low hill. A mile behind me, at the beginning of the gravel road, was a neighbor's house—people I barely knew. Those two houses, mine and the neighbor's, were the closest. I wasn't going to get the car moving. The best thing to do was to abandon it and walk to the neighbor's.

I shut off the motor, turned off the headlights, and got out of the car. I moved a few steps. Immediately, I was in a light-dark world of hard-driven snow. The car was broadside to the wind and already acting as a snow fence. Snow was piled against the passenger side, lifting over the car, and forming a new drift on the other side. There was a drift I hadn't noticed forming a few feet behind the car.

I took a few tentative steps away from the back of the car. My neighbor was just ten telephone poles away—but I couldn't even see the nearest one. On a clear night, my neighbor's mercury vapor yard light shone like a beacon. Now it was nowhere to be seen.

"Stay in your vehicle," said NOAA's Winter Storm Safety Rules. But I didn't want to. I wanted to run into the night, plunging through drifts to the warm haven only a mile away.

"Stay in your vehicle"—if you can find it.

I floundered to an about-face with the wind at my other shoulder. I blundered into the back of the car. I opened the trunk, got the shovel and the summer sleeping bags—the only ones I had with me—and took them into the car with me. I thought I was about to do a dumb thing. What if I found out in the morning that beyond the drift in back of the car, the road was passable?

"Keep watch. Don't let all occupants of the car sleep at once." The only occupant of my car was me. I'd have to stay awake all night.

"Beware the gentle killers—carbon monoxide and oxygen starvation." I rolled the window down a crack. The wind howled.

Midnight. By the car radio, I learned that the temperature was expected to be 17°—not cold enough to freeze me to death, I thought. Not as long as I stayed out of the wind. I set up a program: I would run the car for only about 15 minutes out of each hour, listening to the radio and warming up. I would get fresh air and exercise.

Food wasn't a problem. I had plenty that could be eaten without preparation. But I wasn't hungry. There was even a container of water—and more snow than I could ever use. But I longed for a thermos of hot coffee.

Sometime during the next hour, I developed a fear that snow would clog the exhaust pipe while the motor was turned off. So I checked each time before I started the car up.

The summer sleeping bags weren't adequate, but I put one inside the other, took off my boots and squirmed awkwardly in. The first time I did this, I left the boots on the floor. That was a mistake. Next time, I put the boots in the bag with me. There was now only a little path outside in the lee of the car.

In between periods of activity, I thought about everything—how I got into this, how I was going to get out of it, what I was going to do if I ever did. Against my will, I dozed—only to wake up a few minutes later with nose and toes protesting the cold. It wasn't going to be enough just to live through this—I also had to avoid frost bite. I stepped up the exercise. I wondered how the antelope and the coyotes were faring.

5:00 a.m. The wind was less intense, blowing only fitful gusts now. I watched a distant car's headlights starting toward me, down a slope where the road would have been. The lights disappeared. When they reappeared, they were backing up. It was still dark but the storm had almost stopped. I didn't think it would do any good to signal.

6:00 a.m. I started the car and began the routine of warming it up. A gray dawn revealed telephone poles sprouting undaunted from a barren land. Fences were buried, but I could see the top of the barn. An arroyo, 12 feet deep, between me and home was smoothed across the top as though it weren't there. Nothing moved. I allowed myself the luxury of running the car a bit longer than usual.

7:00 a.m. I was warm now, and bemused and drowsy. I'd made it. I thought I should stay where I was a bit longer—it seemed like a lot of trouble to walk a mile over the snow.

"Beware the gentle killers . . ."

With great effort, I got out of my car into the eerily still white world. I inanely wondered whether to take my purse with me or leave it behind. I leaned on the roof of my car and thought about hot coffee. That did it. I started off toward my neighbor's, clutching my purse.

It took an hour or so to go the distance. The tracks of the car were obliterated by now, and some of the virgin snow was piled into barriers waist-high or higher. But my head was clearing. I took care not to go too near the edge of the road where I knew there were "borrow pits"—ditches deep enough, in some cases, to hold a small car. I followed the telephone poles and half-jumped, half-climbed the drifts. There were short respites between, where the road was bare for several feet.

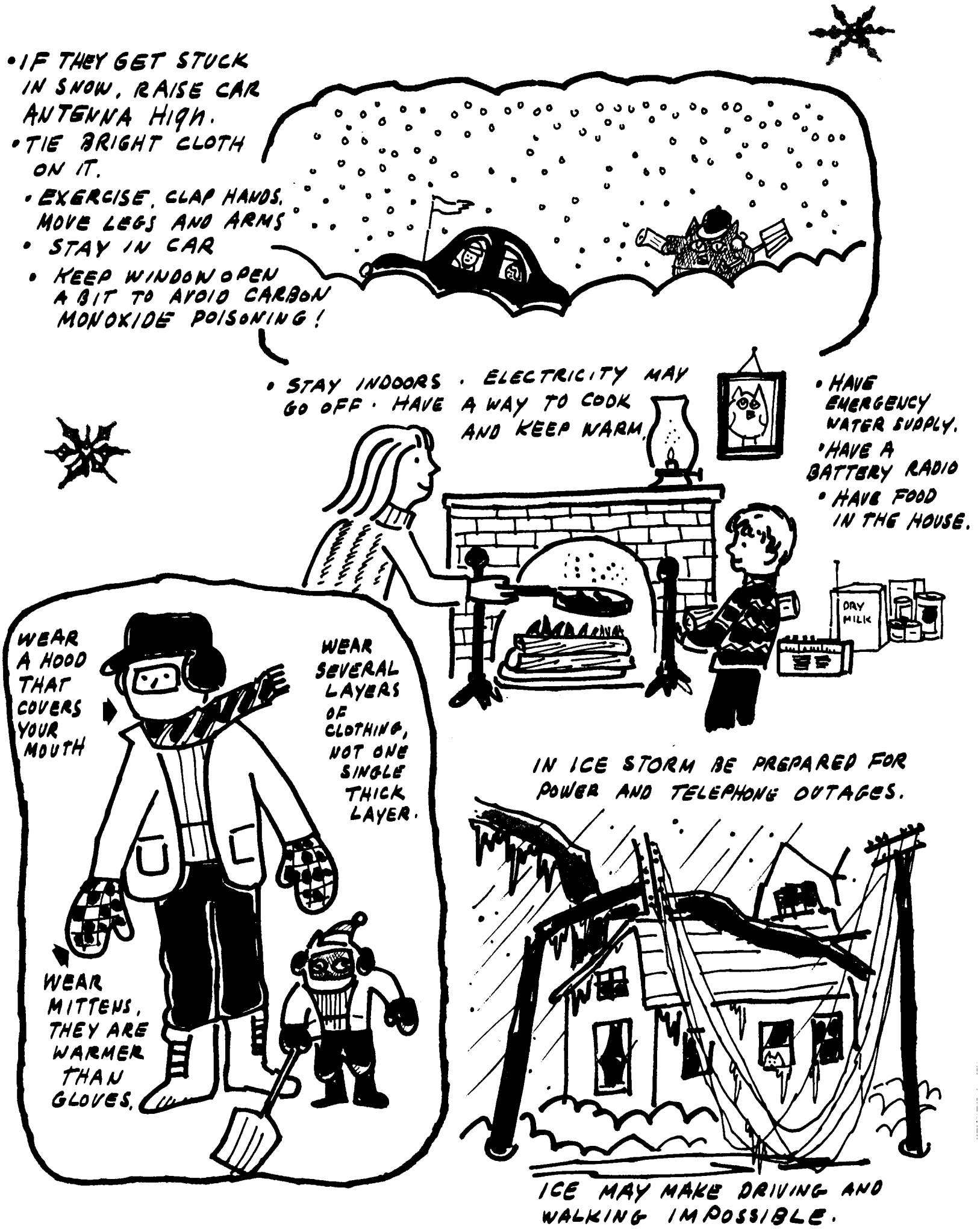
9:00 a.m. I stumbled across the quiet road to the dooryard of my neighbor's house. Two border collies rushed out with a noisy challenge as the rancher's wife helped me inside. At last, there was coffee.

In retrospect, it is difficult to prove that my actions that night really saved my life. Had I rushed to the nearest house almost immediately after the accident, it is possible I would have had the strength to battle the storm and follow the car tracks before the snow got too deep. But in a country where we strung "blizzard ropes" from house to barn as a routine practice—because of the danger of becoming disoriented even in so short a distance—striking out with no guideline would have been folly.

At no time did I consider trying to cover the distance between me and my home because I knew quite well what lay hidden—the deep sides of the dry wash, the cut banks of the stream bed. And telephone poles and trees were scarce and widely spaced. Later I learned the car I saw had been turned back by an 8-foot drift across the road.

On the way home, I could have turned back at a number of points. I had all night to wonder why I didn't. The best safety measure of all would have been not to have ventured out—a night in a motel would certainly have been more comfortable and considerably less risky. Perhaps that rule—"Seek available refuge immediately"—is the best rule of all. □

OWLIE SKYWARN ON WINTER STORMS
"TELL YOUR PARENTS..."
OWLIE SKYWARN
SNOW WATCH
A STORM IS COMING, IT MAY REACH YOU..
SNOW WARNING
A STORM WILL REACH YOU SOON..
GET READY FOR IT...
• IF THEY MUST SHOVEL, WORK SLOWLY.
• DON'T OVER EXERT.
• DON'T GET TIRED OUT!
PREPARE THEIR CAR.. THEY MAY GET STUCK IN DEEP SNOW.
BLANKET
FLASHLIGHT
SHOVEL
MATCHES
CANDLES
PEANUTS
RAISINS
HIGH ENERGY FOODS
TOW CHAINS
TISSUES
FIRST AID KIT
BOOSTER CABLES
KNIFE
SAND PAIL
GAS
PAPER TOWELS
SCRAPER
• KEEP THE GAS TANK FULL
• DON'T TRAVEL ALONE


• IF THEY GET STUCK IN SNOW, RAISE CAR ANTENNA HIGH.
• TIE BRIGHT CLOTH ON IT.
• EXERCISE, CLAP HANDS, MOVE LEGS AND ARMS
• STAY IN CAR
• KEEP WINDOW OPEN A BIT TO AVOID CARBON MONOXIDE POISONING!
• STAY INDOORS · ELECTRICITY MAY GO OFF · HAVE A WAY TO COOK AND KEEP WARM.
• HAVE EMERGENCY WATER SUPPLY.
• HAVE A BATTERY RADIO
• HAVE FOOD IN THE HOUSE.
DRY MILK
WEAR A HOOD THAT COVERS YOUR MOUTH
WEAR SEVERAL LAYERS OF CLOTHING, NOT ONE SINGLE THICK LAYER.
WEAR MITTENS, THEY ARE WARMER THAN GLOVES.
IN ICE STORM BE PREPARED FOR POWER AND TELEPHONE OUTAGES.
ICE MAY MAKE DRIVING AND WALKING IMPOSSIBLE.

A Sea Grant Success

A WAY TO SAVE THE BEACHES

BY JAMES C. ELLIOTT

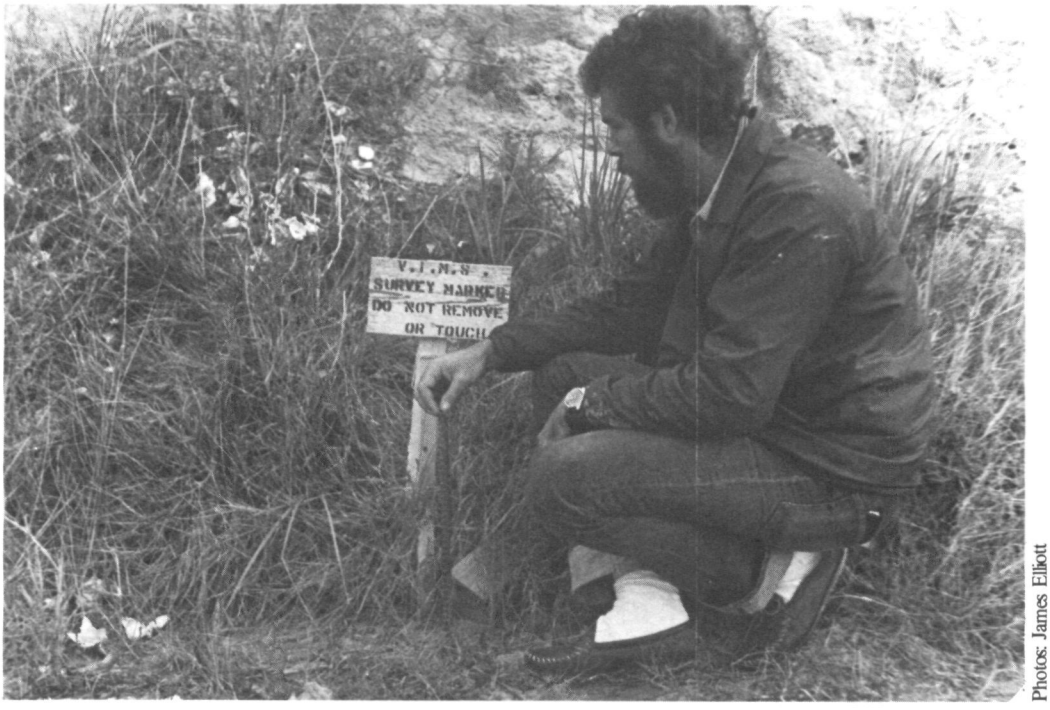
WHEN Gary L. Anderson, a young scientist with the Virginia Institute of Marine Science, used to visit the Eastern Shore of Virginia, he was met with uneasy stares and unenthusiastic conversation. On at least one occasion, he was even confronted by a resident pointing a disturbingly unfriendly gun at him because he was trespassing.

Such a situation might almost have been predicted; Anderson is a former college football player who looms big in almost any company. Out in the field, he dresses in the clothes of an outdoorsman. He also happens to have a beard, and neither his appearance nor his dress could fit the traditional image of a scientist.

These days, the picture is different. Anderson can travel almost anywhere on the Shore with assurance. He is not only accepted by the residents, but is one of the most popular visitors in those parts. Known more familiarly as "Hawk," he is frequently asked into homes, invited to oyster roasts and other parties and, in general, treated with the friendliness and generosity one would expect to be accorded to a neighbor. Much of his newfound acceptance has come about through his down-to-earth and outgoing personality. However, a major contribution has been the success of an experimental shoreline erosion system that he and Dr. Robert J. Byrne, another scientist at the Gloucester Point marine institute, have been able to convince Eastern Shore residents to install.

A low-cost erosion control technique, the system is known as the "perched beach" concept. It involves the use of large sand-filled and polyvinylchloride-coated nylon bags, called "sills." Made in lengths varying from five to 13 feet, the sills normally are placed parallel to the beach, usually at the mean low water line, although several configurations are under experimentation. When filled, they weigh four tons. In effect, the sills elevate the beach face, creating a wider beach with higher backshore elevation. The wider beach results in greater wave energy dissipation, and the higher backshore reduces the duration and intensity of the waves.

The system has particular applicability to the Chesapeake Bay because of the sand, clay and earth cliffs that are found along many of the 3,000 miles of shoreline in Virginia. While the idea of a "perched beach" is not new, it has not found widespread acceptance because it is not considered particularly effective for ocean beaches. The waves along the open coast are too high, as a rule, running eight feet or more, while the waves in the bay or other protected areas seldom, if ever, are higher than three feet.



Photos: James Elliott

Gary Anderson checks a survey marker which the VIMS scientists use to measure the effect the erosion has had along Virginia's Eastern Shore. Evidence of the damage caused by erosion along the Chesapeake Bay (right) is the rubble that once was a home.

The primary cause of erosion in the Chesapeake Bay has been wave action generated by high winds. Full impact of the erosion that has occurred along the bay shoreline was underscored by a recent study of erosion characteristics of the Chesapeake since the 1850s. It revealed that at least 23,000 acres were lost in a 90–year period.

Eastern Shore residents, of course, didn't need the study to tell them what had been happening. They had been in constant struggle with the problem for years, watching their front yards being eaten away by the elements, eventually giving up the battle and watching their homes tumble into the sea or investing large sums of money to have the buildings moved farther away from the shoreline. Some of them have moved as many as three or four times, one resident reported.

Increased attention to the erosion problem on the bay was given by the Virginia Institute of Marine Science (VIMS) in 1972, when a county-by-county assessment of the bay's shoreline was begun, including aerial photography and field analysis. The investigations, which have become known as "Shoreline Situation Reports," have been completed for 23 of the 33 Virginia waterfront counties. As a result of these studies, the need for some sort of low-cost, yet effective protective device became increasingly apparent.

In charge of finding a solution was Dr.

The "perched beach" concept is designed to develop a higher backshore elevation for a beach, which is visible in the top photo. Bottom left photo shows how grass has started to grow in area where erosion was stopped. The picture at the bottom right shows an area where no erosion control system was used.

Byrne, head of the Department of Geological Oceanography at VIMS. Byrne is a tall, blue-eyed scientist with blond hair who, because of his considerable experience with erosion involving ocean inlets, is known by his associates as "Mr. Inlet."

Dr. Byrne had been involved with the shoreline problems for some time. And with NOAA Sea Grant support, he and Anderson set out to find a solution. Their research indicated that the sandfilled bags might be the answer.

It is at this point that the Anderson diplomacy came into play. After visits to many sites along the bay, he came across a location that seemed ideal for the experiment and an owner who was willing to take the chance.

The property owner was Jack Robbins, a young hardware store owner from Eastville.

"I'd been losing about six feet off the cliff every year," Robbins explained. "I thought that if I put in some groins, that would help. So I put them in. If they did anything, they accelerated the erosion. The year they were in, I lost 20 feet off the cliff.

"After seeing what happened that year, I thought, 'Good gosh, if I don't do something I'm going to be living in the water.'-"

At about that time, Anderson came forward with his suggestion to try the bags. He made no promises of success, and-in fact—emphasized that what he was about to suggest was strictly an experiment.

After considerable discussion, Robbins agreed to buy the bags for his beach, if Anderson would fill them and place them.

Anderson agreed quickly, and before long there was a line of bags in front of the Robbins' property. That was in 1974.

How much erosion has taken place since then?

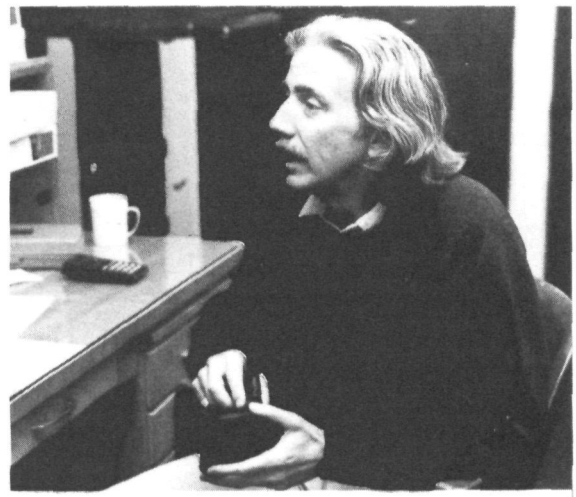
"None," Robbins beamed. "It's really amazing."

The effectiveness of the sills became apparent almost immediately, according to Dr. Byrne. Within three weeks, he said, the width of the beach had doubled, from 30 to 60 feet, and within three months, the back elevation of the beach had increased by four feet.

Robbins' neighbors were so impressed that they ordered sills for their beaches, also. Testimony to the success they have had came from Robbins, also.

"Some of those folks were going to give up and just let their homes go," he said. "Now, I see they are putting on new roofs and fixing up their places."

The bags themselves usually cost about $50 each. The average installation on the Eastern Shore, running about 150 feet, will cost a property owner about $1,500, Anderson reported, a price far below the costs of a jetty or a seawall. If a landowner is particularly adept with his hands and can get a centrifugal pump, Anderson said, he could probably install the bags by himself at much less cost.



Dramatic results occur with the use of the sand-filled bags. Anderson (right) stands at the edge of the beach which has been protected while Eastern Shore resident Jack Robbins stands at the edge of an unprotected area. Top right shows Dr. Robert J. Byrne, who has been instrumental in experimenting with the "perched beach" concept. At the lower right, Lee Weisher (left) and George Thomas, of the VIMS staff, inspect a bag as it looks without sand.

Word of the success Byrne and Anderson were having with their experiment soon reached officials in the City of Hampton. Buckroe Beach, that city's beachshore and long a summer playground for Virginians, had suffered tremendously from erosion.

"We'd been trying unsuccessfully for years to find some solution to our erosion problem," explained Thomas H. Daniel, Director of the Department of Parks and Recreation. "But we just were not able to stop it."

When the city sought advice from the Sea Grant Advisory Services at VIMS, Byrne and Anderson went to work immediately. The recreational beach was nourished with new sand brought in by trucks. Three separate areas were refilled, and sills were installed in two of them, leaving the third one open for comparison. Analysis has shown that the areas in which the sills were installed retained much more sand than the area with the bags. The sills also seem to have altered the destructive behavior of the surf that had been taking place, thus creating a beach of uniform width.

"We're really elated with what has happened," said Daniel. "Previously, we'd be lucky if we could keep new sand along the beach for six months. We've had the sills for two years now, and they're really holding the added material."

Hampton officials have been so delighted, as a matter of fact, they plan additional sand nourishment and more sills.

"They won't solve all erosion problems," Dr. Byrne explained. "But with the work we have done so far, we know pretty well where they will work and where they won't work. We know, for example, that a supply of good coarse sand is necessary for filling the bags. River areas, where there is a lot of clay, aren't too good.

"We've tried them where groins have failed. We've tried them with the assistance of groins and even using some sills as groins themselves. And we've tried them where there were no other structures. In all cases, they have been successful.

"Of course, our track record is short. But we're still in the experimental stage. We're not saying that we're going to stop erosion, but our experience has demonstrated that we can reduce it dramatically."

There are now more than 20 sites along the Virginia shoreline of the Eastern Shore in which this low-cost form of erosion control is in use, and applications for more are growing steadily.

Significantly, the research and experimentation being carried out in the project has resulted in what so many Sea Grant projects do—the creation of a new industry. Several marine contractors, all of whom have been trained by Anderson, are now capable of making the sill installations. One of them is Jack Robbins, the first Eastern Shore resident to take a chance on Dr. Byrne and Gary Anderson and their magic bags. □

Flight edit at work

charting the pilot's landmarks

BY JOHN STRINGER

THE Cessna Skymaster flew northwest toward Sugarloaf Mountain. It was autumn, bright and clear above the morning haze that covered Washington, D.C.

Two NOAA Corps officers, Lt. Cdr. (and chief pilot) David J. Goehler and Lt. Cdr. Richard K. Muller, had arrived at Montgomery County Airport some 20 minutes before the scheduled take-off at 8 a.m. Their assignment—to edit the Washington aeronautical chart, one of 39 Sectional and VFR (visual flight rules) Terminal Charts which are bibles for civil pilots engaged in relatively low-speed, low-level flights.

The plane's direction changed south several miles before they reached Sugraloaf Mountain, and at 2,000 feet, headed into the Washington haze. Below, the roads were jammed with commuter traffic; endless slow-moving lines weaving in and around geometrically arranged subdivisions, turnpikes, and indistinguishable shopping centers with empty parking lots. Monolithic highrises, like enormous sentries, stood beside the major roads leading into Washington.

As the plane approached the center of the city, at 3,200 feet, Washington Approach requested a change in the flight pattern due to the many commercial planes arriving and departing that morning from National Airport. "We're in an extremely congested area," said Goehler. The plane headed upward. Ground visibility became intermittent and, at 4,000 feet, the plane was above the clouds. It was impossible to flight edit the Washington metropolitan area—that would have to be done at another time. The decision was made to head northeast toward Baltimore.

NOAA's Flight Edit Program is an activity of the Office of Aeronautical Charting and Cartography of the National Ocean Survey, and its purpose is to conduct aircraft flights over areas covered by NOS joint civil/military aeronautical charts to examine topographic and aeronautical data for use in the revision of these charts.

The Washington sectional chart covers a vast area from the Atlantic Ocean west to Ohio, north to Pennsylvania, and south to the upper part of North Carolina near Raleigh. More than half of the chart encompasses water—the Atlantic Ocean—making revision a less time-consuming task than for other sectional charts such as the Kansas City chart, which covers one large land area. But the work remains the same: indicating corrections or changes to the published charts; recommending the addition or deletion of data; resolving questions raised by chart compilers that cannot be settled by office review; and evaluating chart usefulness from a pilot's point of view. Additional responsibilities have been added recently to the Flight Edit Program, and these include the photography of bays, inlets, river channels and harbor entrances for use on marine charts and in Coast Pilot publications.

In the aircraft, it's hours of tedious work—updating an aeronautical sectional chart.

Goehler turned the plane north. Through the clouds, there was a momentary glimpse of the Presidential jet at Andrews Air Force Base . . . a vast, empty bowl quickly covered from view by clouds: "That's where the Redskins play!" . . . an abandoned runway . . . "Flying right over NOAA's Riverdale distribution plant." Next was College Park and Byrd Stadium. The clouds persisted. Near Baltimore, the plane changed its course, and headed west. The sky became clear.

When the plane was about 40 miles northwest of Washington, D.C., Muller asked Goehler to circle for a second. "See that new tower on the road down there?" he asked. "It is painted red and white."

"Check," Goehler said and raised his right thumb confirming Muller's observation.

With a ball point pen, Muller added the tower to the 'rough copy' of the Washington Sectional which was attached to a clear, plastic clip board. "Yesterday, we found a golf course west of Dulles Airport, south of Poolesville," he said. "A good visual landmark for the VFR pilot."

During last season's schedule, the Flight Edit Program covered 135,500 square nautical miles. Four sectional charts were completed: Houston, Halifax, Montreal, and Las Vegas. At a later date, Atlanta and Cincin-

A major landmark for the pilot is Harper's Ferry where the Shenandoah River joins the Potomac flowing east toward Washington, D.C.

nati were finished. During 1977, the Flight Edit program is scheduled to complete 15 sectional charts.

Although a number of civil service personnel are authorized to operate NOAA planes, the primary responsibility of the Flight Edit Program rests with the NOAA Corps, one of seven Federal uniformed services.

During the course of a NOAA Corps flight career, an officer may be away from home at least 50 percent of the time. The first flight assignment comes after two to three years of ship duty, and includes an indoctrination period with the Office of Aeronautical Charting and Cartography in the National Ocean Survey. This assignment is followed by about two years in the NOS Flight Edit Program, which calls for visual checking from the air of the detail of the Sectional Aeronautical Chart series. The officer's next assignment is generally with the Coastal Mapping Division's Airport Obstruction Chart Program; this involves piloting a light twin-engine aircraft photographing airports for use in preparing airport obstruction charts.

On a ridge of the Catoctin Mountain range near Frederick, Md., Goehler noted the proliferation of structures where a single tower had been indicated on the chart. A multi-tower symbol would be added.

The Potomac River came in sight, and over Harper's Ferry, the plane veered south, skirting Virginia's Blue Ridge Mountains. "There's another new tower down there," Goehler observed.

At Round Hill, Va., Muller noted that a new four lane road was not positioned accurately on the chart, which indicated that it stopped short of the town. The plane shifted right five degrees longitude to check a corner covered with ground fog the day before. Below, a ridge not unlike all the others—predominately green and russet with bright spashes of yellow: "That's where the big one crashed two years ago," he said.

As the plane continued its course, the mountains gave way to rolling pastures with miles of white fences. Near Upperville, Va., private airports and riding rings were seen. Far off the major highways, large estates, secure in their private parks, rested in solitude. "It's a great feeling," Goehler said, "getting paid for what you really like to do." And ever so easily, he landed the plane at Culpepper, Va.

Born in Appleton, Wis., he graduated from Purdue University in 1967 with a Bachelor of Science in Industrial Engineering. Five years later he received a Master in Business Administration from the University of Santa Clara in Santa Clara, Calif.

Prior to his joining the 29th Officer Training Class of the NOAA Corps in mid-1969, Goehler was a systems analyst for the Lockheed Missiles and Space Company in Sunnyvale, Calif. During this time, he obtained a license as a private pilot—single engine/land.

Goehler's job, which requires long hours of tedious work, is not glamorous nor unduly exciting. His duties are to check visually aeronautical charts, and spend many additional hours over a drawing table transferring his "chicken scratches" from the rough copy to the smooth copy. Because of the large expanse of water on the Washington Sectional, it required only 50 flight hours of work; the total land areas of the Cincinnati Sectional, by contrast, required over 80 flight hours.

After each pilot completes his job and the data is combined on one copy, it is sent to the Visual Charts Base Compilation Section. All information added to a chart must be verified by the compiler who annotates each correction or addition on the border around the smooth copy.

Known as the reproduction base standard, the chart incorporates information from all sources including flight check, U.S. Geological Survey quadrangles, Army Map Service photos, State highway maps, and information from the Army Corps of Engineers, Rand McNally, and the Department of Agriculture's Soil Conservation Service. This procedure involves many weeks of constant review before the chart goes to reproduction for printing.

While in the Culpepper Airport, Goehler inquired whether the supply of its aeronautical charts was up to date. A collateral duty of the Flight Edit Group is to inspect periodically NOS aeronautical chart agents and promote new chart sales. A few minutes later they were flying over Bull Mountain, headed toward Rockville where their morning's aerial observations would be followed by several hours of desk work.

"They haven't fixed that strobe light yet, have they?" Goehler asked later as he helped push the plane into the hanger.

"Nope," said Muller.

It was another day of flight edit. At 3,800 feet above sea level, the gleaming orange school buses on the rural Virginia roads northwest of Washington, D.C. appeared to be motionless. Goehler was at the controls, backed up by Muller who, holding a pair of binoculars with one hand and the chart in the other, quietly viewed the ground.

"We're scheduled to complete the flight check today," said Muller. "And if time permits, we'll photograph some harbor approaches for the NOS Coast Pilot." Used primarily by the maritime industry and recreational boaters, the Coast Pilot is a publication that supplements navigation information shown on standard nautical charts. The engravings of harbor approaches, which had to be abandoned in the early 1940's, were to be reintroduced in the form of aerial photographs—adding still another project for the NOAA pilot.

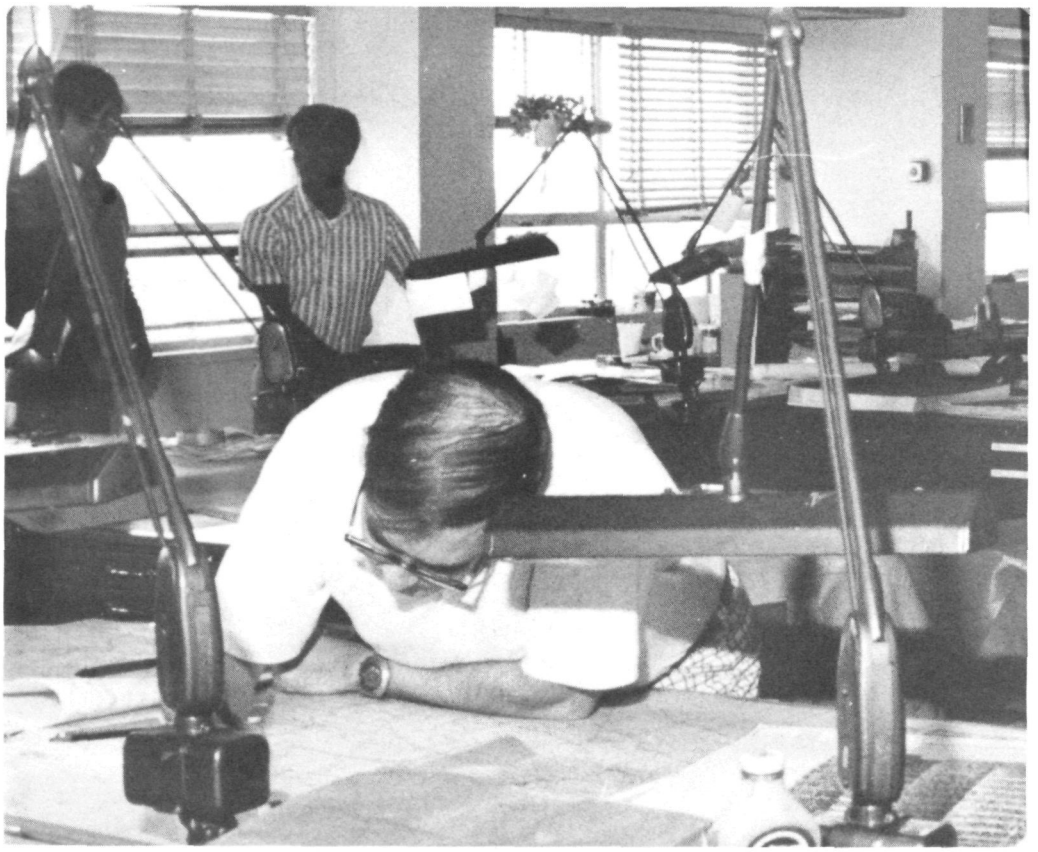
"We also need to photograph an airport under construction near Greensboro, North Carolina." Muller said the photographs would permit a clarification of several conflicting reports obtained from pilots who had flown over the area.

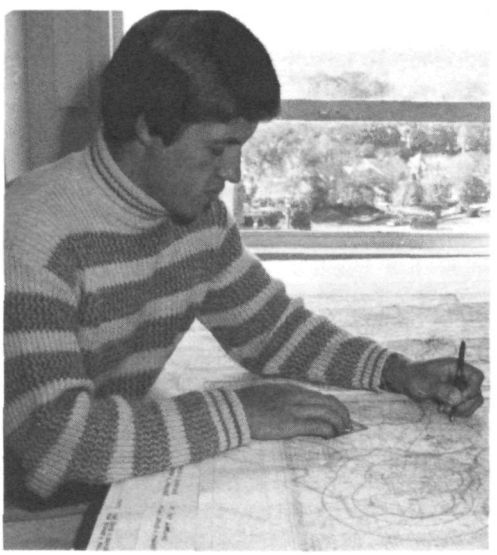
Goehler turned the plane south, and Muller, using the binoculars, followed some new transmission lines that crossed the Potomac. He drew the lines on the chart, noting a blinking light on one of the Potomac River transmission towers.

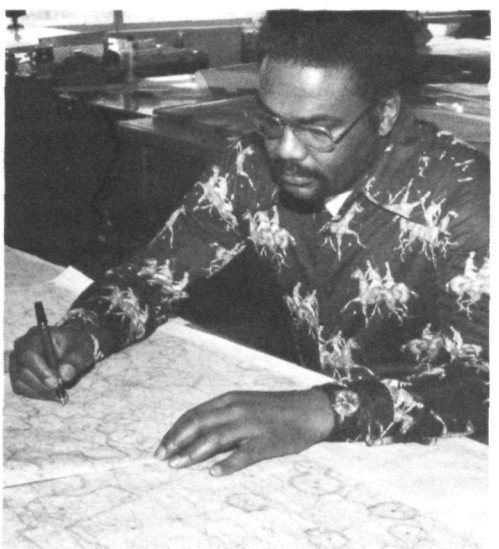
Beyond the vast sprawl of housing developments, the plane flew over the sparsely settled area of Virginia's Northern Neck. In the distance, the winding, muddy Rappahannock River, dotted with tiny, off-shore duck blinds, meandered through pine forests and newly harvested fields to the Chesapeake Bay. Some radio towers were checked. In the James River above Portsmouth was moored the 'dead fleet'—dozens of Navy vessels, side-by-side—a distinct navigational aid. When the well-defined 3000-acre Lake Drummond in the center of the Great Dismal Swamp was passed, the plane turned east toward Elizabeth City, N.C.

"We're going into North Carolina to pick up towers around Elizabeth City," said Goehler who wanted to complete the Washington Sectional during this flight. Muller, the observer, concurred.

Lt. Cdr. Richard K. Muller graduated from NOAA's 30th Officer Training Class in August 1969. A month later he was assigned







While base compiler Herman Braswell (above) verifies flight check corrections on the base standard, Lt. (jg) David Tennesen (left) transfers new information to the smooth copy which is then transferred by project leader William Gidderon (right) to the base standard.

to the Surveyor, a 292-foot ship used primarily for marine charting and geophysical surveys. Norton Sound, Alaska; along the California Coast; Pago Pago, American Samoa; and then a five-month assignment aboard the NOAA Ship Rainier in the waters of Kodiak, Alaska.

In 1971, Muller headed a hydrographic field party which investigated numerous navigational hazards along a 200-mile stretch of Florida's west coast. When this was completed in early 1972, Muller was transferred to flight duty in the Aeronautical Charting and Cartography's Flight Edit Program.

"The revision and maintenance of these visual charts," said Muller, "is an involved communications and cartographic process. Topographic data is revised by the use of aerial photographs, satellite imagery, topographic maps and user-supplied information. Additional source material is obtained from state governments and Federal agencies such as the Federal Communications Commission."

East of Elizabeth City, the plane turned south at Kitty Hawk, flew over the Wright Brothers National Monument, following the 200-mile string of sandbars—North Carolina's Outer Banks. Long a haven for the serious fisherman, the Outer Banks are too remote for the weekend visit. It is still a place where miles of uninhabited beaches remain unspoiled and secluded. It is sanctuary for waterfowl and birdwatchers and as such, aircraft are prohibited below 2000 feet. At the ocean's edge, solitary surf fishermen stood undisturbed, and waited for the bluefish.

Radio towers, fishing piers, and other landmarks were checked and identified, and among the new additions to the chart would be a second road. At Ocracoke, 14 miles below the Hatteras Inlet, Goehler changed course and headed the plane northwest to Rocky Mount, N.C.—a long flight over some of the most monotonous topography on the east coast.

Other than the fact that the landing approach that day was over a cemetery, the municipal airport at Rocky Mount was neither perched on a cliff nor surrounded by mountains. The narrow Tar River, which wandered through the city, passed nearby the landing field where at 12:15, most activity had come to a halt. It was time for lunch.

Since there was no snack bar at the airport, Goehler asked the field attendent where they could find a restaurant. "The Carolina Cafe, about a mile down the road," was the reply. A student pilot, who had just finished his lesson, offered to drive them to the restaurant, an offer that was immediately accepted.

The Carolina Cafe feeds its customers well. Homemade soups and fresh salads, fried flounder stuffed with crabmeat, hushpuppies and rolls, and homemade pecan pie. They walked back to the airport where the plane had been refueled.

It was a zigzag flight to Greensboro. Muller was at the controls; Goehler, the observer—checking towers, new highway construction, and other discernible navigation aids. It was an open, uncluttered area of large farms with seemingly endless fields of soybeans, tobacco, and peanuts. Many of the harvested fields were being burned-off, smoke drifting upwards in isolated, white spirals until air currents leveled the plumes into vapor-like undulations. Near Raleigh, the farms appeared smaller; green was the dominant color of the fields.

About six miles from the new airport which Goehler was to photograph, Muller reduced the plane's air speed, lowered the wheels for more drag, and maneuvered the plane into the correct angle. Goehler pushed open the cabin door and began taking pictures. The force of the wind pummeled the cabin, tearing at the charts secured between the two officers, as the plane arced around the airfield.

"Check," said Goehler who then closed and locked the door. The photographs would provide an exact airport symbol, its position on the chart, elevation and type and length of the runway.

The plane rose upwards, leveled off at 8000 feet and headed northeast toward Rockville.

Mission completed. □

After their lunch break, Lt. Cdr. David J. Goehler (left) and Lt. Cdr. Richard K. Muller head back to the Rocky Mount (NC) Municipal Airport to complete the Washington Sectional flight edit. During the preflight check that morning, Chief Pilot Goehler (below) makes sure that the front engine oil level is correct in the NOAA Skymaster.

THE WORKADAY WORLD OF NOAA DIVERS

BY LT. (J.G.) DAVID H. PETERSON*

A warm sun shown through the morning haze, one day in May of 1974, as NOAA launch 1256 cleared the jetty at the entrance to Rockaway Inlet on the southwest shore of Long Island, and headed out on a southeasterly course toward Ambrose Light Tower. It was one of those mornings when there was hardly a breath of wind, when sea and sky seemed one in the haze. The destination was a series of six current meter stations deployed a few months earlier by the NOAA ship Ferrel, in a neat line beginning about one mile south of Atlantic Beach and extending offshore about eight miles.

Aboard the launch were the four members of the Ferrel's dive team, Lt. Dennis Pepe, Lt. (j.g.) Thomas Bergner, John Skeens (one of the ship's two electronics technicians), and the author. At the helm was Lt. (j.g.) Ronald Jones, the Ferrel's current meter officer.

As the launch sliced along through the calm water at about 12 knots, the team passed the time checking over diving equipment, then suiting up in wet suits. After about an hour's run, Jones maneuvered the launch up to the marker buoy of Station 6, to which they made fast. The job this morning was to service and inspect the current meters on each of the six arrays in the Long Island transect.

The diving operations started out routinely. Lts. Pepe and Peterson donned SCUBA cyclinders, weight belts, masks, fins, and snorkels. After a final quick gear check, they picked up their tools and equipment, and entered the water.

The first dive of the day is always somewhat of a shock; the water always seems coldest then. This morning was no different—the 45° water made the divers catch their breath. With the flash of a quick "OK" sign, Pepe led the way 86 feet down to the anchor and the bottom current meter situated just below the acoustic release device. There the work began. At each of the three Aanderra current meters on that array, the divers explored carefully with their fingers—seeing was difficult, sometimes impossible in the murky water—until they found two small zinc cyclinders, used as "sacrificial anodes" where corrosion is concentrated. They removed what was left of the two in the meter, and replaced them with new cyclinders. Then they located and carefully cleaned the

Lt. (j.g.) Peterson, an officer in the NOAA Corps, is NOAA's Assistant Diving Coordinator

plastic rotor assembly and the transducer, a sensitive underwater receiver. Both had become fouled with tiny marine organisms that had to be removed gently with small brushes. Finally, they inspected the vane and spindle assemblies, checked the seizings on the shackles, and looked for corrosion and kinking problems on the wire cable.

The two divers then worked their way up the array to log as short a bottom time as possible, for computing the next dive. They surfaced and climbed the diving ladder back aboard the launch. Total time in the water, less than 15 minutes. One down, five to go. Lt. Jones started up the engine and the team headed north to Station 5, a mile and a half away.

At Station 5, the other two divers took their turn to get wet. It was also their turn for a few anxious moments.

The boat tied up to the large witness buoy and the divers made a quick inspection of the anchor chain. Since it was only a short swim to the current meter marker buoy, the team elected to remain tied up to the larger buoy and have the divers snorkel over to the current station. The swim didn't take long but just as they reached the marker buoy, a huge fin broke the water about 150 feet away from the boat between it and the divers, and started drifting lazily toward them.

At that point everything began to happen very rapidly. The team members on the boat—somewhat less than cool, calm, and collected—started shouting "Shark! Shark!" and pointed in the direction of the approaching fin. When the divers saw it, they made an expeditious retreat to the boat, avoiding the ominous fin and swimming as strongly and calmly as possible.

After a tense moment getting the two divers safely back aboard, the team watched breathlessly as this terror from the deep moved closer toward the boat. When it was about 25 feet away they discovered that the monster shark was really a very large specimen of the innocuous ocean sunfish *Mola mola*—a creature to strike fear in the hearts of plankton but hardly grown men.

Feeling somewhat sheepish after the false alarm the team returned to its task and completed it without further incidents.

However, although the reaction seemed unjustified then, later in the summer near that same Station 5, they did encounter a creature to strike fear in the hearts of grown men—a 12-foot, cruising hammerhead shark. The team's strong reaction at that time was indeed appropriate.

In the workaday world of NOAA divers, the maintenance work on current meters is commonplace, suggestive if not typical of the jobs that need to be done. While for the most part the divers enjoy diving (they are all volunteers), they dive to get the job done, not to experience the thrill of the sport.

In a study completed in 1974, NOAA estimated the recreational diving population in the United States at almost two million, with approximately a half-million actively using their diving skills. The vast majority of these people, inspired by their perceptions of the undersea world, imbued in them perhaps by Cousteau, and aided by readily available instruction and equipment, do dive just for the thrill of the sport. As a news magazine recently said, many of them dive to experience "an otherworldly adventure, a kind of kaleidoscopic space odyssey that some call a magical underwater high." For many of them the lure of the undersea world is that it is an escape, an adventure-filled diversion from a world they see as overpopulated and polluted. These "sport" divers, as they call themselves, are growing in number by some 250,000 new enthusiasts every year.

But the other portion of the total diving population consists of men and women whose reason for being in the sea is of a much more serious nature. They are much smaller in number, only some 4000 to 5000. They are the American scientific divers. Of this group, the largest single contingent are the men and women who are the divers of the National Oceanic and Atmospheric Administration.

Diving for science is sometimes exciting, particularly in large and complex Man-in-the-Sea saturation diving expeditions such as NOAA's Florida Aquanaut Research Expedition (FLARE) and the Scientific Cooperative Operational Research Expedition (SCORE), operations mounted by the Manned Undersea Science and Technology Program. It can also be routine, repetitive, and sometimes surprisingly hard work, as is the case with most of the day-to-day field diving operations of the National Marine Fisheries Service, the National Ocean Survey, and the Environmental Research Laboratories.

Who are these NOAA divers, and what do they do when they dive?NOAA divers comprise the largest diving complement of any Federal civil agency—some 400 strong and growing steadily. They can be found throughout NOAA, from Seattle, Washington to Miami, Florida; from Woods Hole, Massachusetts to Tiburon, California.

Of course, when most people think of

Lt. Peter Gadd (above left) and Richard Rutkowski, ERL Diving Officer, pause aboard NOAA ship George B. Kelez between dives in New York Bight; a training and proficiency dive in ice-covered quarry lake near Columbia River is carried out by George Swan and other NMFS divers participating in Lower Columbia River Search and Rescue Council operations.

scuba diving, they visualize sunny blue skies and hot sun shining over clear ocean waters, with the divers gliding among brilliant displays of colorful fish and corals. One of the largest groups of NOAA divers, however, is at Auke Bay, Alaska.

Alaska?

The NMFS Auke Bay Biological Laboratory indeed houses one of the largest, and probably the most active, of all NOAA diving units. Among the NOAA people who might be found in a wet suit on any particular day in the field is Lou Barr, Auke Bay's Unit Diving Officer. He and his associates—now about 20 divers, both scientists and technicians—dive regularly in the chilly Alaskan coastal waters, and in the rivers and glacier-fed lakes as well. They observe the ecology, behavior, and spawning of the Pacific sockeye salmon, they study the population dynamics of the huge Alaskan King crab and the tanner crab, and they carry out many other fisheries research projects in the water.

Among their more interesting assignments was that of studying the effects of the nuclear testing at Amchitka Island in the Aleutians on the subtidal benthic community.

Further down the coast, there are two active NOAA diving groups in Seattle, Washington. William High, Unit Diving Officer at the Northwest Fisheries Center, heads a small group that works to develop new and improved salt water fishing gear, including traps and otter trawls. They dive to emplace and remove the gear, and to observe the reactions of fish—both target and non-target species—to the gear. Lt. Cdr. Lloyd K. Thomas, operations officer of the NOAA ship Fairweather, is the Unit Diving Officer of the Pacific Marine Center, which is the focus for both ship- and land-based divers who undertake a variety of tasks to support the research at the center.

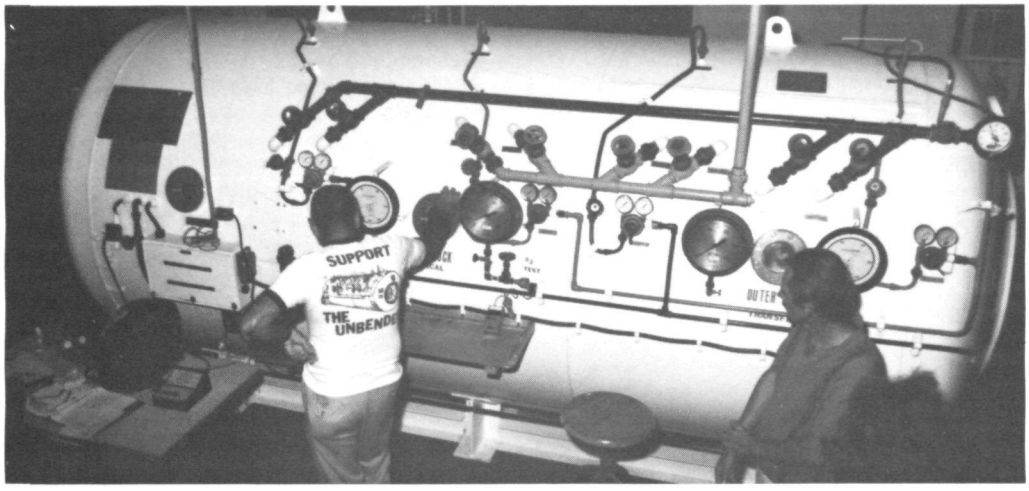
Fisheries biologist George Swan, at an inland NMFS field station in Clarkston, Washington, on the Idaho border, leads an unusual group of divers who work the Columbia and Snake River systems of Oregon, Washington, and Idaho, observing salmon and trout behavior and population dynamics in this critically important estuarine system. River and lake diving can pose many problems that are different from those of ocean diving. Strong currents and poor visibility are characteristics of rivers, adding to the discomfort that divers often endure in the course of their work. Diving in high-altitude lakes—a relative rarity amongst NOAA working divers—requires different decompression tables, owing to the lessened atmospheric pressure.

In addition to the problems caused by nature, problems caused by humans and human structures or equipment are always present in diving—and they too can be different in river diving than in ocean diving. In May of 1975, research biologist Emil Slatnick dove to make an inspection of gatewell orifices at Little Goose Dam. He didn't have to dive far—gatewell orifices, which are about six inches in diameter, are only three to six feet underwater. Built into the dams to permit fingerlings to migrate downstream toward the ocean, they at times become clogged with debris. After determining that an orifice was clear, Slatnick was pulled abruptly against it when his buoyancy compensator vest was sucked in by the force of the water. After briefly trying to free himself he signaled to his buddy diver, Larry Linge, who descended, and together the two pulled the vest free. An unusual diving situation—and one that resulted in a slight change in diving procedures, to avoid possibility of the situation reoccurring.

Across the nation, in Miami, Fla., science technician Richard Rutkowski of ERL's Atlantic Oceanographic and Meteorological Laboratories is the MLC Diving Officer for ERL, responsible for the safe conduct of all diving in ERL. Because of his interest in diving safety, he worked long and hard with other NOAA people and with members of the local diving community to set up a first rate hyperbaric chamber installation at the NOAA Miami Virginia Key complex. In the seven months that followed its activation early in March, 1976, Rutkowski and the chamber assisted 16 of 23 victims of various types of medical emergencies brought there. Of the 16, 13 were divers and three were pilots suffering from altitude decompression sickness.

For his unselfish dedication to diving safety, Rutkowski received a NOAA Public Service Award in 1976.

There are about 13 qualified divers at AOML, including both scientists and technicians. Much of their recent work has taken place in the MESA-New York Bight project,



U.S. Coastguardsmen rush civilian diving victim from helicopter to NOAA's hyperbaric chamber on Virginia Key, Miami, where technicians anxiously monitor recovery. "The Unbender" is their nickname for the life-saving facility.

working with AOML's Physical Oceanography Laboratory and Marine Geology and Geophysics Laboratory. "We install, retrieve, and maintain many kinds of scientific instruments," said Rutkowski, "including current meters, a CV (concentration velocity) probe, and various prototype instruments. We have to make sure that they are aligned properly, oriented correctly, and kept in serviceable condition."

"Much of this instrumentation is complex and expensive," said Dr. Donald Swift, a geologist and qualified diver at AOML. "We depend upon divers to make sure that it works properly. Scientists who are also divers can go down and see first-hand the nature of the seafloor, which helps us understand what the instrumentation is telling us."

Another environment, another part of the country, another set of scientific and diving problems are faced by Dr. Richard Chambers and his diving unit at the Great Lakes Environmental Research Laboratory in Ann Arbor, Mich. During the ice-free summer months, the divers carry out an active diving program throughout the Great Lakes, collecting bottom sediment samples and making direct observations of the limnological characteristics of the lakes, in support of their laboratory work. They maintain a close liaison with Dr. Lee Somers of the University of Michigan, whose diving program is one of the most active among the Sea Grant network. Dr. Somers is the guiding force behind the hyperbaric chamber facility at the university hospital, which serves a major portion of the Great Lakes Region.

The NOAA diving unit with experience in the greatest number of currently available types of diving modes is probably the Manned Undersea Research and Technology (MURT) team of the Northeast Fisheries Center, Woods Hole, Mass. The team is headed by Dr. Richard Cooper, NMFS Diving Officer, and has had extensive experience in air scuba, with operational experiences also in surface-supplied diving, submersible lockout diving, and saturation diving in ocean-floor habitats. Like their colleagues in Auke Bay, the MURT team of scientists and technicians are cold water research divers. Their major lines of research are population dynamics and ecology of the lobster, and early natural history and predator-prey relationships of such important food fish resources as herring and pollock.

Aboard the four largest classes of vessels in the combined NOAA research and surveying fleet both NOAA Corps Officers and other crew members carry out diving duties. These commissioned officers and crew are NOAA's largest category of divers, followed closely by the fisheries biologists. Diving operations conducted by ship's personnel range somewhat farther afield than do the biologically oriented operations of the seventeen fisheries diving units. During the nine or ten months of each year that NOAA ships conduct field operations, their divers are in the water assisting in such marine chart surveying activities as determining the least depths of water over shoals and pinnacles, when it is difficult or hazardous for the ships to do it.

Ten basic rules for diving safety

1. **Have regular diving physical examinations.**
2. **Never dive without proper training.**
3. **Never dive alone or unattended.**
4. **Always plan your dive.**
5. **Always know how deep you are and how long you've been at that depth.**
6. **Know the name, location, and phone number of the nearest recompression treatment facility.**
7. **Maintain and use your equipment properly.**
8. **Avoid over-exertion.**
9. **Never hold your breath during ascent.**
10. **Watch your buddy and listen to your exhaust.**

The wire drag surveys of the 90-footers Rude and Heck use divers to verify "hangs" (where the wire is hung up on an underwater obstruction) and to characterize navigational hazards by visual inspections and least depth determinations. The NOAA ships McArthur and Ferrel regularly carry out tidal current surveys using divers for current meter deployment, maintenance and retrieval. Most of the marine charting vessels make excellent and efficient use of divers in the installation, maintenance and recovery of their tide gages, deployed for their tidal datum determinations which are essential in hydrographic surveying. Indeed, in the more inhospitable or inaccessible areas in Alaska, divers are the safest means of deploying and recovering this important equipment. The two Tides Branches of the NOS Marine Centers also use divers frequently in this work.

Many times at sea or in port, the routine operations of ships seem to be affected by Murphy's Law ("In any field of endeavor, if something can go wrong, it will go wrong"). Even the most experienced and careful Officer of the Deck can fall prey to the caprice of the sea. Mooring lines and equipment deployed over the side sometimes foul the screws and rudders, causing frustration for the officers and inconvenience to the scientific missions. These problems are usually rectified quickly and efficiently by the divers. Other ship-related diving is also carried out on a routine basis. These maintenance tasks include hull inspections, intake cleaning, cleaning and servicing of bow propulsion units, and other mundane but necessary tasks.

Not all the diving done by NOAA divers is for scientific and technical purposes. In several instances NOAA has been called upon by agencies such as the U.S. Coast Guard and the National Transportation Safety Board for diver assistance. The Rude and Heck in 1974 responded to Coast Guard requests for diving assistance in locating and recovering a Coast Guard search aircraft which went down at sea in the Gulf during a search and rescue mission. The NOAA ships located the wreckage and recovered the bodies of the lost airmen. (The story of this assistance is told in detail by Raymond S. White, Jr. in the NOAA quarterly, January 1975.)

The NOAA divers at AOML in Miami performed a similar public service in locating and recovering the wreckage and victims of a light plane crash off the coast of Florida. This was at the request of the National Transportation Safety Board, which was investigating the accident. Very recently Dr. Cooper's MURT dive team at the Northeast Fisheries Center in Woods Hole, Mass., and divers from the Center's Narragansett, R.I. laboratory, responded to a Coast Guard request for diving assistance as disaster struck off the coast of Cape Cod. Last October a 65-foot scallop boat went down in heavy seas, with the loss of all hands except one. The NOAA divers found the wreckage on the first search dive.

These three incidents illustrate the readiness of NOAA diving units to help other agencies and organizations when called upon. When someone is in trouble, NOAA divers are there to respond.

The undersea environment, like space, is one that is totally alien to the human condition. In both, humans can enter only as a direct result of ingenuity and technology. Just as the oceans themselves in an intrinsic sense are a challenge, so is the ability to work and study in them. Divers must be willing to learn many aspects of the diving environment in order to work there safely. An appreciation of physical laws and their effects on the human body, the development of an ability to act instinctively and maintain one's self-control in a rapidly changing situation, and confidence in diving partners and equipment are all necessary for safe diving. Zero visibility, cold water, fickle currents, surf and swell, sea critters that can sting or bite, and pollutants are among the hazards that NOAA divers contend with as they go about their jobs underwater.

Why do they dive? If all 400 NOAA divers were asked, they might come up with 400 different answers. The common denominator is probably that—despite the usual discomforts and the occasional risks—they receive their satisfaction in terms of the results their efforts produce. Through diving NOAA is provided with better understanding of the total marine environment and a more adequate knowledge of marine resources, and because of this the NOAA divers receive a return on their investments in time, training, and experience. □

Commerce Secretary Honors NOAA Staffers

NOAA employees have received Gold and Silver Medals in a ceremony held at the Department of Commerce. The Awards—six Gold Medals, 22 individual Silver Medals, and two group Silver Medals—were presented by Secretary of Commerce Elliot L. Richardson.

Gold Medals, the Department's highest honor, are bestowed for rare and outstanding contributions of major significance to the Department, the Nation, or the world, such as major contributions to science, technology, or administration; highly distinguished authorship; heroic action involving jeopardy of life; and demonstrated outstanding leadership in the administration of major programs.

Recipients include:

Dr. Gaylord R. Miller, Director of the Joint Tsunami Research Effort in Honolulu was honored for his scientific results on tsunamis (the long, often destructive ocean waves caused by Pacific earthquakes) and his outstanding leadership in the establishment of the Joint Tsunami Research Effort and Tsunami Warning Service.

The citation accompanying the gold medal calls the ERL oceanographer "one of the world's foremost authorities on tsunamis. He has been at the forefront in international cooperative programs with the Soviet Union and Japan and in the utilization of deep sea instrumentation to measure tsunami characteristics and ocean bottom seismic activity."

David H. Wallace, Associate Administrator for Marine Resources was awarded a Gold Medal for his outstanding technical leadership in international cooperative fisheries management.

Wallace is recognized as the chief architect of a management approach for North Atlantic fisheries which has reduced allowable catch to levels where most fish stocks are no longer over-exploited, but at the same time has increased the catch permitted U.S. fishermen.

Dr. Dayton L. Alverson, NMFS Director of the Northwest and Alaska Center in Seattle, Wash., was honored for his outstanding performance, abilities, and contributions as both an administrator and scientist.

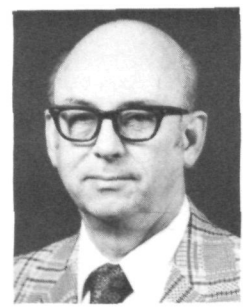
Dr. Alverson was cited for his most notable professional achievements that include the publication of well over 100 articles in fisheries science, and service as an advisor, delegate, or creator of many important national and international meetings.

Dr. Miller

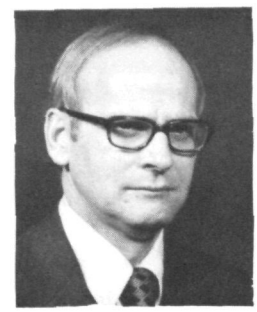
Mr. Wallace

Dr. Alverson

Mr. Hubert



Mr. Mitchell



Mr. Mckay

Lester F. Hubert, a research meteorologist with the National Environmental Satellite Service received the Gold Medal for his work in the use of satellite observations in weather forecasting.

Hubert has been in the forefront of research and development activity in the use of satellite observations for the last decade. In recent years he has investigated the potential of obtaining reliable wind fields from geostationary satellite pictures showing cloud motions, and played a leading role in creating a fully-functioning system to accomplish this.

Daniel B. Mitchell, Director of EDS' National Climatic Center in Asheville, N.C., received the Department of Commerce Gold Medal for his outstanding leadership in the development and execution of United States data management programs in the international Global Atmospheric Research Program's Atlantic Tropical Experiment (GATE).

Starting many months before the GATE field phase, Mitchell, then Deputy Director of the EDS Center for Experiment Design and Data Analysis in Washington, D.C., made major contributions to the development of international and U.S. plans, procedures, data formats, and schedules of data processing.

Grady F. McKay, Chief of computer services operations at the National Climatic Center, Asheville, N.C., was honored for his outstanding direction and technical expertise in processing, by computer, large-scale national and international meteorological and oceanographic programs to extract meaningful scientific data.

The Center's digital archive of national and international meteorological data sets is the immediate result of Mr. McKay's work. His innovative, creative approach to the multitude of problems encountered in environmental data processing and his tenacity in seeking useful solutions to these problems have been prime factors in the Center's ability to achieve its data processing goals.

Silver Medals are awarded for contributions of unusual value to the Department, such as contributions to science, technology, or administration; outstanding skill or ability in the performance of duties which has resulted in program advancement; meritorious authorship; or unusual courage or competence in an emergency.

Eight researchers from the ERL Atmospheric Physics and Chemistry Laboratory's Atmospheric Electricity Group received a Silver Medal Award for suppressing lightning strikes by artificial means in thunderstorms. Receiving the special award were Dr. Heinz W. Kasemir, William E. Cobb, Dr. David Rust, F. James Holitza, Billy R. Caldwell, Fredric N. Gould, Sharon L. Bokan, and Brandon L. Grebence.

Raymond M. Lumpkin, Chief NOAA Headquarters Personnel Section

Lt. Richard P. Floyd, NOAA Corps.

Edward W. Ferguson, manager of the NESS Satellite Field Services Station in Kansas City, Mo.

Dr. Edmund S. Hobson, a Fishery Research Biologist of the NMFS Tiburon Laboratory, Tiburon, Calif.

Douglas V. Mason, a technician in the NOS Atlantic Marine Center.

Dale E. Westbrook. an Engineer with the NOS.

Carl F. Kelley, (Posthumous Award) Director of the NOS' National Geodetic Survey Information Center.

Susumu Kato, a Fishery Research Biologist of the NMFS Tiburon Laboratory, Tiburon, Calif.

Dr. Earl E. Gossard, Chief of the Meteorological Radar Program of the ERL Wave Propagation Laboratory.

Dr. Jerry Galt, an oceanographer with the ERL Pacific Marine Environmental Laboratory.

Carl A. Posey, Public Affairs Officer for the Environmental Research Laboratories in Boulder.

William T. Hodge, Principal Scientist, Science Advisory Staff, at the National Climatic Center in Asheville, N.C.

Thomas Winterfeld, an advisor for international programs in EDS' National Oceanographic Data Center.

Bruce J. MacGill, Chief of the Resources Management Staff of the Environmental Data Service.

Walter J. Morawski, a computer specialist in the Environmental Data Service.

Seven scientists in the EDS Center for Experiment Design and Data Analysis received a Silver Medal Award for their scientific and technological contributions to the processing and validating of scientific data collected by U.S. ships during GATE, the 1974 study of how heat and moisture from the tropical oceans supply energy to the atmospheric circulation. The group included Ward Seguin, Robert Dennis, George Saxton, Michael Hudlow, David Saxton, James Almazan, and Donald Acheson.

Aaron L. Zimmerman, who recently retired as Meteorologist-in-Charge of the National Weather Service Forecast Office in Seattle, Wash.

James G. Georg, technical liaison representative of the National Weather Service at Lakeland, Fla.

Philip A. Calabrese, chief of the Meteorological Services Division of the NWS Central Region

Maurice E. Pautz, Principal Assistant of the National Weather Service's Forecast Office in Denver, Colo.

William E. Fox, Hydrologist-in-Charge of the Atlanta, Ga., NWS River Forecast Center.

Armand J. Desmarais, meteorologist in the National Weather Service's Data Assimilation Branch of the National Meteorological Center.

Marcus W. Brooks, Chief of the National Weather Service's Overseas Operations Division Engineering Branch.

California Gets Top Sea Grant

The University of California has received the largest Sea Grant ever awarded, $2,120,000 for continuing marine-related research, education, and advisory services.

The grant will be augmented by more than $1,579,000 in matching funds from the State, local counties, and various private businesses.

Participating in the California program, now in its ninth year of support from the Office of Sea Grant, are the Berkeley, Los Angeles, Davis, San Diego, Santa Cruz, and Santa Barbara campuses of the University of California; San Diego State, Humboldt State, and Stanford Universities; California State University at Northridge; and the California Academy of Sciences.

Dr. Robert B. Abel, Director of the Office of Sea Grant, said the size of the grant was a strong indication of the enormous tasks the California Sea Grant program is continuing to undertake in the marine field.

"With its 47 separate projects involving more than 600 participants, the program is one of the State's best tools in the efficient and effective use of its more than 1100 miles of coastline," he commented.

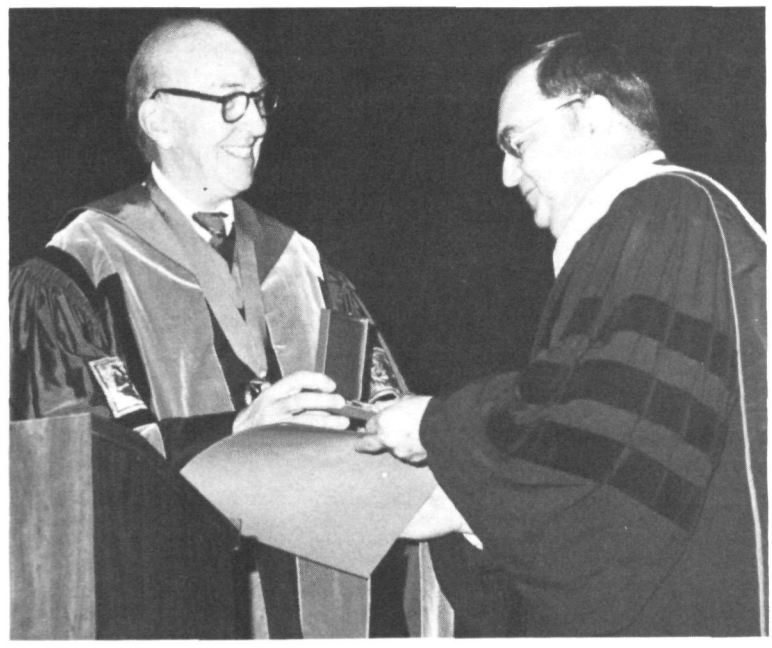
One of the most innovative of the current Sea Grant projects, underway at UC, San Diego, deals with the substantial potential energy that exists between large masses of water with different salinities. This energy is particularly concentrated where rivers flow into the ocean, and although "salinity power" has been recognized for several years, there have been few attempts to put it to work.

According to scientists working on the project, the osmotic pressure difference between seawater and fresh water is equivalent to the water head in a dam over 780 feet high. Between river water and the water of a highly saline area like the Great Salt Lake, the pressure is equivalent to a dam some 15,000 feet high. Researchers are now building a model to test several methods to capture this energy.

Another project in the energy field is aimed at minimizing the hazards that earthquakes pose to offshore oil facilities—wells, platforms, and pipelines.

Work is under way on a variety of other projects including an assessment of the sand and gravel potential of California's central continental shelf, a search for antiviral compounds in algae that show promise in treating disease in humans, and a continuing effort to grow land crops using seawater for irrigation.

WHITE AWARDED SMITHSONIAN MEDAL



Dr. Robert M. White, NOAA Administrator, has been awarded the Smithsonian Institution's Matthew Fontaine Maury Medal by Secretary S. Dillon Ripley, of the Smithsonian.

The presentation took place in the Eisenhower Theatre of the John F. Kennedy Center for the Performing Arts during the opening ceremonies of "The United States in the World," an international conference cosponsored by the American Council of Learned Societies, the American Studies Association, and the Smithsonian.

The medal was established in 1970 in honor of Maury, a 19th century U.S. Naval officer recognized as the founder of the science of oceanography. The Smithsonian awards the medal for distinguished contributions in underwater ocean science, an interdisciplinary field of immense complexity whose understanding is one of mankind's greatest challenges.

Dr. White was honored for distinguished service as the first Administrator of NOAA, and for his participation in fostering research on a national level in the ocean sciences.

The citation notes that Dr. White has "combined the skills of a gifted administrator with those of a human scientist," and that he has pioneered an international cooperation in marine biology and ecology. It also lauds him for his efforts to "protect our fellow mammals who still make the seas their home."

In remarks prepared for presentation, Secretary Ripley said that Dr. White was one of the leading scientist-administrators in the United States. He also said that the international conference provides a "most propitious opportunity for recognizing leadership in exploring knowledge about a domain on which we are all dependent—the earth's water system."

Secretary Ripley also stated that in honoring Dr. White during the celebration of the American Revolution Bicentennial, "we also are celebrating the father of oceanography in the United States—Matthew Fontaine Maury, who published his classic *Physical Geography of the Sea* in 1855."

NESS Scientists Develop Snow Cover Forecast Key

A new technique for estimating as far as three months in advance how much of the Northern Hemisphere will be covered by snow in winter months has been developed by two scientists with the National Environmental Satellite Service.

Donald R. Wiesnet and Michael Matson have developed equations based on an analysis of nine years of snow-cover data gathered by NOAA's polar-orbiting and geostationary satellites.

They see their method, termed Antecedent Snow Cover Technique, as being useful in forecasting generalized continental winter conditions, preparing agricultural crop forecasts, and for climatological studies.

In a paper published in a recent issue of the American Meteorological Society's *Monthly Weather Review*, they provided details of their technique, which uses December snow cover as the basis for estimating the extent by area of snow cover not only for the next month, but for January through March. With other equations, February snow cover can be estimated by combining December and January data.

Estimates can be made for Eurasia, as well as for the entire Northern Hemisphere, with the equations.

"The significance of being able to estimate winter snow conditions lies in the fact that such estimates, if accurate, ultimately can be used in sophisticated models of global circulation to improve long-range forecasting, a goal that has been pursued by meteorologists for many years," Mr. Wiesnet, a Senior Research Hydrologist, said.

"World and national interest in climatic change and future food production is at a high level," he continued. "The routine, constant, uniform collection of data, day after day by NOAA satellites, is providing a new and exciting data base whose potential value has merely been scratched by these findings. As the satellite snow cover and other data become better known and better accepted by researchers, the information will be applied to a widening variety of meteorological and climatological problems."

Stressing that long-range forecasting is the responsibility of the NWS, not NESS, he predicted the approach developed by his and Mr. Matson's research ultimately might prove useful in making improved 30-, 60-, and 90-day winter forecasts.

Their technique currently is being tested and evaluated in the NESS Environmental Sciences Group.

Boost Mississippi Coastal Fund

The coastal management program in Mississippi, developing a plan to balance future uses of its coast, has received additional funding through a $33,868 grant from the Office of Coastal Zone Management.

The program is designed to encourage efficient use of coastal areas for recreation, conservation, commercial fishing, agriculture/aquaculture, energy production, and various other competing activities.

Mississippi is in the second year of developing its program with funds received from OCZM.

To develop its program, Mississippi has received $342,000 through two NOAA grants and added another $176,000 in State matching money. The latest funds are a supplement to the second year NOAA grant.

Link Ionosphere Bubbles to Radio Noise

Giant bubbles in the earth's ionosphere may be the cause of a common disruption of radio and satellite communications.

With a colorful manmade cloud over Brazil, a rocket probe, and a portable radar, an international team of scientists has discovered a six-mile-diameter bubble rising rapidly through the ionosphere, and has developed a theory linking such bubbles to radio disturbances.

Dr. Ben B. Balsley, David A. Carter, and Warner L. Ecklund of the Environmental Research Laboratories' Aeronomy Laboratory, and seven other scientists from Cornell University, the University of California at Berkeley, and the Max Planck Institute of Physics in Germany made their find while trying to discover the cause of a phenomenon known as "equatorial spread F."

In point-to-point communications through satellite relays, the signals pass through the ionosphere both on their way to and from the satellite. At certain times—usually at night at low altitudes—the signals become extremely distorted. This happens when the radio beam is reflected or scattered by small, dense clouds—or "blobs"—of electrons in the ionosphere.

The group recently has completed analysis of the results from a major field experiment at Natal, Brazil, in 1973 and has formulated a theory to explain how motions in the ionosphere could produce the irregularities that cause spread F.

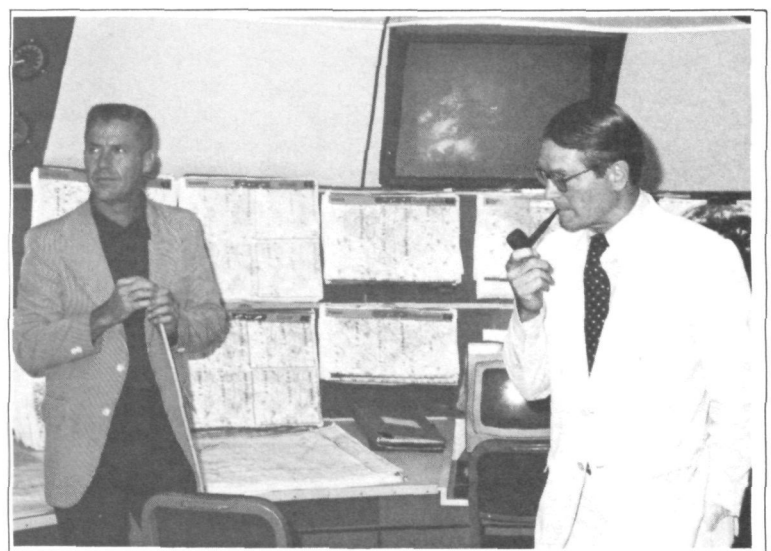
From Natal, near the magnetic equator, a National Aeronautics and Space Administration Javelin rocket was launched into the ionosphere during a certain time interval after sunset. At a height of 275 miles (460 kilometers), the rocket released a cloud of metallic barium, a harmless substance that "colors" a patch of the ionosphere, allowing scientists to see otherwise invisible ionospheric motions with a telescope. Part of the barium cloud rose rapidly after being released, showing a general upward drift of the ionosphere.

The rocket also carried instruments to measure the density of the plasma (ionized particles) which comprises the ionosphere. Data from the rocket instruments showed extreme fluctuations in plasma density, including one large region, about six miles (10 kilometers) thick, where the plasma thinned out drastically, becoming 100 times more tenuous than the surrounding area.

Meanwhile, a radar on the ground detected a patch of irregularities rising rapidly through the ionosphere. Its initial velocity was over 840 miles (1,400 kilometers) an hour, a rate even greater than the velocity of the barium cloud. From records of its trajectory, the scientists inferred that the patch had originated at the location of the hole detected by the rocket. They believe that the rapidly rising, 10-kilometer hole they saw was like a bubble in the ionosphere. The smaller irregularities that cause spread F may be due to turbulence on the edges of such bubbles.

The charged particles in the ionosphere, explains Dr. Balsley, are held up against the pull of gravity by the lines of force of the earth's magnetic field. As the sun heats the day side of the world, horizontal winds develop that try to draw the ionized particles along, but the magnetic field lines hold them back. The conflicting forces generate an electric field, which pushes the ionosphere upward. At night, a reversed electric field arises due to cooling of the atmosphere, and the ionosphere is driven downward again.

But, says the ERL scientist, the ionosphere doesn't sink uniformly. "If you have a jar with some molasses on the bottom and turn the jar upside down, the molasses won't run toward the cap in an even sheet. It moves in globs or streams. The ionosphere acts much the same way. While the dense plasma sinks in globs, other areas of low density rise to the top. The bubble we saw was where it was rising."



Commerce Secretary Elliot L. Richardson inspected the National Weather Service's National Hurricane Center in Miami, where he is shown discussing activities with Director Dr. Neil Frank (left). The Secretary, Dr. Robert M. White, NWS Director Dr. George P. Cressman and Dr. Frank flew from Washington to Miami aboard NOAA's new P-3 aircraft, viewing several coastal areas considered especially vulnerable in the event of a hurricane.

Unique Guamanian Coastal Areas To Be Studied Under CZM Grant

Areas that possess a unique quality, or a distinct or special value, and that lie within Guam's coastal zone, will be given special attention under a $189,000 grant from the Office of Coastal Zone Management. Guam will add $50,727 in matching territorial funds.

OCZM awarded the grant to help Guam continue developing a coastal management program that will achieve the best and balanced use of the island's coastal resources.

Part of the program will be the delineation of areas of critical concern—critical either because of their natural value or because of pressures from commercial development. Some such areas are those of significant agricultural or industrial production, those that offer substantial recreational opportunity, lands that pose a potential hazard if developed, and areas that protect the island's land and water resources.

Guam plans to evaluate the impact on each of the outlined areas from proposed land and water uses.

Other elements to be examined during the second year include identifying the coastal boundary, determining permissible land and water uses, developing methods for exerting territorial control over coastal uses, and establishing an organization to implement the program.

NOAA BACKS DELAWARE AQUACULTURE

The University of Delaware will use part of a $700,000 Sea Grant to pursue its long-term goal of establishing a new technology for raising shellfish in a unique aquaculture system.

More than $509,000 in non-Federal matching funds will be added to the NOAA grant.

The Delaware aquaculture project at the University's Marine Studies Center at Lewes is being conducted by a team of Sea Grant-supported biologists, chemists, engineers, and economists. Using an unusual closed system which employs recycled, filtered seawater and specially formulated diets of algae, scientists have been able to grow both oysters and hard clams from egg to market size in record time.

A most promising aspect of the aquaculture system is its facility for raising the algae upon which the shellfish feed. A series of rearing tanks for algae is housed in a greenhouse designed to take advantage of the sun's light and heat, materially reducing one of the most expensive energy costs of the aquaculture system.

Responding to the severe industrial and residential pressures resulting from man's activities along Delaware's coastal zone, a number of projects in coastal and ocean engineering are planned under this year's grant to deal with coastal erosion.

Included will be a study of beach erosion due to extreme storms and an examination of the effect wind has on sand dunes, one of nature's most important protective barriers along the shore.

In a related project dealing with the socio-economic aspects of the coastal zone, researchers will determine the relative capacity of certain areas to absorb the substantial impact expected from offshore oil and gas exploration off the mid-Atlantic coast. Coastal counties of New Jersey, Delaware, and Maryland will be surveyed to assess the possible effects of the offshore oil development. The results of the study should be of particular value to local management and planning agencies.

Texas Investigates Deepwater Uses

The University of Texas will undertake a unique investigation of potential uses for the cold, nutrient-rich water from the deep ocean under a $314,000 Sea Grant. An additional $157,000 in matching funds has been pledged by the University, coming from various non-Federal sources.

Nudging Nature

NOAA Report Lists 72 Weather Mod Attempts

Seventy-two weather modification projects, more than half of them intended to increase precipitation, were conducted in the United States last year, according to a report published by NOAA.

With the goal of modifying weather over a 163,000 square mile target area in 25 states, the projects also were aimed specifically at dispersement of fog and the decrease of hail.

The report did not attempt to evaluate the success or failure of the weather modification activities.

The report, produced by NOAA's Environmental Modification Office, represents the most complete compilation available of both commercial and government weather modification projects conducted in the United States during the year. By law, those individuals and commercial firms engaged in weather modification activities must report on their projects to NOAA. Additionally, through informal agreement, any government agencies attempting to modify the weather also advise NOAA.

The 1975 summary showed 72 projects, over half in five states—11 in California, nine in Oklahoma, seven in South Dakota, and six each in Colorado and Michigan.

In area coverage, South Dakota—with a target area of 50,085 square miles—was the largest, followed by Utah, North Dakota, Kansas, California, and Florida.

Other states in which weather modification projects were conducted were: Alaska, Delaware, Idaho, Illinois, Indiana, Iowa, Maryland, Montana, Nebraska, Nevada, New Hampshire, Oregon, Pennsylvania, Texas, Washington, and Wyoming.

The summary indicated that while the number of weather modification activities in 1975 was slightly fewer than for the preceeding year, the total target area sought to be affected was about 10,000 square miles greater.

Seeding of clouds with silver iodide was the most frequent method used in the modification efforts, with dry ice, propane and polyelectrolytes also used. Ground-based and airborne equipment were used almost equally in the seeding techniques.

In addition to providing detailed information on the various modification programs, the report lists all current regulations concerning weather modification, including recent amendments to the law. It also contains copies of revised reporting forms.

Scrimshanders Obtain Reprieve

The economic hardship suffered by holders of sperm whale oil and scrimshaw legally obtained prior to the passage of the Endangered Species Act of 1973 is being remedied, according to the National Marine Fisheries Service.

The Act banned the import and sale of endangered species, and their parts and products in interstate and foreign commerce, and did not permit commercial firms to use parts of endangered marine mammals, even though they had been obtained before the Act became law.

NMFS has published interim regulations which among other things outline the procedures for applying for the permits.

Scientists to Prospectors: Try Tectonic Plate Borders

The Pacific Ocean may be surrounded by a ring of riches, scientists with NOAA and the United Nations believe.

Deposits of oil and metals, according to Dr. Peter A. Rona of the Environmental Research Laboratories and Lawrence D. Neuman of the U.N. Office for Ocean Economics and Technology, are linked to plate tectonics—the global geologic process that includes sea floor spreading and continental drift. Because of this, they say, marine prospectors should concentrate on centers of tectonic activity, and the Pacific Ocean is ringed by them.

The earth's crust is divided into a jigsaw puzzle of irregular plates; some stationary, some moving slowly at a rate of only a few centimeters a year. The borders of the plates are scenes of massive, sometimes violent, geologic activity. At undersea ridges along some plate edges, new crustal material wells up from the molten mantle of the earth and spreads outward. Elsewhere, at deep ocean trenches, the plates collide, with one usually sliding beneath the other. Under most of the Pacific Ocean is a single crustal plate that grows along the East Pacific Rise—which runs from Mexico southwest to near Antartica—and is being consumed beneath the Indian Ocean, Asia, and North America.

Along the trenches and ridges surrounding the Pacific, the scientists believe, are immense deposits of oil and metals.

Where oceanic crust is descending below a continent, curved strings of islands, known as "island arcs," form offshore, sectioning the ocean into smaller basins such as the Sea of Japan and the Bering Sea.

According to Rona and Neuman, trenches and island arcs act as barriers that accumulate sediment and organic matter, both from the continent and the ocean basin. Here, oceanic circulation is restricted, oxygen is not replenished in the water, and the organic matter is preserved. Geothermal heat in the trenches and small basins help convert the organic matter to petroleum. Finally deformation of the sediments by the powerful pressures of colliding plates forms traps where the petroleum can accumulate.

At boundaries where new crust is being generated, as along the East Pacific Rise, hydrothermal processes would concentrate metals, say Rona and Neuman. In the first stage of this process, the two explain, cold dense sea water descends through cracks in the ocean floor to be heated by contact with hot and molten rocks. It then rises, leaching metals from the crustal rock as it goes, and discharges from the ocean bottom as hot springs. Some of the leached metals combine with sulfur in the sea water and precipitate in layers containing copper, iron, and possibly gold. Others precipitate as oxides (compounds with oxygen).

The presence of mineral-rich sediments at a young and an old rift suggests to the scientists that the mineral formation process may continue throughout the lifetime of a spreading rift. They believe fields similar to those in the Atlantic and the Red Sea may exist along the East Pacific Rise.

Trenches where two plates are converging are also good candidates for metals prospecting, the two predict. Precious metals, including gold, silver, and platinum; base metals such as antimony, copper, lead, mercury, tin, and zinc; and iron and iron-alloy deposits containing chromium, cobalt, manganese, molybdenum, nickel, tungsten, and vanadium are concentrated by processes there.

Deposits of these metals occur landward of the converging plate boundaries along the western edges of North and South America. In the western Pacific, such deposits can be found on island arcs such as Japan, the Philippines, and Indonesia.

It is thought, say the scientists, that the metals are extracted from oceanic crust saturated with sea water as it descends into the earth's hot interior and begins to melt. The metals ascend again as components of molten rock, are concentrated in fluids released from the rock, and deposited on the ocean floor.

TIDE GAGES INSTALLED IN PRUDHOE BAY BY PACIFIC TIDE PARTY

The Pacific Tide Party recently installed two specially modified Bristol bubbler tide gages at Prudhoe Bay, Alaska. The gage was modified to a five-foot range so that the small tides along Alaska's Arctic Coast could be measured accurately.

Mickey K. Moss, Assistant Chief, and Lt. Garth Stroble installed the gages at ARCO Docks 1 and 2 at the request of the National Ocean Survey Tides Branch. A permafrost zone beneath the water necessitated the use of a portable steam generator to steam a pipe into the permafrost; the pipe was used to support the tide staff and tide gage orifice.

A five-man field party under the direction of Bill Lewis, from the NGS, ran 20 miles of geodetic levels between the two tide gage locations.

A portable Cobra drill used to drive bench marks attached to long rods into the permafrost.

INDIVIDUALS, UNITS RECEIVE 1976 NOAA AWARDS

Mr. Peck

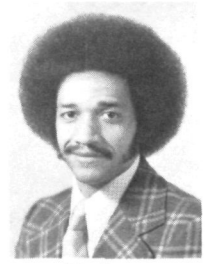
Dr. Kemmerer

Dr. Manabe

Mr. Mondschein

Mr. Rutkowski

Mr. Morales


Mr. Ross

Five NOAA employees have received 1976 NOAA Awards, and two received NOAA Equal Employment Opportunity awards.

Each Award is a plaque and $1,000.

Special mention also was given to recipients of NOAA Unit Citations awarded since last year's NOAA Award ceremony.

Dr. Robert M. White, NOAA Administrator, presented the NOAA Awards for:

—Program Administration and Management to **William L. Peck,** recently retired Deputy Regional Director of the National Marine Fisheries Service Northwest Region, Seattle, Wash.;

—Engineering and Applications Development to **Dr. Andrew J. Kemmerer,** Chief of the Technology Division of the NMFS Southeast Fisheries Center, Bay St. Louis, Miss.;

—Scientific Research and Achievement to **Dr. Syukuro Manabe,** a Research Meteorologist at the Environmental Research Laboratories' Geophysical Fluid Dynamics Laboratory, Princeton, N.J.; and

—Public Service to **Herman F. Mondschein,** Hydrologist in Charge at the National Weather Service River Forecast Center in Kansas City, Mo., and

—**Richard L. Rutkowski,** a Physical Science Technician and Diver at ERL's Atlantic Oceanographic and Meteorological Laboratories in Miami, Fla.

The NOAA EEO Awards, for outstanding activities in support of equal employment opportunity, were presented to:

—**Frank F. Morales,** who until recently was a Fishery Market News Reporter with NMFS in Los Angeles; and

—**Worthington Ross,** a Program Support Specialist with the National Ocean Survey in Rockville, Md.

Mr. Peck, who for six years was Director of the NMFS Pribilof Islands Program, was honored for management of the area's Northern fur seal resource and his contributions toward improving the quality of life of the Aleut people of the islands. He was cited for initiating improvements in procedures relating to harvesting of the fur seal; for his contributions as an advisor to the U.S. negotiating team for the North Pacific Fur Seal Treaty; and for helping the Pribilovians develop self-leadership. He took a leading role in the construction of a new school facility and in motivating young Pribilovians with leadership potential to obtain academic and vocational training, and is credited also with development of a comprehensive community development plan for the islands which is still in use today.

Dr. Kemmerer was honored for his international leadership in applying remote sensing from aircraft and satellites to the location and assessment of fishery resources. His material developed for NASA's ERTS-1 Experiment was voted by that agency as the outstanding contribution to the application of space technology to other fields. As the Nation moves into management of a very large fish resource under the extended jurisdiction law, his efforts will prove even more valuable.

Also, several other governments have asked him to assist them in planning and developing remote sensing programs.

Dr. Manabe was honored for his international leadership in the field of weather circulation and climatic modeling and simulation. In the past 16 years, he has been responsible for many important contributions leading to greater understanding of the energetics of the tropics and atmosphere as well as the role of the hydrologic cycle and of continental orography (physical geography dealing with mountains).

His research is considered fundamental to the ability to account for the climatic impact of aircraft activity, energy utilization alternatives, and other human sources of pollution.

Mr. Mondschien was honored for accurately predicting flooding of Minot, N. Dak., last spring and thus contributing to the safety and welfare of people in the area. He was cited for his early recognition of flood dangers through evaluation of Souris River Basin snowmelt and commended for his timely and accurate real-time daily river forecasts.

The Corps of Engineers, basing its flood protection strategy upon Mr. Mondschein's predictions, took preventive measures which, it is estimated, saved area residents an estimated $67 million in flood damage.

Mr. Rutkowski was honored for establishing at AOML a diving recompression chamber facility which already has helped save the lives of several divers.

He was cited for his personal dedication, tenacity, and skill in finding a surplus Navy recompression chamber in Boston, Mass., arranging for its transfer to AOML, and raising money both from NOAA and private sources to install the chamber.

There have been an average of 32 serious diving accidents in South Florida in each of the past four years. The victims of a number of these accidents could have benefitted from the recompression chamber, had it been available.

Mr. Morales, who is employed now by the Social Security Administration in Phoenix, Ariz., was honored for supporting the Federal EEO program in an outstanding manner by unselfishly dedicating himself to EEO counseling.

He became involved in EEO activities in 1973, when he was appointed regional representative for the Federal Spanish Speaking Program. The following year he was named NOAA-wide EEO Counselor for the Southwest Region and last year was elected Chairman of the NMFS Southwest Region EEO Committee.

Mr. Ross was honored for his performance in the development, implementation, and monitoring of equal employment opportunity.

He has demonstrated exceptional ability as an EEO Counselor, a post he has held in addition to his regular duties since 1970.

Last year, he processed 217 informal complaints, and settled all except six. His advice has saved NOAA money, improved relationships between employees and managers, and contributed to a better working atmosphere.

The groups to whom NOAA Unit Citations have been presented since last year's Awards ceremony are

In the National Ocean Survey:
—Aeronautical Chart Automation Project;
—Hydrographic and Topographic Survey Copying Program Task Group;
—Network Maintenance Branch, National Geodetic Survey;
—NGS Horizontal Control Party G-21;
—NOAA Ship Davidson;
—NOAA Ship Discoverer;
—NOAA Ship Miller Freeman;
—NOAA Ship Oregon;
—NOAA Ship Researcher;
—North American Datum Staff; and
—Physical Science Services Branch.

In the National Weather Service:
—East Coast Weather Patrol;
—Forecast Staff, WSFO Boston;
—Warning Coordination Center, Central Region;
—Upper Air Unit, WSO Amarillo;
—WSFO Bismarck;
—WSFO Des Moines;
—WSFO Minneapolis;
—WSFO Omaha;
—WSFO Sioux Falls;
—WSMO Chatham;
—WSMO Portland, Maine;
—WSO Fargo; and
—WSO LaGuardia.

In the National Environmental Satellite Service:
—Geostationary Satellite Data Acquisition Section.

In the Environmental Research Laboratories:
—Wave Propogation Laboratory's Optical Wind Sensing Group.

In the National Marine Fisheries Service:
—ICNAF Meeting Support Group; and
—Law Enforcement Division in Alaska.

In the Environmental Data Service:
—EDS Deepwater Ports Project Office Staff; and
—Staff, Assessment Division, Center for Climatic and Environmental Assessment.

In the NOAA Corps:
—NOAA Officer Training Center Staff.

President Thanks Five For Savings

Five NOAA people have been honored by President Ford for their efforts, which have resulted in significant cost savings or energy conservation. First year measurable benefits of achievements of the 15 Department of Commerce employees honored by the President totaled over a million dollars.

Congratulatory letters from the President were presented recently by Dr. John W. Townsend, Jr., Associate Administrator, to:

Nicholas A. Garifo, an Electronics Engineer in the Facilities and Schedules Branch of the National Weather Service Communications Division.

Walter A. Hogge and **Douglas E. Ford,** Communications Management Specialists in the Telecommunications Management and Planning Division in the Office of Management and Computer Systems, Office of the Assistant Administrator for Administration.

Sandra M. Glover, a Telecommunications Assistant in the same office as Mr. Hogge and Mr. Ford.

The fifth NOAA employee was **John H. Kinney,** Regional Engineer of the National Marine Fisheries Service Alaska Region in Juneau.

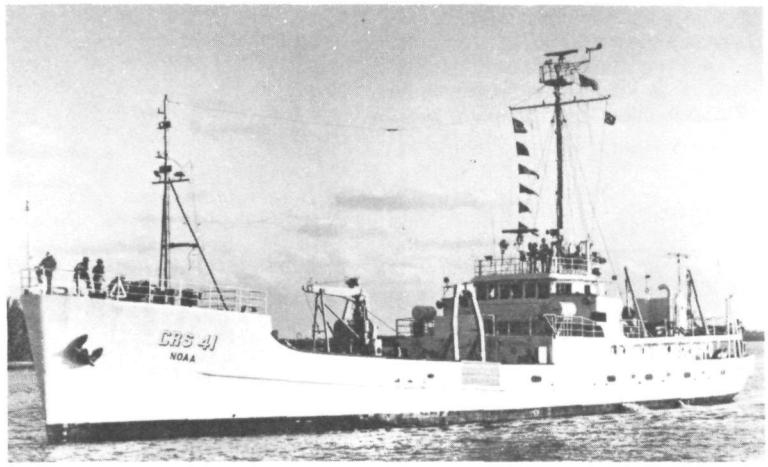
Marine Scientists Study Effects of Oil on Birds

The College of the Atlantic in Bar Harbor, Maine, has been awarded a $79,220 contract by the Environmental Research Laboratories to assess the effects ocean currents have on breeding colonies and food habits of marine birds at Norton Sound in the northern Bering Sea area of Alaska.

The contract, which extends work done at Bluff and Sledge Islands off Alaska's Seward Peninsula, is part of a major environmental study managed by ERL for the Interior Department's Bureau of Land Management as a portion of the Bureau's Outer Continental Shelf Environmental Assessment Program. These studies seek to determine the probable ecological impacts of oil exploration and development activities on Alaska's outer continental shelf.

A major focus of the research is to learn population patterns, abundance, and food dependencies of marine birds in coastal habitats at King Island off the Peninsula.

"Belle" Effect Minimal



When Hurricane Belle charged past New York last August, it also passed through one of the best-studied bodies of water in the world.

For the last three years, NOAA has been studying the New York Bight—the corner of the Atlantic bordering Long Island and New Jersey—to understand the effects of the area's 20 million inhabitants on the marine ecosystem. The major project is part of NOAA's Marine Ecosystems Analysis (MESA) program, managed by the Environmental Research Laboratories.

Belle provided an opportunity to study the effects of a hurricane, and soon after the storm passed, project manager Dr. Larry Swanson was on the phone rounding up the ships and scientists.

The NOAA Ship Kelez, on her way to Newport, Rhode Island, for maintenance, was recalled to recover current meter arrays that had been deployed throughout the Bight. The Kelez was able to recover all 35 meters, and about 80 percent of the associated instrumentation. It was the first comprehensive array of current meters to survive a hurricane. The measurements they collected, when analyzed over the next few months, may provide new information on hurricane driven currents.

Dr. George Freeland and John Burns of NOAA's Atlantic Oceanographic and Meteorological Laboratories in Miami also sailed with the Kelez after the hurricane . They collected more than 80 samples of bottom sediments at half-mile intervals through the northwest corner of the Bight concentrating on the sewage sludge dumpsite there. The scientists had surveyed the area only three months before and are looking for changes brought by the storm.

From the MESA New York Bight Project's 50-foot (15-meter) catamaran Johnson, the two also scanned the bottom of the Bight with sonar. The project has an established network of track lines along which sonar measurements had been made only three months previously. After Belle, the Johnson retraced these paths, collecting sonar records along 29 miles (47 kilometers) of the ocean bottom to see if bottom sediments had been redistributed.

Other researchers from the Miami laboratories, Dr. Robert Young, Lt. Richard West, and Philip Hanson, set out to study the effects of the hurricane on the suspended matter in the Bight waters.

Dr. Malcolm Bowman, a physical oceanographer from the State University of New York at Stony Brook, studied the temperature, salinity, and chlorophyll (a measure of biological activity) in surface waters and at selected depths to determine whether the intense rainfall from the storm augmented the plume of fresh water from the Hudson River.

The data have not all been analyzed yet, but, say the researchers, Belle seems to have had little effect on the Bight ecosystem. Surveying the region by helicopter, Young saw only the usual amounts of floating debris; the Hudson River plume appeared normal for that season. It will be at least six months before the water samples are completely analyzed, but, he says, "first inferences are that the system was normal for this time of year. If it was disturbed by Belle, it didn't take long to return to equilibrium."

There were several reasons for Belle's small impact, say the scientists. By the time the storm reached the New York area, it was milder than anticipated, and it passed rapidly through the area. Then, too, the researchers point out, the fact that the storm passed through at low tide minimilzed its effects on water levels.

Belle was not the ideal subject for a study of hurricane effects. But even though preliminary surveys suggest that the storm had little ecological impact, analyses, yet to come, of the water and sediment samples, may show more subtle effects.

Anastasion Heads New Ocean Unit

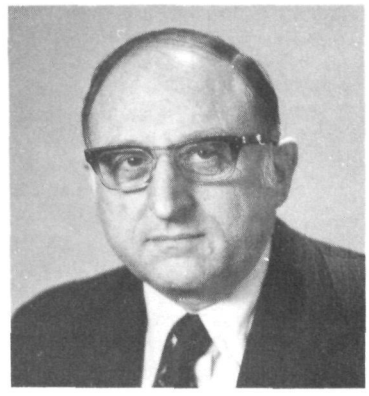
NOAA has established an Office of Ocean Engineering, which includes the Data Buoy Office, the Office of Manned Undersea Science and Technology, and certain functions of the former National Oceanographic Instrumentation Center.

Funded at slightly less than $9 million—all drawn from existing component groups—it is headed by Acting Director Steven N. Anastasion.

It reports to the Administrator and receives policy guidance from the Associate Administrator for Marine Resources.

"Ocean resources, their sound use and environmental protection, are vitally important to our Nation," Dr. White, NOAA Administrator, said in announcing the office. "Energy and other crucial offshore development requires significant advances in fundamental engineering knowledge. Our knowledge is now inadequate; the lack of that knowledge is contributing daily to the high cost of continental shelf development, and we must intensify our efforts to acquire it."

Not only does the office coordinate existing NOAA ocean engineering programs, it initiates some of its own, and serves as a focus for technology transfer within the entire marine community, working closely with other Federal, academic and industrial organizations.



Mr. Anastasion joined NOAA in 1972 after retiring as a Captain at the end of a 30-year career in the U.S. Navy during which he held a variety of sea and shore posts. Formerly Chief of the Plans and Program Coordination Office in the Office of Marine Resources, he is Chief Scientist for the U.S.-French Cooperation in Oceanography, and is U.S. Chairman of the Marine Resources and Engineering Coordination Committee of the U.S.-Japan Natural Resources Agreement.

noaa/people

Mary Gearhart, Program Support Specialist for the Assistant Administrator for Administration has received a Department of Commerce Bronze Medal in recognition of her dedicated, extremely competent performance and initiative in the development and improvement of operating procedures for the Office of Administration.

George T. Gregg, Meteorologist in Charge of the National Weather Service Forecast Office in Albuquerque, N. Mex., has received a Department of Commerce Bronze Medal for accomplishments including assistance to the Bureau of Land Management and the U.S. Forest Service in applying weather information to control of forest fires and management of public lands, and leadership in improvements in winter storm and flash flood warning services in New Mexico.

Dr. Robert F. Hutton, Special Assistant for State Affairs in NOAA's Office of Marine Resources, was installed as the 88th President of the American Fisheries Society at a recent ceremony in Dearborn, Mich.

Dr. Joseph F. Caponio, Director of the Environmental Data Service's Environmental Science Information Center, has been appointed to serve on the Federal Library Committee's Executive Advisory Committee for the next two years.

Herman C. Anderson, Chief of the Chart Information Branch, and **John T. Hanna,** Staff Assistant, represented the National Ocean Survey at the recent 1976 Fall National Conference of the U.S. Coast Guard Auxiliary held in Baltimore, Md.

Deedee Solow, a Biological Oceanographer with the Environmental Data Service's National Oceanographic Data Center, participated in a Deepwater Dumpsite 106 project cruise that investigated the impact of chemical waste on marine organisms offshore of New York City.

James L. Dicke, a Supervisory Meteorologist in the Environmental Research Laboratories' Meteorology Laboratory, which is part of the U.S. Environmental Protection Agency's Environmental Science Research Laboratory in Research Triangle Park, N.C., was among a group of EPA employees awarded that agency's Bronze Medal.

Raymond J. Sauer, Administrative Officer in the Administrative Operations Division at the Northwest Administrative Service Office (NASO) in Seattle, Wash., recently received a Department of Commerce Bronze Medal for "exemplary service manifested by significant contributions and achievements in areas of contracting/procurement and administrative services."

Elizabeth Y. Gamble, a clerk in the Hydrologic Research Laboratory of the National Weather Service Office of Hydrology, has been accepted for graduate study and awarded a scholarship for a two-year Master's Degree Program in Minority Mental Health, at Washington University in St. Louis, Mo.

Carol Wright, Secretary to the Director of the Environmental Research Laboratories in Boulder, Colo., since 1974, recently was awarded a Certified Professional Secretary rating by the National Secretaries Association.

Dr. John M. Miller, a veteran meteorologist and air pollution expert, has been named Director of the Environmental Research Laboratories' observatory on the slopes of Mauna Loa, Hawaii.

John J. O'Brian, formerly in charge of the National Marine Fisheries Service Boston Market News Office before retiring last year, recently was awarded a Department of Commerce Bronze Medal for 38 years of original and superior leadership in collecting, analyzing, assembling, publicizing and disseminating fishery market news to business and industry.

Richard M. Barazotta and **James R. Budd** of the National Environmental Satellite Service have received certificates for successfully completing NOAA's 20/20 Upward Mobility Training Program.

George Blandino, Lead Forecaster at the National Weather Service Forecast Office in Milwaukee, Wis., recently received a Department of Commerce Bronze Medal for "his unselfish dedication to the public in carrying out the National Weather Service mission in an extremely competent manner."

Alec Slepitza, a Cartographer in the Review Section of the Visual Chart Branch in the National Ocean Survey's Office of Aeronautical Charting and Cartography, recently received a Department of Commerce Bronze Medal "in recognition of major contributions in the preparation and maintenance of accurate aeronautical charts."

Orval C. Turner, Personnel Management Specialist in the Operations Branch of the Personnel Division, recently received a Department of Commerce Bronze Medal in recognition of his many years of meritorious service in Personnel Administration and for his effective supervision and training of new personnel.

Philip E. Schideler, Meteorologist in Charge of the Weather Service Forecast Office in Topeka, Kansas, recently received a Department of Commerce Bronze Medal for his "sustained and extremely competent performance, and for his efforts toward developing a strong local forecast program."

Lloyd G. Heavner, Meteorologist in Charge of the Billings, Mont., Weather Service office, has been named MIC of the Missoula, Mont., WSO. He replaces **Edward W. Nelson** who retired.

Suzanne Servis, Administrative Associate with the State University of New York-Cornell Sea Grant Program, in Albany, N.Y., has joined the staff of the Procurement and Grants Management Branch of the Administrative Operations Division, under the Intergovernmental Personnel Act.

John V. Graff has been named Meteorologist in Charge of the National Weather Service Forecast Office in Minneapolis, Minn., where he has served as Principal Assistant since 1969.

Being sworn in as Deputy Director of the Environmental Data Service is Dr. Thomas D. Potter, former Director of EDS' National Climatic Center in Asheville, N.C. Dr. Thomas S. Austin, EDS Director, administered the Oath of Office, and Mrs. Potter held the Bible.

Robert E. Cardinal, MIC at the Weather Service Office in Yakima, Wash., recently received a Department of Commerce Bronze Medal for superior performance as meteorologist in charge of several National Weather Service Offices.

George F. Wall, Weather Service Specialist at the National Weather Service Office in Fort Wayne, Ind., recently received a Department of Commerce Bronze Medal "for his initiative and devotion to duty, especially during dangerous weather events."

The National Marine Fisheries Service personnel at the Northeast Fisheries Center in Woods Hole, Mass., recently received a NOAA Unit Citation for contributions to the recent Assessment Subcommittee Meeting of the International Commission for the Northwest Atlantic Fisheries.

Fern Gwynn, Supply Technician in the Administrative Management Division at National Weather Service Western Region Headquarters in Salt Lake City, Utah, recently received a Department of Commerce Bronze Medal for "Outstanding service over a long period of time."

Beatrice M. Chappell of the National Weather Service Systems Development Office in Silver Spring, Md., recently received a Department of Commerce Bronze Medal in recognition of her superior performance and outstanding achievement in the field of fiscal control.

Evelyn Allan, Secretary to the Scientific Services Division at National Weather Service Western Region Headquarters in Salt Lake City, Utah, recently received a Department of Commerce Bronze Medal for her outstanding service over the past decade.

Helen C. Fleischhauer, of the Auke Bay Fisheries Laboratory in Auke Bay, Alaska, has received a Department of Commerce Bronze Medal for outstanding technical contribution to production of scientific publications.

Capt. James P. Randall has been appointed Commanding Officer of the NOAA Ship Ranier. He has been serving as Associate Director of the National Ocean Survey's Office of Aeronautical Charting and Cartography since 1974.

Daniel B. Mitchell, Deputy Director of the Environmental Data Service Center for Experiment Design and Data Analysis (CEDDA) has been appointed Director of EDS' National Climatic Center in Asheville, N.C. He succeeds **Thomas D. Potter.**

Dr. Danny L. Fread, research hydrologist with the National Weather Service's Hydrologic Research Laboratory, Silver Spring, Md., received two national awards for 1976 from the American Society of Civil Engineers.

Two scientists from the Soviet Union recently toured NOAA's Office of Marine Technology Test and Evaluation Center at the Washington Navy Yard. Dr. Aleksey N. Kosarov of Lomansov University, Moscow (second from left) and Dr. Boris G. Popov of the Soviet Hydrographic Society, Moscow (second from right) look on as Stanton B. Russell, General Engineer at the Laboratory (left) explains a testing unit used for evaluating oceanographic instruments. On the right is Dr. Robert B. Abel, Director of the National Sea Grant Program, who served as host for the Soviet visitors.

ERL Scientist Williams Is Jupiter's Weatherman

The frigid hydrogen atmosphere of Jupiter, seemingly so alien, may actually behave something like the earth's atmosphere—and something like the the oceans too.

An Environmental Research Laboratories scientist applied a computer model of the earth's atmosphere to Jupiter and found it not only reproduced the patterns known to exist, but provided new explanations of such visible features as the Great Red Spot and the horizontal stripes, and revealed a four-year cycle in the transfer of heat.

"Essentially what I'm trying to do is predict the weather on Jupiter," explains Dr. Gareth P. Williams, who heads a team at ERL's Geophysical Fluid Dynamics Laboratory in Princeton, N.J., that studies the atmospheres of other planets.

"Weather" on Jupiter differs from earth's, but the basic behavior of the two atmospheres turns out to be quite similar. "So Jupiter represents an alternative climate to earth's. The same principles apply, but the conditions are different," says Dr. Williams.

"There also are similarities between circulation on Jupiter and what we find in the oceans on earth," he adds. The reason is the rotation of the mammoth planet dominates the behavior of its atmosphere.

"The influence of rotation is probably something like 100 times what it is in the earth's atmosphere. Things tend to get smeared out in the horizontal much more strongly. This is how it is in the ocean on earth."

The result is an atmosphere that moves mainly in the horizontal. Turbulence, which on earth can go any which way, on Jupiter is two dimensional.

It can't dissipate energy, so it transfers it to larger scales. Eddies in the Jovian atmosphere combine to form ever larger eddies. Dr. Williams explains, "you get a cascade of energy. The eddies get bigger and bigger until they reach a critical point, when they begin to feel the influence of the curvature of the planet." At this point, when the eddies have grown to the size of the visible bands, giant waves, moving east-west, develop.

The waves, called Rossby waves, slow down the cascade of energy. They transfer energy from the eddies into a mean flow of the atmosphere around the planet. This mean flow, a series of jet streams, corresponds to the varicolored bands—light-colored "zones" alternating with darker "belts"—we see in telescopic images of the planet.

The jet streams on Jupiter are like those on earth, except more numerous. While earth has only one jet stream in each hemisphere, Jupiter has four or five running parallel to the equator. The Jovian jet streams form along the boundaries between adjacent bands, so that the edges of each band are traveling in opposite directions.

"The basic purpose of atmospheres is to transfer heat from the equator to the poles," says Dr. Williams. The sun pours more heat into equatorial regions than polar regions. When the difference between the two extremes builds up to a critical level, cyclones (closed circulation systems with low atmospheric pressure) and anticyclones (high-pressure regions) develop to reduce the temperature gradient, and then die out when the distribution of heat is stable.

Honor NCC's J.R. Owenby

James R. Owenby, Jr., a Meteorologist with the Environmental Data Service's National Climatic Center in Asheville, N.C., was one of the 10 outstanding handicapped Federal employees for 1976 honored at ceremonies in Washington, D.C.

During "Nationally Employ the Handicapped" Week, and as a kick-off, members of the President's Cabinet and heads of other Government agencies jointly reaffirmed their support of affirmative action in the hiring and promoting of handicapped men and women in all segments of this Nation's society.

Although a victim of polio at the age of six, and as a result unable to walk, Mr. Owenby has established a professional career and contributed significantly to the quality of life in his community.

He was graduated with honors from high school, and in 1959 earned a pre-engineering certificate from Asheville-Biltmore Junior College.

In 1961, he was appointed a statistical draftsman with NCC, and a Meteorologist in 1970.

He was one of the founders of an organization of physically handicapped called the "Door Openers" who seek to encourage other physically disabled people to participate in community activities. Members help the handicapped find employment, work for better design of homes for the handicapped, and encourage the local government and stores to install sidewalk ramps and other devices to ease the movement of the handicapped.

NACOA RECOMMENDS MAJOR POLICY ACTION

The National Advisory Committee for Oceans and Atmosphere, in a wide-ranging report, has advocated significant changes in the Nation's energy, marine, weather and climate programs.

Chairman of the 25-member group, charged with reporting to the President and Congress annually on the state of the Nation's marine and atmosphere programs, is Dr. William J. Hargis, Jr., Director of the Virginia Institute of Marine Sciences.

In a report transmitted to the White House on September 28 by the Secretary of Commerce, NACOA recommended refocusing Federal atmospheric and oceanic planning and operational activities.

Major recommendations are:

–That an ad hoc task force be established by legislation to formulate a comprehensive marine affairs policy and plan pending development of a continuing coordinating mechanism. NACOA stated that oceanic events are developing more rapidly than are plans to cope with them.

–That the Nation explore and develop offshore oil and gas resources consistent with environmental safety and the need for maintaining strategic reserves; and that the process be reconciled with an economic atmosphere suitable for development.

–That Congress enact pending legislation for a program of climate watch, forecasting and research under the coordination of the Secretary of Commerce.

–That NOAA receive responsibility for coordinating and managing a coherent Federal program of weather modification research and experimentation.

–That Federal funding for the National Sea Grant program be increased from $23 million to about $40 million per year over the next three to five years, and that its legislation be amended to free earmarked funds from matching criteria; and that its operations, goals and priorities be studied.

"A Report to the President and the Congress" is for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, at $2.00 per copy.

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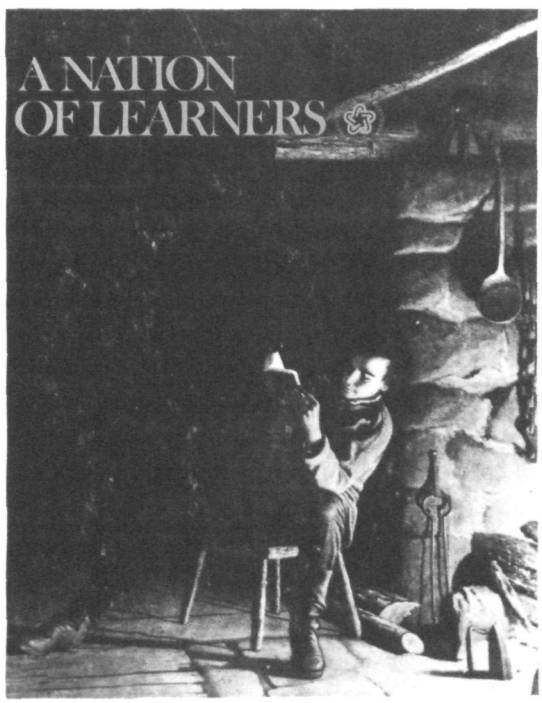

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