VOLUME 6 NUMBER 4 OCTOBER 1976

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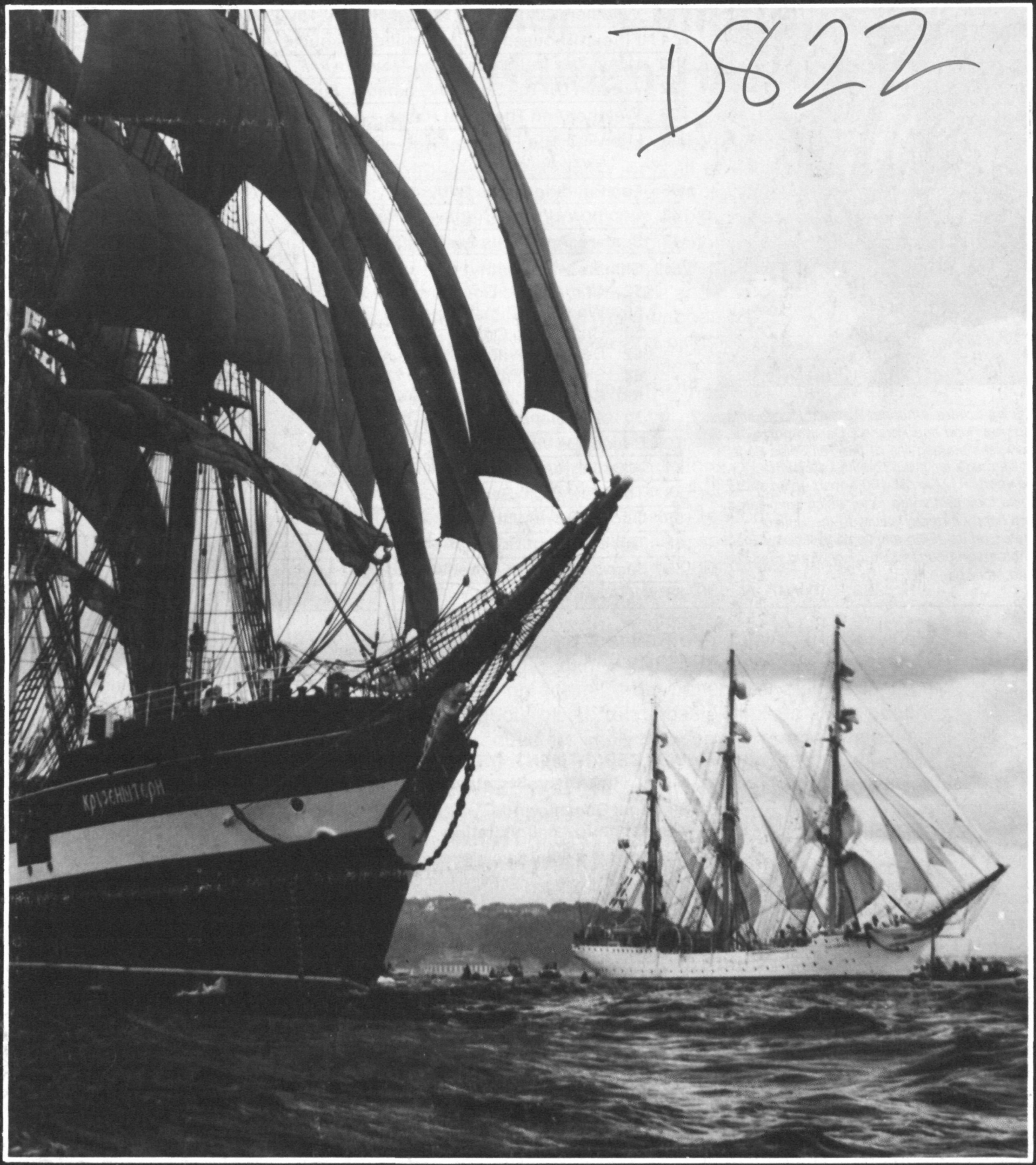

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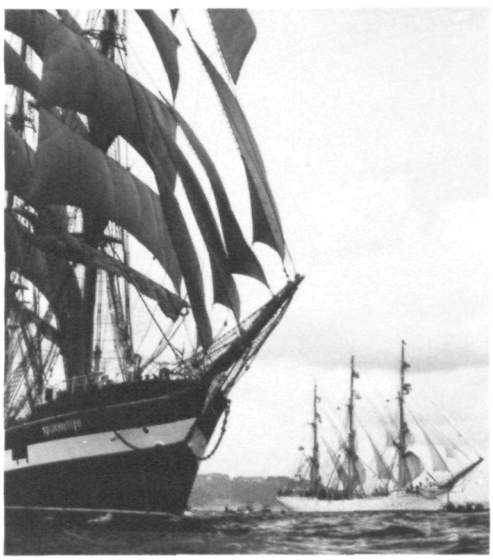

Racing toward America, Russia's Kruzenshtern, in foreground and Poland's Dar Pomorza, leave the starting line of the Tall Ships Race at Bermuda for the 632-mile voyage to Newport, R.I. Almost 100 ocean-going sailing ships took part in the race, which culminated in a happy birthday salute to the United States on its 200th anniversary. Alastair Black photograph courtesy Cruising World magazine. See story page 13.

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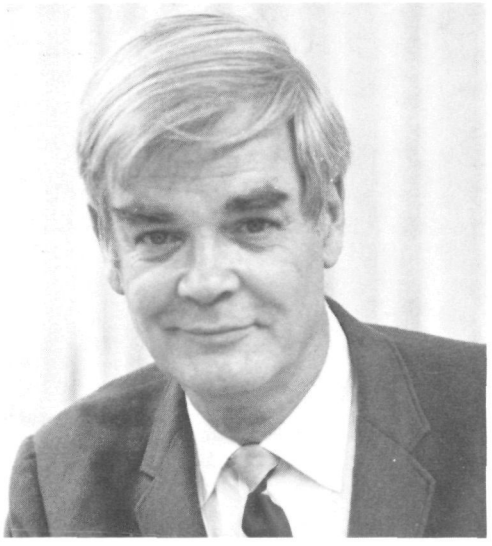
Weather, Climate, and Human Health



Shivering—perspiring—heatstroke—aching joints—asthma attacks—depression . . . all of us are aware of the relation of weather and climate to these experiences. None of us is immune to the influence of weather and climate upon our physical and psychological well being. Hippocrates himself, the Father of Medicine, wrote of human reactions to hot and cold winds and related the outbreak of epidemics to seasonal weather changes.

The effects of weather and climate upon human health are often caused by the continuous variations in the atmosphere in which we live. The moisture varies, temperature and pressure rise and fall, suspended particles and aerosols vary in quantity. Meteorologists have been asked about the effects of these variations on health for as long as there has been a weather service. Before the turn of the century, the Weather Bureau responded by publishing statistics for the physician in a special monthly climate and health booklet. But the amount of data was meager, and there were inadequate means to process the statistics.

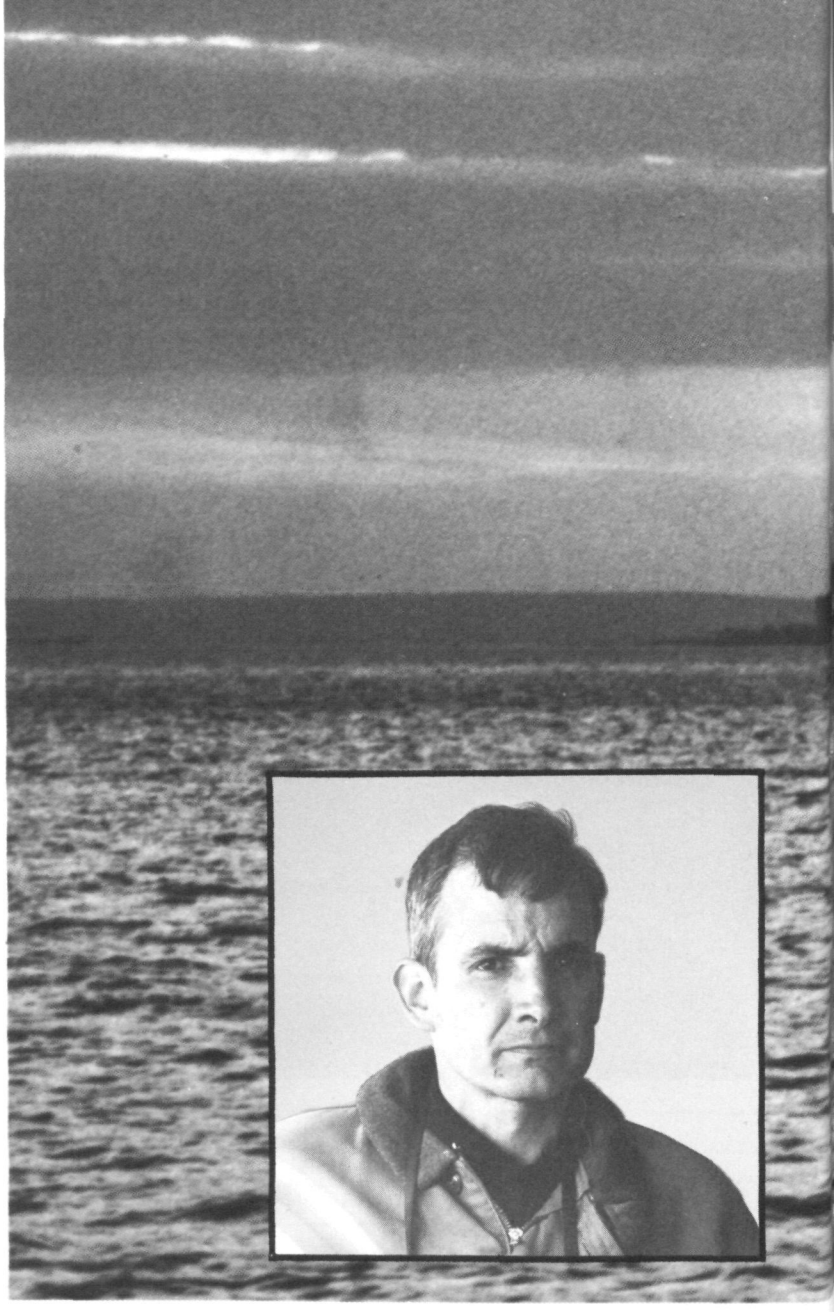
For many years, the Environmental Data Service's National Climatic Center (NCC) in Asheville, N.C., has been answering queries from patients and physicians on various aspects of the relationship of climate and health. Nearly all requesters imply that symptoms and related discomforts are worse during certain types of weather and climate. We in EDS are convinced that NOAA, by using the national climatic data base to produce innovative health-related products, would develop a more systematic program to meet the needs of these customers.

The articles that follow document the pervading influence of weather and climate on our health. They also explore the need to tie together the efforts of the medical and atmospheric science communities to work toward improvement of the quality of human life.

Thomas S. Austin

Taking the pulse of the New York Bight

FIFTEEN THOUSAND SQUARE MILES OF TROUBLE



BY ROLAND PAINE

There were no dog days in the summer of 1976 for Larry Swanson and the staff of the MESA New Bight Project. Instead, it was a time of anxious calls from local health officials, of lengthy inspections of fouled beaches, of urgent chemical analyses of recreational waters, of hastily-called meetings among scientists and public officials, and of hours and days spent with news media, explaining what was known and trying to lay the groundwork for what might follow. Through all of this, the regular research and operational programs continued at their planned pace.

That the project staff was so busy was in part its own doing. For in the three years that the project has operated, Cdr. R. Lawrence Swanson, NOAA, Manager of the MESA New York Bight Project—to give him his full identification—and his scientific and operational crew have earned a reputation for accuracy, candor, and prompt response. The project scientists are trying to determine the fate of pollutants in the New York bight and their effect on the ecosystem, as well as the important physical and biological processes taking place there. So whenever there appears to be an emergency in the waters that wash the shores of Long Island and New Jersey, officialdom and citizens alike call upon them for explanations and assistance. In the summer of 1976, it seemed to be one after another.

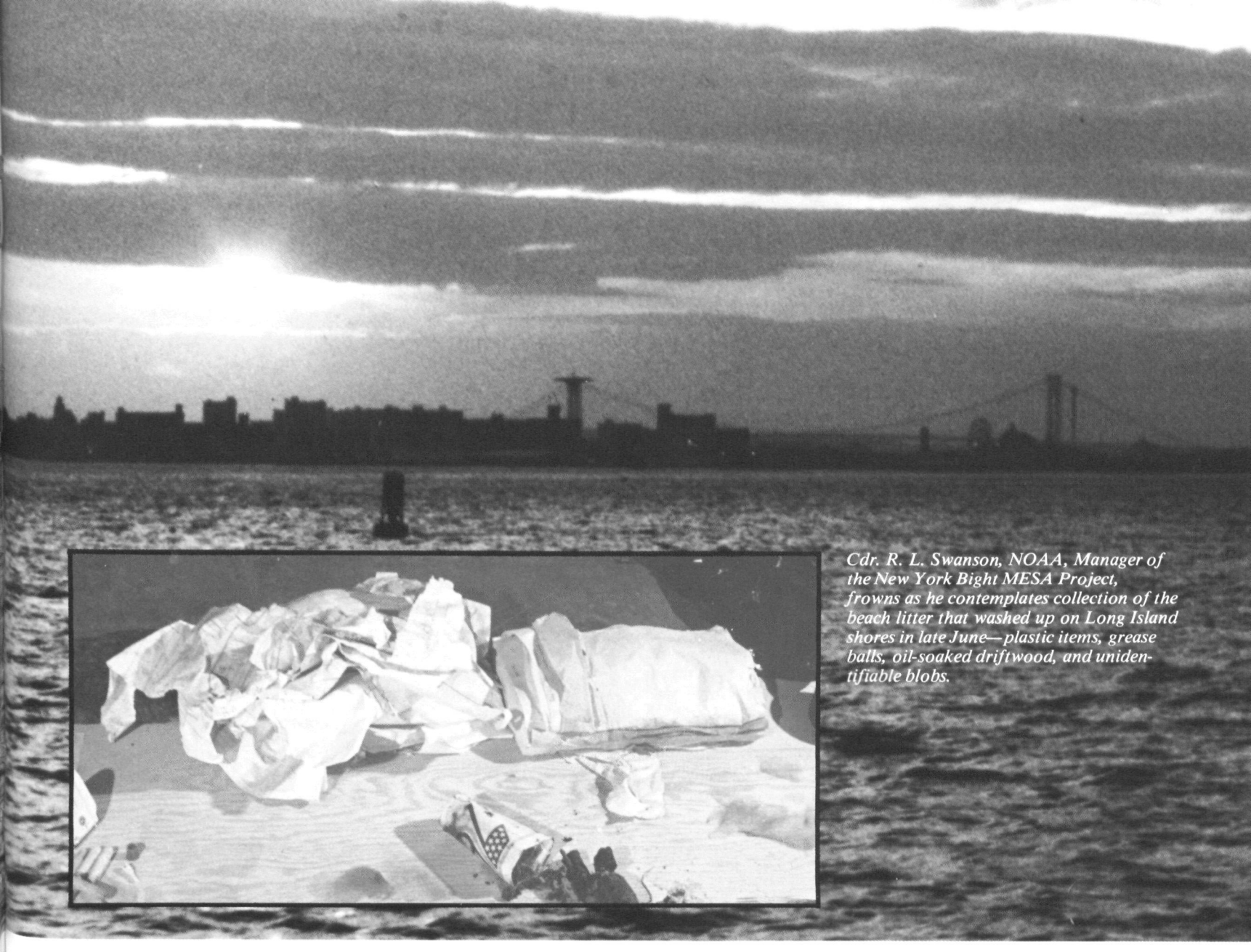
Early summer was a period of relative calm.

On June 14 the roof fell in, and dreams of the summer doldrums—if indeed there had been any—quickly died. On that day reports came in from all along Long Island's shores, from even beyond Fire Island, from almost as far out as Montauk Point itself—reports of an appalling mess of trash found along the high tide line on the beaches. Plastic cups and straws, grease balls and tar lumps, hygienic items by the thousands, oil-soaked driftwood, and numberless unidentifiable lumps of rubbish littered the sands. Because tar and black "gunk" were apparent in much of the trash, the notion that the sewage sludge dumping was somehow involved came easily to the minds of many concerned citizens. Beaches were closed, and the telephones began to ring in the Old Biology Building at the State University of New York, Stony Brook, where the MESA New York Bight Project headquarters is located.

"We have spent almost full time on the beach litter problem since it was first reported," said Swanson, a bit morosely perhaps, exactly one month later, July 14, when the project was also involved in its second and third emergencies of the season.

Emergency number two was a huge fish kill in early July off a 55-mile stretch of New Jersey ocean shore from Barnegat Inlet to Sandy Hook, an area described by the New York Times as "just south of the controversial sewage sludge dump site off New York Harbor." While the NMFS Sandy Hook Laboratory was most directly concerned, many inquiries went first to the MESA project office. Emergency number three was another wash-up of beach litter on July 7, this time including fireworks debris.

At the same time, the project was in the third day of a major and



Cdr. R. L. Swanson, NOAA, Manager of the New York Bight MESA Project, frowns as he contemplates collection of the beach litter that washed up on Long Island shores in late June—plastic items, grease balls, oil-soaked driftwood, and unidentifiable blobs.

long-planned week-long experiment to track, by acoustic and other devices, sewage sludge particles from the moment they are dumped by one of New York City's modern sewage sludge tanker vessels until the particles could no longer be detected. In addition, Swanson and members of his staff, plus the officers and on-board scientists of the NOAA ship George B. Kelez, were conducting briefing sessions for Congressional staff members and a network television crew. And the project staff was preparing testimony for Congressional hearings to be held later in the month in the town of Hempstead on Long Island.

Swanson's auditors at the briefing sessions had an opportunity to catch up on, and sort out the various emergencies of the period. They also learned of a current example of the quick response that has earned the project its good public service reputation. After mentioning the time spent on the beach litter problem, Swanson continued:

"We have even brought this problem into the current acoustic experiment. During part of the Kelez cruises we will tow a Neuston net to catch floatables—the material that stays on the wter's surface rather than slowly sinking and dispersing in the water column. These results will be tied into the overall research plan of which the acoustic experiment is a major part. We know from previous experiments that floatables move with the wind, so we can correlate their movement with that of the less buoyant particles in the water. The composition of the floatables in the sludge will also tell us more precisely what correlation, if any, there might be between the sewage sludge dumps and some of the stuff that washed up on the beaches."

The degree to which the project has had to concentrate on the sewage sludge problem—or, more broadly, the problem of ocean dumping in the New York Bight—was not anticipated at the beginning of the work in July, 1973. As stated in an early fact sheet on the program:

"The New York Bight, a 15,000-square-mile area of ocean waters and continental shelf off New York and New Jersey, is the subject of a comprehensive marine ecological investigation. The . . . investigation . . . includes the coastal waters from Montauk Point, Long Island, to Cape May, New Jersey, and is the first regional ecology project undertaken by NOAA's Marine EcoSystems Analysis (MESA) Program.

"Objectives of the New York Bight Project are: to develop a better understanding of the physical, chemical, geological and biological processes of the Bight; to assess man's impact on the system; and to improve predictions of the consequences of present and proposed actions.

"The first year's efforts of the project are designed to examine in detail that portion of the Bight most heavily impacted by mankind. This area, designated as the Apex, includes the major ocean dumping sites . . ."

So, while the ultimate purposes of the research were to be practical and useful in application to critical areas of coastal management, much of the research was looked upon as basic in nature. Ocean dumping was included as a major area of emphasis for the first year, but it appeared in those early days that this was an applied reasearch or engineering

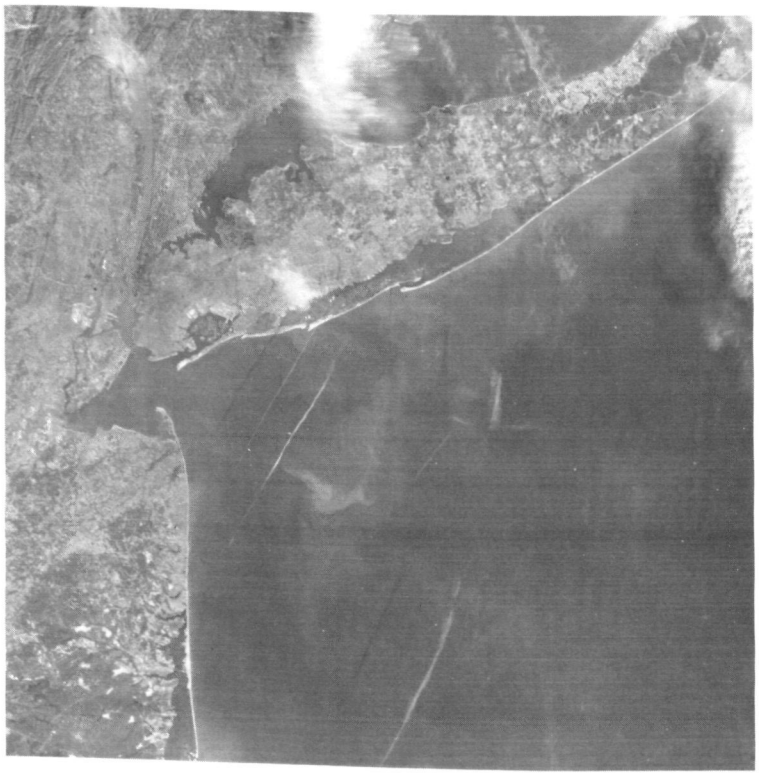
Modern New York city sewage sludge vessel, cooperating in MESA research, pumps out its cargo at sewage sludge dump site in the New York bight (right), while small research vessel measures dispersion rates of sludge particles; observers in helicopter watch operation.

problem that would not necessarily occupy a major share of attention.

The project established its headquarters at the State University of New York at Stony Brook, far out on Long Island but a center for the top-flight research talent that the project planners wanted to draw upon. An operations base was established at Floyd Bennett Field, an abandoned Naval Air Base in Brooklyn at the gateway to New York Harbor. On the other side of the harbor, the National Marine Fisheries Service laboratory at Sandy Hook, New Jersey, completed the triangle of NOAA installations around the Bight that would be heavily involved in the project. Sandy Hook would have a major role in the investigations of the living marine organisms of the Bight—a part of its regular assignment—and fundamental geological and physical oceanographic studies would be undertaken by the Atlantic Oceanographic and Meteorological Laboratories (AOML), based in Miami, Florida. Like MESA, AOML is a part of NOAA's Environmental Research Laboratories. To lend additional academic assistance early on, the New York Sea Grant Institute, based at the State University of New York, was brought in along with many of the other institutions of higher educations in the area.

Project Manager Swanson—who like so many other NOAA Corps officers possesses special qualifications—brought to the work a rare blend of operational and academic credentials. Cdr. Swanson can also be called Dr. Swanson, for he holds a Ph.D. in physical oceanography from Oregon State University. (In 1975, he won the NOAA Award for program administration and management.) He gathered around him a staff of scientists and experts including two young NOAA Corps officers, both then lieutenants, geologist Nicholas Prahl and geological oceanographer Robert Roush, plus Charles Parker, a physical oceanographer. Dr. Joel S. O'Connor, biologist and ecologist, soon came aboard as did Harold M. Stanford, a chemical oceanographer. What at that time was looked upon as a broad-based marine ecological study with basic research orientation got under way.

In December, 1973, sewage sludge dumping was suddenly page one news throughout the New York metropolitan area. The spectre of a black ooze advancing on the beaches was thrust into public view. One



scientist even announced that by the summer of 1976 "the beaches will be unusable because of contamination from the sludge beds." Newspapers and electronic media around the country picked up the story. Also for the first time, the telephones at project headquarters signaled that newsmen and public officials and concerned citizens were demanding to know what NOAA thought about all this, and what NOAA proposed to do about it.

At the outset NOAA had no clearly defined role in the controversy. There are four ocean dump sites in the Apex of the Bight a few miles seaward of Ambrose Light—for sewage sludge, dredge spoil, cellar dirt, and industrial acids. They are under the jurisdiction of the Environmental Protection Agency. There had been few systematic studies of the effects of these dump sites on the surrounding marine environment, and the MESA New York Bight Project had recently compiled

the research results of its initial field program launched six months previously, and was in a position to compare its preliminary findings with the earlier results. In response to the public outcry, the project issued a lengthy fact sheet just four days before Christmas of 1973, summarizing the results of its first look at the problem.

The document set the tone for what became the project's practice —state the facts as clearly as possible, discuss alternative possibilities, when the facts are inconclusive don't hesitate to say so, and make the information available publicly as soon as possible. Thus stated the summary comparison between the recently-obtained MESA data and data from 1970 studies by the State University of New York at Stony Brook and the National Marine Fisheries Service Sandy Hook Laboratory:

"1. The 1973 data (from MESA) are considerably more detailed, and direct comparison and integration of findings from the two years is difficult.

"2. The 1973 data show evidence of sludge bed migration to within 3.5 miles of Long Island with some evidence suggestive of sludge as close as 2 miles from the beach. Comparison with the 1970 studies suggest recent northward migration of 8 miles from the sludge dump site.

"3. Although it is known that sludge is now present within several miles of Long Island, the rate and causes of this movement have not yet been determined. It might be, for example, that an unusual natural event such as hurricane Agnes could have moved this material.

"Further analyses are being undertaken to confirm whether the sludge bed has indeed moved recently, and if so, why. Considerably more analysis will be required before stating whether or not the sludge bed has moved over an extensive area. Recognizing that the sludge bed has existed for several decades, it is still a matter of conjecture as to whether or not it has suddenly moved northward at a rapid rate during the past 3 years."

The report was not popular with many people in the area. Their fears had been aroused. They had been led to believe that if the sludge was that close to the beaches, it must indeed be rapidly moving shoreward. The NOAA-sponsored scientists were berated for their timidity. However, the project staff maintained its position steadfastly, and won the support both of colleagues in Federal and local agencies and of many deeply involved citizens.

At the same time, urgent discussions were taking place among the project staff, cooperating groups from the Atlantic Oceanographic and Meteorological Laboratories and the NMFS Sandy Hook facility, and NOAA headquarters. In view of the great public concern, and because of the role assigned to NOAA in the Marine Protection, Research, and Sanctuaries Act of 1972 (the "ocean dumping" act), decisions had to be made about the future direction of the New York Bight project.

"We believed that it was extremely important for us to take an active role in developing the best management policy regarding ocean dumping," Swanson said. "We reasoned that no matter how much we all wanted to eliminate ocean dumping, this was simply not going to be possible in the near term. Without our active involvement, irrational management decisions might be made on the basis of public emotion rather than consideration of minimizing the overall negative environmental impacts."

With the support of NOAA Associate Administrator David H. Wallace, a new direction was established for the project. In sum, it was decided that the project would.

—take a lead role in research on the effects of sewage sludge dumping;

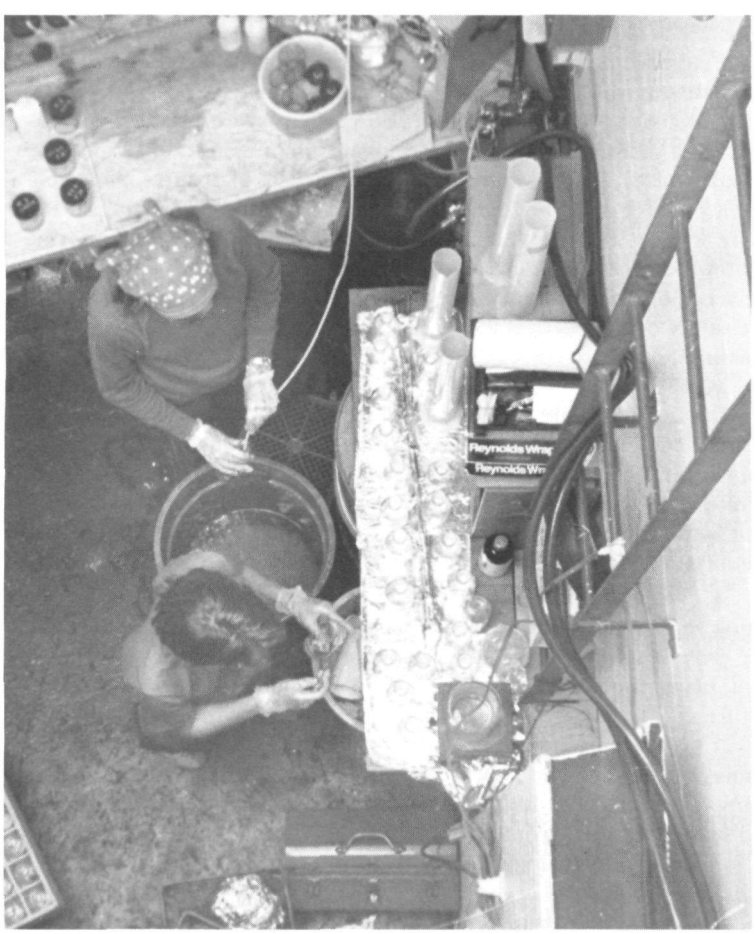
—redirect 75 to 80 percent of project resources toward the problem;

—be extremely open about making its data known;

—take every opportunity to inform the public, through its advisory committee, hearings, lectures, and the news media, of its understanding of the situation;

—assist EPA in reaching a reasonable management decision, based on scientific understanding, about continued use of the dump site.

Biologists from NMFS Sandy Hook laboratory carry out many research projects aboard NOAA Ship George B. Kelez. Above, team consisting of (from left) Andrew Draxler, Christine Evans, Linda Rowbik and Barbara Mantel prepare water laboratory in hold while waiting for samples to be collected. Below, when samples are aboard, the group works rapidly at preliminary testing, then seals the bottles for further onshore analysis.



Acoustic sounder used in AOML research of Dr. Robert A. Young and Dr. John R. Proni is prepared for lowering into the bight.

In July and August of 1974 the sludge problem again cropped up in news reports, and with the summer season in full swing the sensitivity of the issue was heightened. By that time the project had begun to establish itself in the minds of many as unbiased and thorough, and EPA leaned heavily on the NOAA research in making its determinations about the dump site. The tremendous increase in public involvement required bringing aboard Paul Eisen, data manager, and Stanley Chanesman, who works primarily in intergovernmental relations and is Secretary of the New York Bight MESA Advisory Committee. On July 10 of that year the EPA Deputy Regional Administrator told a meeting, called by area Congressmen, that while pockets of natural muds containing sludge could be found in random spots off Long Island shores, there was no evidence that huge quantities of the stuff were moving shoreward. The beaches were safe. Two days later NOAA and EPA officials held a joint public meeting on the problem, and again pointed to the safety of the beaches and the lack of evidence that the sludge was moving shoreward.

At EPA's request, the project had begun to study the possibility of moving the dump site farther out to sea, but by midsummer there was insufficient evidence about this to make any judgments. In mid-September, however, a NOAA letter went to the EPA Regional Administrator for Region II (which includes the New York-New Jersey area) that summed up NOAA's position, based on the work of the project. Essentially, NOAA said:

1. While we do not believe that an immediate change in the existing sewage dumpsite is required on the scientific evidence at hand, the probability of increasing amounts of sewage in future years means that plans should be initiated toward changing the location in the future;

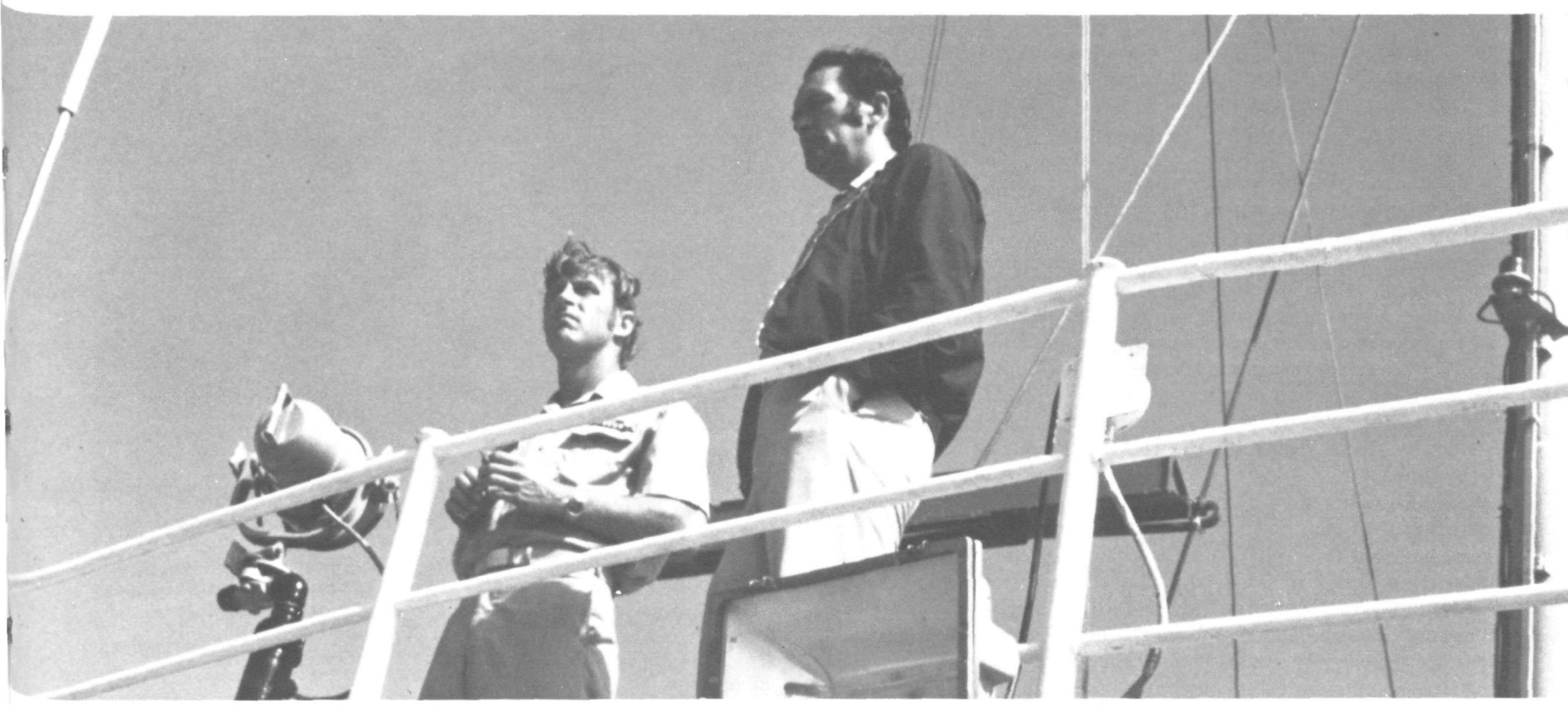
2. Any dumpsite on the continental shelf is bound to cause some damage to the area, so it is strongly urged that any new site be interim only—every effort should be made to avoid long term use of the Bight for sewage sludge disposal;

3. Intensive ecological investigations of any proposed new site should be conducted.

To mount its scientific work, the project had, in the meantime, as-

Dr. Robert A. Young, AOML, and Barbara Mantel, NMFS Sandy Hook, obtain water samples from rosette sampler bottles.

Phil McGillivary, AOML chemist, works in water laboratory set up in van on deck of Kelez.



On bridge of NOAA ship George B. Kelez during 1976 summer operations in New York Bight is skipper (at left) Lt. Cdr. John Stachelhaus, while his relief, Lt. Cdr. John Decoste, observes activity.

Jean O'Reilly and Dr. James Thomas of NMFS Sandy Hook work with water samples in laboratory aboard Kelez.

sembled a small collection of facilities, housed chiefly in trailers, at the Floyd Bennett Field operations base. Cdr Ned Austin initially established the base. Close to the wharf where a NOAA-assigned ship ties up—most recently, the George B. Kelez—were an office trailer, a ship headquarters trailer, and dormitory space. A large warehouse was utilized, and later there were trailers for an electronics workshop and scientific laboratories. From the Ferrel, first NOAA ship assigned to the project, came Lt. Cdr. Clarence W. Tignor, a NOAA Corps officer who now serves as MESA Operations Officer and is in charge of logistics support for the project. The only nod to esthetics in the otherwise spartan complex is a collection of potted plants lent to the project by Mrs. Tignor, and faithfully watered by her husband during moments of break from his daily tasks.

"We provide everything from scientific instruments and buoys to office supplies," said Tignor not long ago.

Assisting at the base are Claude Robinson, Senior Electronics Technician, and J.Z. Bell, in charge of instrument calibration, along with a crew of specialists who repair and maintain the critically important electronics equipment at their electronics workshop trailer. "Their work keeps us in business," said Tignor. "Having instruments that work when they're needed, and that make measurements that are compatible, is the life-blood of a scientific project in the field. That's what Robinson's group makes certain happens, and they are why we are able to operate as effectively as we do."

The project has not lacked for ship support to undertake both regular runs to monitor emplaced instruments, and special cruises for a variety of scientific purposes. The National Ocean Survey has scheduled the Peirce, Researcher, Albatross IV, Delaware II, Oregon II, and Rorqual at various times to participate in the project, and much of the success can be attributed to their work.

Though the MESA New York Bight Project began in 1974 to bend its efforts primarily toward the sewage sludge dumping problem, it did not forget the earlier concept of broad-based studies designed to give a complete picture of this heavily stressed area of coastal ocean. Many scientists had conducted studies of many problems in the Bight, but

nowhere was all this information readily available to scientists, government officials, interested citizens, and managers who might need it. MESA therefore arranged with the New York Sea Grant Institute to publish a series of monographs and an Atlas, designed to bring together the state of knowledge about the Bight in various scientific and engineering fields. Of the planned 32 monographs, 10 had been published by the summer of 1976, including such titles as Tides, Waste Disposal, Port Facilities and Commerce, and Artificial Fishing Reefs. Attractive and well illustrated, the monographs are proving to be highly successful components of the project's information dissemination program. Project Manager at Sea Grant is Jay Ginter and Senior Editor is Jean McAlpine. An editorial board coordinated by MESA and headquatered at Stony Brook oversees the work on the manuscripts.

The Sea Grant Institute is also pursuing health-related projects on the effects of persistent chemical pollutants in plankton and the question of whether the surf transfers viruses to the atmosphere, with joint funding by MESA, Sea Grant, the Rockefeller Foundation, and SUNY Stony Brook.

Spearheading the project's investigations of the living marine resources of the Bight, and of the possible effects of ocean dumping on them, has been the NMFS Middle Atlantic Coastal Fisheries Center, under the direction of Dr. Carl J. Sindermann with headquarters at Sandy Hook and laboratories there, at Milford, Delaware, and Oxford, Maryland. Certain benthic (bottom dwelling) organisms in particular have been intensively studied because they generally stay in one place and have continuous direct contact with sediments, so any deleterious effects should be relatively direct and easy to ascertain.

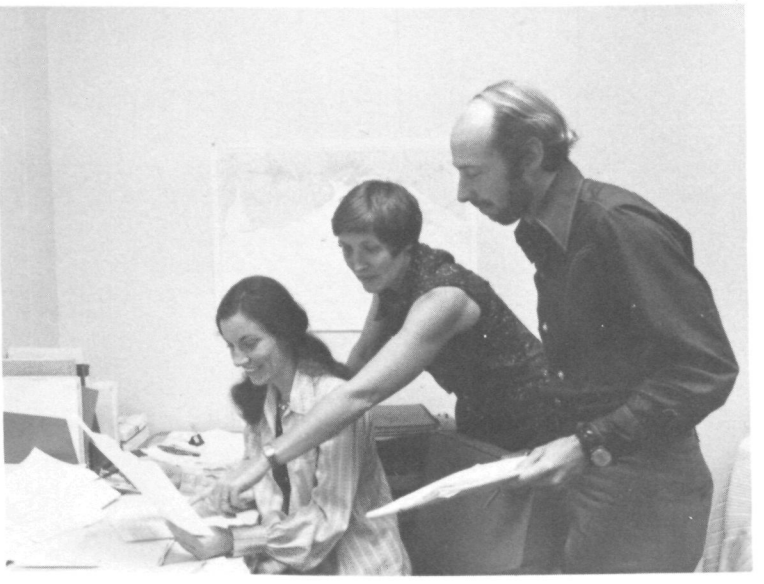
Studies have shown that the number of species has remained about the same—Dr. John B. Pearce of Sandy Hook found little change from a study in the late 1960's to studies in 1973 and 1974. The number of species, and numbers of individuals, was severely depressed in the relatively polluted and poorly flushed Raritan Bay, but much less effect was noted in the Apex outside the bay. Apparent small declines in the numbers of individuals there, the NMFS scientists believe, can probably be attributed to natural variability rather than increased environmental stress.

NMFS biologists have also reported the occurrence of fish with erosion of fins ("fin rot") inside the Apex to be greater than outside, and further research on this phenomenon is under way. Shellfish in much of the Apex contain unacceptably high concentrations of coliform bacteria, and a circular area with radius of about six nautical miles around the sewage sludge dump site was closed to shellfishing by the Food and Drug Administration (FDA) in 1970. Four years later FDA expanded the closed area considerably because of bacterial contamination from ocean outfalls and outflow from the Hudson-Raritan estuarine complex.

As a result of the multilaboratory study of environmental contaminants and their effect on the marine ecosystem, thirty-nine staff members of the Middle Atlantic Coastal Fisheries Center were awarded a NOAA Unit Citation for their outstanding contributions to the project.

The Atlantic Oceanographic and Meteorological Laboratories in Miami have sent up a number of scientists with a wide variety of experiments to further the work of the project. For example Dr. Donald V. Hanson's physical oceanographic program obtained data from drifter and current meter studies showing a circular clockwise motion ("gyre") of the waters during much of the year in the inner Bight. Dr. J. William Lavelle and Dr. Donald J. P. Swift both have traced a small amount of sand transport throughout the year at a depth of about 60 feet, with a large amount during severe storms. This work led to a complete redesign of a multimillion dollar outfall on the south shore of Long Island. These kinds of information, related to much of the other data obtained by the project, shed light on how contaminants may be carried through the waters—one kind of motion for lighter particles that stay in the water column, and another for the heavier material that sinks to the bottom.

Grantees, too, have made major contributions to the work. Dr. James A. Mueller of Manhattan College conducted an extensive study of the relative amounts of contaminants brought in by four major pollution sources in the Bight. He found that the greatest amount comes from runoff—untreated sewage and animal wastes that are washed directly from streets and sewers into the ocean waters, reaching particularly high peaks during periods of heavy rainfall. The other sources of contaminants are ocean dumping, municipal and industrial wastewater, and atmospheric fallout. Dr. Mueller also confirmed that the largest amount of contamination comes from the New York Metropolitan area, primarily from the Hudson River outflow.



Across New York state, at SUNY Albany, the Sea Grant Institute editorial team works on monographs and atlas of New York Bight project. From left, Cynthia Williams, associate editor; Jean McAlpine, senior editor; and Jay J. C. Ginter, project manager.

Keeping things humming at MESA New York Bight headquarters at the State University of New York, Stony Brook, are Bette Maligno (at left) and Diane DeLuca.

In addition to the regular participants and contractors and grantees, numerous other groups within NOAA have rallied round to help. "The National Environmental Satellite Service has worked with us in using its remote sensing capabilities," said Swanson, "and it has been particularly cooperative in developing new sensor applications for obtaining information that we are interested in having. The National

Weather Service not only provides us with real-time weather information when and where we need it, but is making important contributions to our Atlas series. And when the data are collected, we use guidelines provided by the Environmental Data Service for organizing it and getting it into channels where it can be retrieved and used as necessary."

Close cooperation among various research groups has characterized the project, and careful planning frequently makes possible integration of several research efforts toward a common goal. For example, in July 1976 a week-long experiment to track sewage sludge particles in the dump site used the collaborative efforts of many people including Dr. Robert A. Young, Dr. John R. Proni and Patrick Hatcher of AOML, Dr. James P. Thomas of NMFS Sandy Hook, Charles Parker of the project staff, and Dr. Iver L. Duedall of SUNY, Stony Brook. Several vessels, including the Kelez and SUNY's Onrust, took part.

Immediately after a sewage sludge vessel dumped its load in the designated site, two acoustic echo sounders were lowered over the side of Kelez. Each emitted sound waves, one at 200 kiloHertz (200,000 cycles per second) and the other at 20 kHz, which were reflected off particles in the sludge. The resultant echoes were picked up and recorded both on magnetic tape and on a shipboard visual display. Use of two widely different frequencies permitted detection of different sizes of particles.

While the lower frequency echoes directly traceable to the sludge disappeared after about an hour, indicating that the larger particles had probably fallen to the bottom, the recordings continued to show large point scattering in the area. The scientists surmised that these were probably echoes from fish feeding on the sludge. The higher frequency echoes continued to be detectable for several hours, indicating that the smaller particles sank at a much slower rate and as a result were more widely dispersed by current and tides.

Use of the AOML-developed acoustic technique made possible accurate estimates of how far and how fast the sludge spreads horizontally and vertically in the first few hours after dumping. By showing where the sludge was concentrated, it enabled the chemists and NMFS scientists to take their samples with far more accuracy than would otherwise have been possible. Utilizing an on-board chemistry laboratory, Hatcher identified important chemical constituents found immediately within the sludge, as well as chemical transformations taking place during those first few hours.

Finally, in work space provided in a hold of the Kelez, NMFS biologists worked to find out how quickly oxygen in the water is taken up after the sludge is dumped, a measure of increased metabolic activity on the part of small organisms in the water and thus of how rapidly the sludge is decomposed.

"If the sludge is rapidly decomposed—what we call labile—it is more likely to have an effect on the living creatures," said Thomas. "Tiny marine life such as bacteria and other plankton feed on the sludge. If it is toxic and kills them, there will be little evidence of increased metabolic activity. But if it is non-toxic, the animals will burn up oxygen taking the material in. Anything in the sludge—heavy metals, for example—may be ingested and may subsequently be passed along up the food chain."

While the acoustic experiment was planned and executed as applied research devoted to solving certain specific problems of sewage sludge dumping, it had many broader implications—a characteristic it shares with many experiments in the Bight project. As Hal Stanford of the project staff explained:

"Had we not become so heavily involved in the sludge question, we might nothave carried out this specific work—but, we still would have had to do something very like it. This experiment tells us not only about sludge, but also about distribution of suspended solids, about currents, and about organic activity in the water column. All of these are significant in painting a broad picture of the Bight as well as in determining what is happening to the sludge itself."

In the first three years of its existence, the MESA New York Bight Project has accomplished several highly important tasks. Through its scientific work, a far more comprehensive understanding of the complex dumping problems in the Bight has been achieved—the sources of dumping, the dynamics of the natural Bight processes and interactions of the dumped material with these processes, and consequences of the dumping. The project provided the bulk of the scientific contribution to a landmark Environmental Impact Statement on moving the existing sewage dump site, opposed plans to move it unless the situation deteriorated, and encouraged the Environmental Protection Agency to select a firm date for phasing out ocean dumping of the sewage sludge. In each case these recommendations were followed. EPA has targeted 1981 as the year sludge dumping in the Bight shall stop.

To ensure that its information is scientifically trustworthy, the project provides the scientific community with opportunities to review its assessment of the situation, and keeps in close touch with its advisory committee.

To ensure that its information is readily available, the project has carefully developed rapport with the public in the area. Claire Stern, Executive Director of the Long Island Environmental Council, commented:

"Most scientists are hesitant about becoming involved in public discussion. I have therefore been most pleased at how Cdr. Swanson and his staff have tried to help the public understand their work. At times of great stress they kept their cool, they didn't stray outside their field of expertise, but they did tell us what they knew—they tried very hard to provide the factual basis so that responsible decisions could be made. We are very grateful to them."

During the mid-summer crisis period, the project staff worked long hours to try to find out the causes of the wash-up on the beaches, and to try to answer questions from the public about them. The NMFS Sandy Hook Laboratory staff carried out the same activity with respect to the fish kill. A lengthy statement issued by the Middle Atlantic Coastal Fisheries Center on July 15 summarized for the public the history, characteristics, and probable explanation of the phenomenon. In sum, said MACFC, a massive phytoplankton bloom utilized much of the available dissolved oxygen in the water, and fish and invertebrates that could not escape the low-oxygen areas were killed.

The beach problem, Swanson's group concluded, was caused by a combination of circumstances including the massive regular outpourings of raw and semi-treated sewage from the Hudson-Raritan estuarine complex, a temporary increase in raw sewage diverted into the Hudson owing to the upgrading of certain New York sewage treatment plants, and New Jersey pier fires and other accidents that occurred during the same period of time. A 12-day period of persistently strong southwesterly winds was responsible for pushing the mass up onto the beaches, they reported, noting that while the wind direction is not unusual at that time of year, the strength and persistence were. The beaches that had been closed in late June were all reopened by July 1, after the winds changed and the wash-ups ceased.

In addition to the direct public and media contacts maintained by staffs of the Bight project and the MACFC, Swanson made a full report on both the beach litter problem and the fish kill to the Congressional committee hearing July 24 at Hempstead.

Where does the project go from here?

"Now that we have reached this stage, I think our responsibilities are even greater than before," say Swanson. "Because of the work of the project, NOAA has made some very forthright statements about sources and effects of contamination in the Bight. It is now our responsibility to check, double-check, and assure the public that our assessment of the situation was correct. If upon further investigation we find that we have made a mistake anywhere along the line, or if the danger to the public increases in the future, we must provide the information to the public and to the appropriate authorities so that remedial action can quickly be taken."

Research on contaminant cycling is continuing, a program of monitoring the sewage sludge is being undertaken, and new avenues of research into the other, more significant, contaminant sources—dredge spoil. Hudson River effluent, and urban runoff—are being planned.

If other crises occur, such as those of the summer of 1976, the project intends to be ready. □

Photo: Alastair Black, *Cruising World* magazine

It was the greatest nautical spectacle in the history of the United States, and perhaps the world. It may never be excelled. To many eyes, it was the standout ceremony of the Nation's Bicentennial.

The event was, of course, the parade of ships in New York Harbor on the 4th of July—popularly known as Operation Sail 1976. Actually, three events were involved.

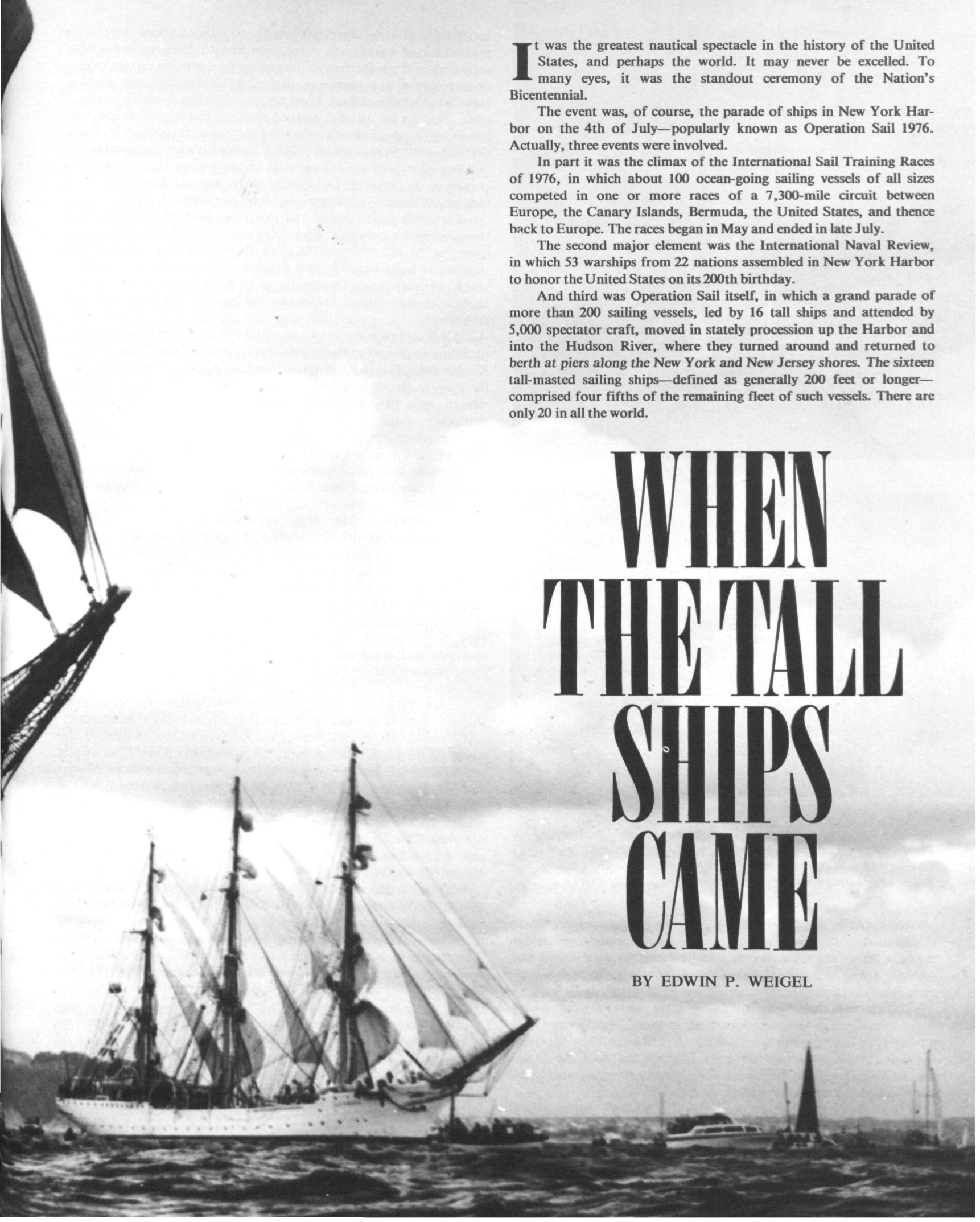
In part it was the climax of the International Sail Training Races of 1976, in which about 100 ocean-going sailing vessels of all sizes competed in one or more races of a 7,300-mile circuit between Europe, the Canary Islands, Bermuda, the United States, and thence back to Europe. The races began in May and ended in late July.

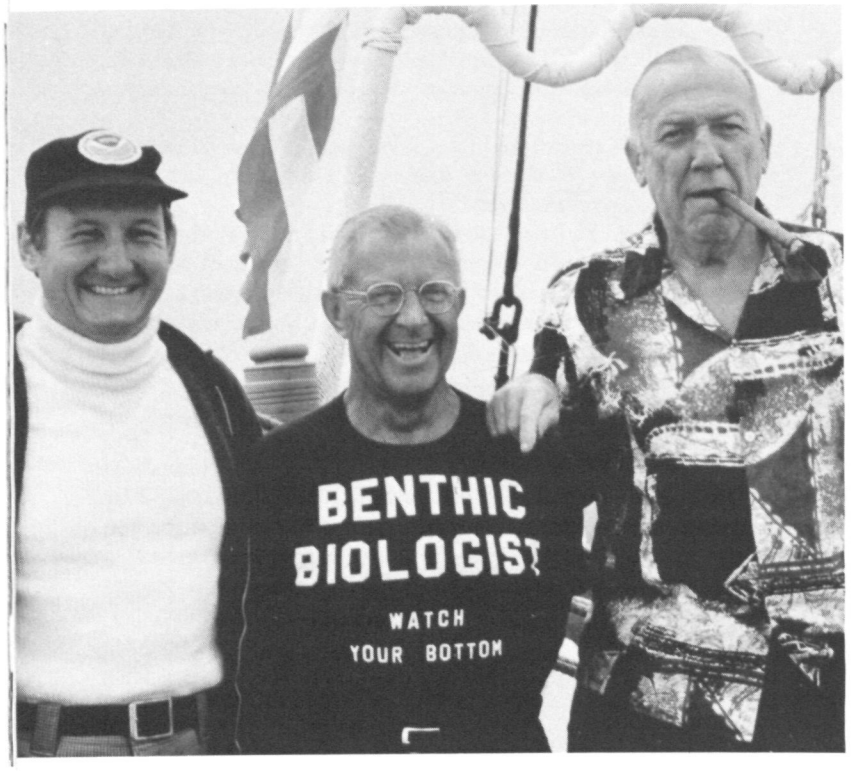
The second major element was the International Naval Review, in which 53 warships from 22 nations assembled in New York Harbor to honor the United States on its 200th birthday.

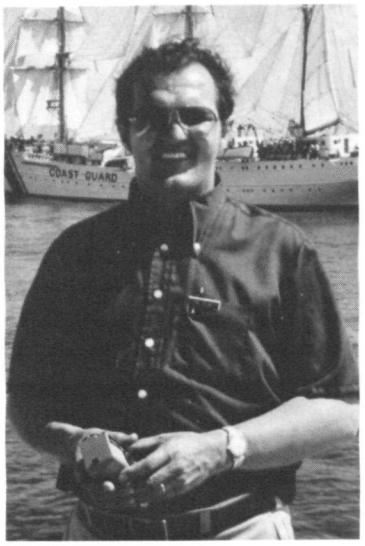
And third was Operation Sail itself, in which a grand parade of more than 200 sailing vessels, led by 16 tall ships and attended by 5,000 spectator craft, moved in stately procession up the Harbor and into the Hudson River, where they turned around and returned to berth at piers along the New York and New Jersey shores. The sixteen tall-masted sailing ships—defined as generally 200 feet or longer—comprised four fifths of the remaining fleet of such vessels. There are only 20 in all the world.

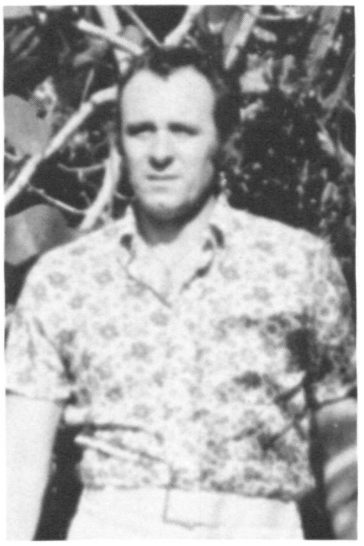
WHEN THE TALL SHIPS CAME

BY EDWIN P. WEIGEL









Dr. John Apel (top, wearing cap), Dr. John Rankin and Dr. Athelstan Spilhaus were aboard the Westward during the tall ships race. Tom Holmes, bottom left, made weather observations on the Morganthau. Ross LaPorte gave Gulf Stream data.

NOAA was there throughout—providing weather forecasts to the ships when far at sea and near the shore; twice daily updates on the position of the Gulf Stream and its meanders and eddies, and specially prepared tide and current charts for ship captains and spectator sailors as they cruised along U.S. shores and into U.S. harbors.

NOAA also had representatives in the Sail Training Races. Aboard the staysail schooner Westward, in the 632-mile Bermuda to Newport, R. I., race, were Special Consultant to NOAA Dr. Athelstan Spilhaus, Pacific Marine Laboratory Director Dr. John Apel, and Gerald Hood, a NOAAite from the Atlantic Oceanographic and Meteorological Laboratory in Miami.

To appreciate fully the complexity of this coordinated effort, one must backtrack. Advance descriptions and forebodings about the series of events had been more than a little chilling to weather forecasters and decidedly so to the U.S. Coast Guard, charged with maintaining safety and order among the population afloat. There were predictions of wall-to-wall ships, motorboats, dinghies and rubber rafts in New York Harbor, milling about in confusion certain to produce accidents and numerous drownings. There was apprehension about what a sudden squall might do to landlubbers manning spectator craft. New Jersey officials worried that pressing crowds might send some viewers tumbling down the 100-foot Palisades to injury or death. On both sides of the Hudson, officials wondered what might happen to building roofs and ancient piers under the weight of unprecedented crowds, as an estimated five million people assembled to see the spectacle of a lifetime. Would these platforms give way?

Partly by good fortune and partly by good planning, none of these calamities occurred. There was one reported maritime casualty during the July 3-4 weekend in the New York area. A small boat capsized in Long Island Sound. One person drowned and three were saved. Late-afternoon thunderstorms on both days were not serious enough to overturn numerous vessels or dampen spectator enthusiasm.

All in all it was a glorious success as about 25,000 crew members of sailing ships and warships paid tribute to the United States—on its Bicentennial. The birthday gift—and what a gift it was!—brought a lump in the throat and tears to the eyes of many American men and women who had almost forgotten how it felt to be intensely patriotic.

Something special was rekindled in American hearts and minds that day.

Perhaps the most important role in this remarkable event was played by one man, Frank Braynard, general manager of Operation Sail 1976.

Braynard works for New York City's South Street Seaport Museum, which fronts on the East River in Manhattan. He is a maritime author, historian, artist, and co-founder of the Museum. At one time he was a ship news reporter for the New York Herald-Tribune. Later he was a Commerce Department employee (Maritime Administration, 1970-71).

Twelve years ago Braynard was secretary of Operation Sail 1964, which brought 24 ships from 12 countries to New York in a spectacle that some said then would never be duplicated. Among those ship were 11 of the tall ships that participated in the Bicentennial parade.

It was 1971 when Braynard began making plans for an event to surpass the 1964 parade. He recognized early that the U.S. Bicentennial "would provide a delicious excuse," and traveled around the world promoting his vision. In so doing he lined up some 200 sailing vessels from 35 nations to participate. Among testimonials to his success was the willingness of foreign governments to pay nearly all the bills. Operation Sail 1976 is estimated to have cost more than 70 million dollars, of which the private group managed by Braynard put up about 1.5 million dollars. Japan alone spent 3 million dollars to refit the four-masted bark Nippon Maru for its voyage halfway around the world and back.

When the dimensions of Braynard's success began to come clear to him, he sought long in advance to let his countrymen know the value of the birthday gift being bestowed on the United States by other lands. He told newsmen that Operation Sail 1976 would be "the largest gathering of sailing ships since 1827, when 26 British, French and Russian ships, frigates, brigs and schooners took on more than 80 Turkish and Egyptian craft in the eastern Mediterranean during the Greek War of Independence."

He was conservative. As it turned out, even that comparison didn't match the event as it ultimately took place.

A senior U.S. Navy officer on the scene said: "There is nothing comparable to this, with so many vessels from so many countries on hand. It is undoubtedly the largest assemblage of vessels from different countries participating in a single display that we will see in our lifetime."

To produce the centerpiece of this display—the 16 tall ships and other large sailing vessels—Braynard drew on a tradition that is not

familiar to most Americans because the United States has had little part in it. This is the series of biennial International Sail Training Races sponsored by the British Sail Training Association and other groups, and participated in by ocean-going sailing vessels from many maritime nations around the world since 1956. A key requirement for entry is that half the crew of a ship be between the ages 18 and 25.

In this program, "Tall Ship Races" have been taking place every other summer in the waters of the North Sea, the Baltic, and the British Isles. Fifty to 60 sailing vessels from some 20 nations usually take part, and afterward gather in a terminal port for a regatta involving crew exchanges and a "Parade of Tall Ships." In 1972, for the first time in the history of these races, two U.S. vessels participated—the U.S. Coast Guard bark Eagle and the privately operated hermaphrodite-brig Black Pearl.

Thus it is not surprising that to many Americans it seemed almost like a resurrection of the past when Braynard and his fellow American sailing enthusiasts conjured up a canvas armada of a bygone era, to awe and delight their countrymen on the nation's birthday. The "magic" was in persuading the 1976 Sail Training Race participants to make Newport their terminal port and regatta city, and to conduct the parade of tall ships in New York Harbor. Braynard added to the flotilla by inviting a host of smaller ships, and thus produced the grand total of some 200 full-rigged ships, barks, barkentines, brigs, brigantines, yawls, ketches, and sloops on parade.

The 1976 Training Races consisted of a 1,425-mile first race from Plymouth, England, to Tenerife in the Canary Islands, which began May 2; a 2,517-mile second race from Tenerife to Bermuda; a 632-mile race from Bermuda to Newport, in which the greatest number of vessels (almost 100) took part, followed by a three-day regatta in Newport that ended July 1. (A few vessels participated in a fourth race back to Europe later in July; others conducted secondary Operation Sail stopovers in such cities as Philadelphia, Baltimore, Washington, D.C., Norfolk, and Miami, and in the Great Lakes.)

It was only after the Bermuda-to-Newport race that Operation Sail 1976 actually began, culminating in the 12-mile-long parade of ships on the 4th of July, from the Verrazano Narrows up New York Harbor to Spuyten Duyvil on the Hudson, and thence back to nearby berths for public viewing.

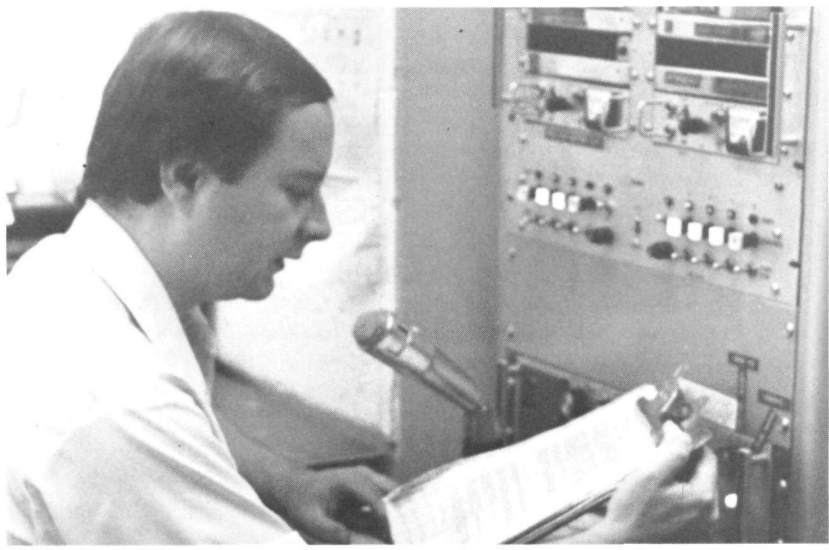
Against this two-month backdrop, NOAA's participation began with the passage of the sailing ships from the Canary Islands to Bermuda. The Miami Weather Service Office and the Satellite Service kept a watchful eye for weather conditions they believed might endanger the tall ships. Aside from a little rough weather, all went well.

At Bermuda, NOAA's participation broadened. Oceanographer Dr. John Apel briefed race participants on characteristics of the Gulf Stream and how to use them to advantage. Ross LaPorte, from the Satellite Field Services Stations, World Weather Building, handed out up-to-date photographs from the GOES 1 satellite showing latest positions of the Gulf Stream sinuosities and eddies. William McKee, from National Weather Service Eastern Region headquarters, explained how weather forecasts from Washington, D.C., New York, Boston and other East Coast cities would be made available to the fleet.

The formal weather briefing for race participants was given by the U.S. Navy, as is customary for races between Newport and Bermuda.

On June 20, the armada gathered at the starting line under clear skies, breasting sparkling seas. Unfortunately, soon after the starting gun, two accidents occurred. Spain's 2,478-ton Juan Sebastian de Elcano collided with Argentina's 2,587-ton frigate Libertad, leaving one Elcano crewman injured and causing the Spanish topsail schooner to return to Bermuda, with bowsprit broken, foretopmast hanging, race prospects ended (the vessel rejoined the fleet in Newport). Libertad stayed in the race, in spite of two torn sails, three liferafts lost, and some broken rigging. Repairs were made underway.

The second collision occurred between a U.S. entry, the 155-foot barkentine Gazela Primeiro, and Romania's 269-foot bark



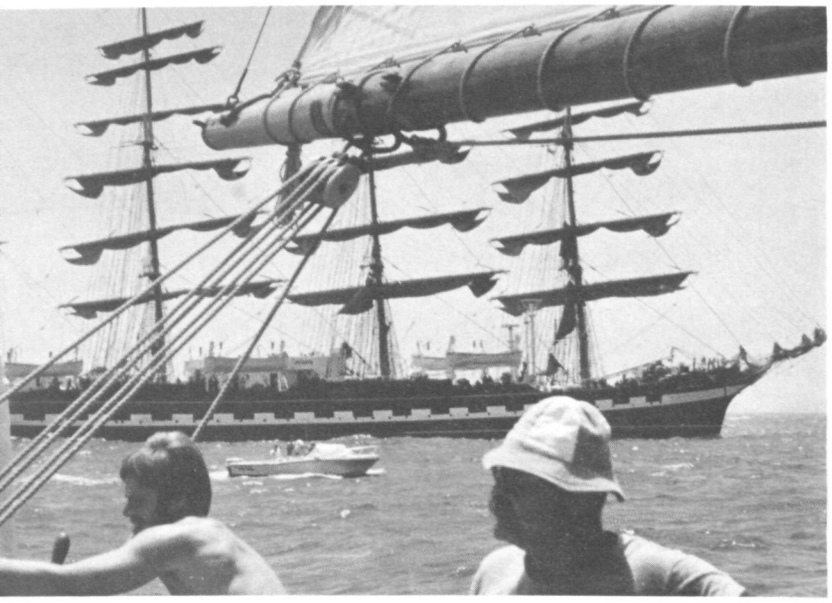
Harold Gibson, at top, head of the New York Weather Service Forecast Office, was responsible for critical weather predictions when thousands of vessels jammed New York Harbor. Marine meteorlogist James Travers manned NOAA Weather Radio.

Mircea. This time it was the U.S. vessel which was dismasted and limped back to port for repairs, while the Romanian bark continued.

Both Dr. Spilhaus and Dr. Apel, watching from the schooner Westward, said later that the collisions left an erroneous impression of poor seamanship. They believe it important that the record be set straight. Said Dr. Spilhaus:

"I believe the primary problem was the onlooker boats, which were not kept out of the way. Also, the three classes of ships—tall ships, minor tall ships (such as Westward) and racing ships—should have been separated by about 45 minutes as they approached the very short, 1.8-mile starting line. Tall ships need maneuvering room, and they didn't have enough. It was a terrible hodge podge. We came close to colliding ourselves, with Russia's 3,000-ton Kruzenshtern."

Westward's helmsman "had to spin the wheel rapidly to avoid it," said Dr. Apel.



NOAA's Jerry Hood (wearing hat) got an uncomfortably close view when Russia's Kruzenshtern passed near the Westward off Bermuda. Colombia's Gloria, right, provided vintage grace and dignity to a New York pier after the tall-ships parade.

The collisions had an interesting aftermath. Dr. Spilhaus said one of the most memorable incidents in the entre voyage, in his opinion, was when, "immediately after they got to Newport, the captain of one of the ships that was dismasted went aboard the ship that had collided with him and said to the other captain, 'Look, it was all my fault,' to which the other replied, 'No, it was my fault,' And they began arguing about whose fault it was. And then they had a drink together.

"This contrasted so marvelously with some of the dreadful things that happened at the Olympics. I was just tremendously struck by the friendship at sea, with 26 nations participating and not an incident, really, except for some of the little things when they were in port . . . the protests and so on, which did not involve the seamen themselves."

As the international sailing fleet proceeded northward, the ships began receiving other NOAA services. From the Weather Service Forecast Office at Washington, D.C., via the Coast Guard radio station there, came routine marine weather weather forecasts every six hours. These arrived as radioteletypewriter messages, and wer relayed to the fleet by voice radio from the Coast Guard Cutter Morganthau, which was escorting the vessels to Newport, and by a Massachusetts vessel, the Bay State, also acting as a communications ship.

Every three hours, the fleet received from the Satellite Field Services Station at Washington a specially tailored update in the "spotlight" area where most of the sailing ships were congregated. As described by Ross LaPorte:

"The area we tried to cover with these 'nowcasts' of weather conditions was usually 100 to 150 miles in radius, and moved north as the fleet moved north. We included information on severe storms, squalls, anything important we saw approaching.

"Each day, on two of these 'nowcasts—the ones at noon and midnight, Greenwich time—we included a Gulf Stream analysis. We gave the latitude and longitude of various points on the west wall of the Stream. They were only interested in one wall, and we gave them a series of 15 to 20 spots, depending on how many meanders there were, to be plotted on a chart. Then all they had to do was what you used to do when you were a kid—connect the dots and make a picture—to produce the west wall. By this means they could see where the meanders (curves) and eddies (detached whirlpools) were located. Those are the really important elements for a sailor, depending on where he wants to go.

"We also gave them a projection of what we thought the Gulf Stream might look like 24 hours later, if we expected something drastically different to occur, such as a meander being cut off to become an eddy. Then we would indicate where we thought the eddy would be, whether it would be cold or warm, and so on. Some eddies are 100 miles or more in diameter."

One indication that the Gulf Stream reports were used by shipmasters came from Washington Post reporter Ken Ringle, aboard Argentina's Libertad. Ringle wrote that when the fleet became becalmed three days out of Bermuda, the Gulf Stream was the critical factor. He described how the Libertad's captain plotted his course to enter the Stream about 240 miles due east of Fenwick Island, Del., where the stream was narrow, to avoid being swept off course to the east. He said another ship seemed to have miscalculated and was fighting a back-flowing eddy of the Gulf Stream. (Later, another testimonial to the value of the Gulf Stream reports came from skippers participating in the Boston-to-Plymouth, England, race, who asked the Boston Weather Service Forecast Office to provide them with such data.)

The fleet was becalmed by a somewhat unusual expansion of

America's response to her majestic birthday visitors was overwhelmingly enthusiastic. Above, a New York fireboat spouts a welcome to Spain's Juan Sebastian de Elcano. Crowd at left in Bermuda typified throngs who visited the tall ships in port.

the Bermuda high to the west—correctly forecast by the Weather Service, incidentally. The result was a predictable letdown in spirits, temporarily. Operation Sail became "Operation Drift" or "Operation Snail" to the youthful crews. With a wind of less than 5 knots, sails flopped lazily above a glassy sea. The tall ships crept northward at two knots or less.

Washington Star reporter John Sherwood, aboard the U.S. Coast Guard training bark Eagle, wrote that a winning suggestion on how to keep up morale was to wait for the British schooner Sir Winston Churchill to show up with its all-girl crew, board the vessel, throw a party, and forget the race. Instead, Eagle exchanged 10 cadets for three hours with Russia's Kruzenshtern.

Tradition prevailed again.

Aboard the Libertad, the Post's Ken Ringle found Latin nautical tradition much easier to take, calm or no calm. Ringle wrote that the ship was a sea-going advertisement for the Argentine good life, with her freezers crammed with Argentine beef, holds stacked with cases of Argentine beer, Argentine wine, Argentine sherry, Argentine brandy, and Argentine champagne. Breakfast one day consisted of freshbaked sweet rolls and rich, Brazilian coffee; lunch was steak with both white and red wine; dinner, a two-course main dish of pasta and beef (with wine), fruit, more Brazilian coffee, and smooth Argentine cognac "that will set you free." Before both lunch and dinner there were cocktails and hors d'oeuvres. Ringle wrote, obviously after considerable skepticism:

"From all I can discover, Libertad officers really do live like this all the time. The captain eats a little better, the crew a little worse . . . (Yet) nobody ever seems to get fat or drunk."

Meantime, aboard the Westward, it was education as usual, with visiting scientists Spilhaus and Apel lecturing 18 student/apprentices en route. Half of the students were male, the other half female.

Westward—a 200-ton 100-foot staysail schooner—is an ocean-going classroom and oceanographic-research vessel. She is owned and operated by Sea Education Association (S.E.A.), which is a private firm that, in cooperation with Boston University, offers a full-semester college course on the ocean environment. The "Sea Semester" consists of six weeks of shore study and six to seven weeks at sea. Apprentices—that is, students—stand watches in good weather and bad, chip rust, sew sails, paint, clean, and assist in handling oceanographic equipment such as plankton nets, bathythermographs, hydrophones, and photographic gear. They record and sort scientific data, preserve specimens, make observations, and perform some analyses on samples.

While the Sail Training Race to Newport gave the students a once-in-a-lifetime view of most of the world's largest remaining windjammers, the students still had to perform the myriad tasks of maintaining a working ship and to pursue their studies.

"They didn't have time to be bored" said Dr. Apel.

Dr. Spilhaus lectured about "environment and economy." He said: "This is a topic I've talked about for a long time. I call it 'ecolibrium'—that is, the balance between economy and ecology.

"Then I talked to them about creativity in general—how you maintain a childlike curiosity about the world around you so that you continue to be creative. I related that to creativity in the oceans—trying to tell them that oceanography is not really a discipline, but a huge area in which anybody—painter, writer, scientist, mathematician—can focus attention and do worthwhile things in NOAA's area of activity."

Dr. Apel said, "I lectured on the Gulf Stream and then on waves, which happen to be my specialties." He added:

"In the Westward tradition, we tried to key our lectures to things that were happening—in my case, a spell of rough weather for the

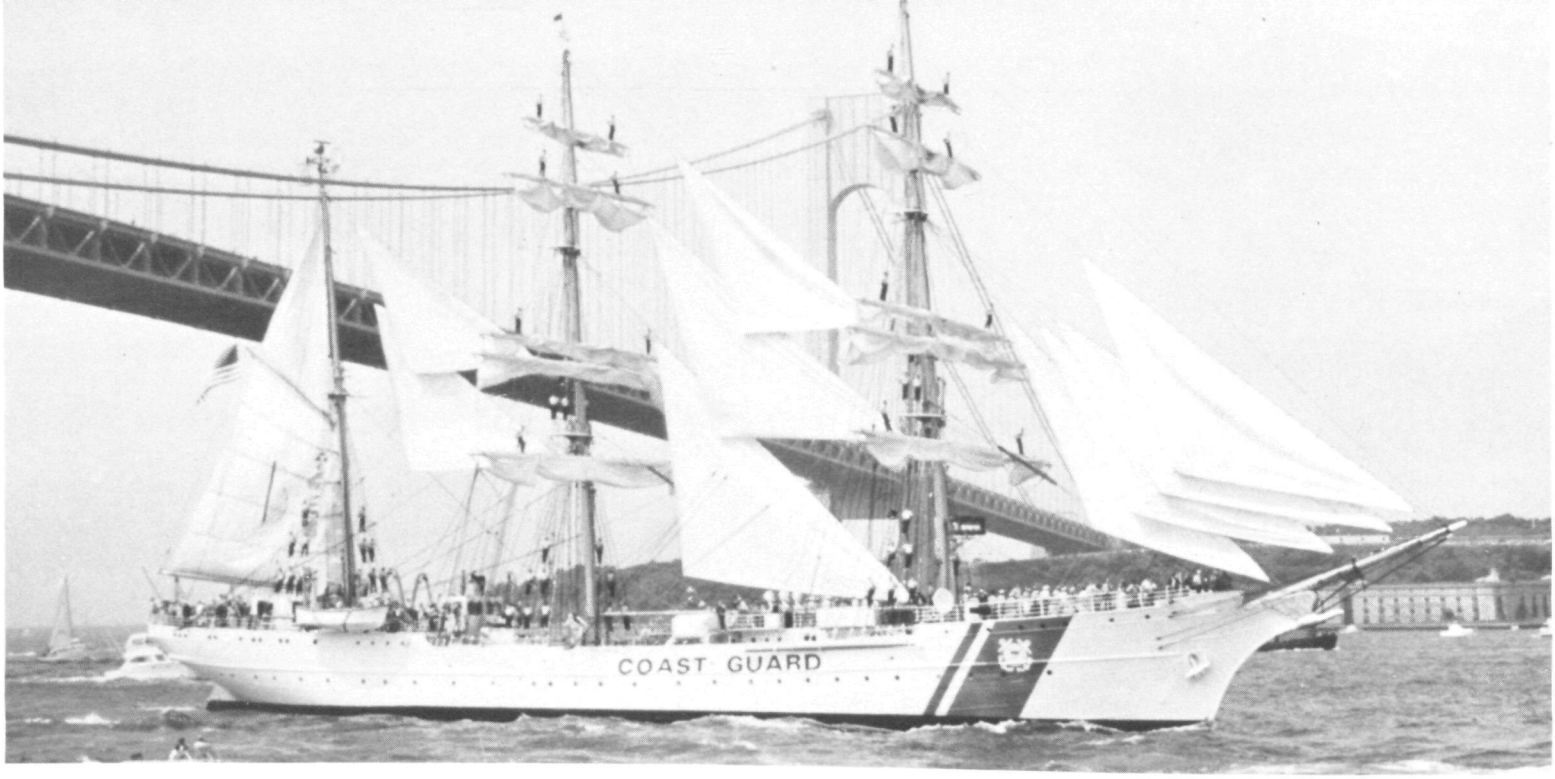


Photo: R. Adm. Harley D. Nygren

U.S. Coast Guard's Eagle was host ship for Operation Sail and led the parade of 16 tall ships up the Hudson River.

wave lecture—while Dr. John Rankin, the Westward's chief scientist and a biologist, used a large school of porpoises for a lecture on sea mammals of all kinds."

Other NOAA'ites on the scene during the Bermuda to Newport race were Thomas Holmes and Herbert Chadwick of the Weather Service's Eastern Region headquarters, aboard the Coast Guard cutter Morganthau. Holmes and Chadwick took regular three hourly weather observations—consisting of wind direction and speed, temperature, dew point, cloud-type and height, atmospheric pressure and pressure tendency, sea-water temperature, waves and swell. These were dispatched by radio to a Coast Guard shore station and thence to the National Meteorological Center, to be melded with other data used in forecasting for the fleet.

"We were prepared to take upper-air observations (using balloon-borne radiosondes) if the occasion called for it." said Chadwick. "We had all the gear and were ready to go. But the weather was so clear and calm for the most part that we didn't need to."

The tour aboard the Morganthau covered more than the tall ships race. The Coast Guard cutter first acted as escort and rescue ship for a race going the other way, from Newport to Bermuda, involving smaller sailing craft.

"We picked up the tall ships when they were about 100 miles out of Bermuda," said Chadwick. Shortly afterward, the calm set in, and the two weather observers were given a close-up view of almost all the classic windjammers drifting on an oily sea as the Morganthau cruised past one after the other.

At 6 p.m. Thursday, June 24, the race was cut short and declared officially over, even though there still was considerable distance to go to Newport. There was too little time to finish it and be on hand for other events on schedule. America was waiting.

Winner of the truncated race was West Germany's Gorch Fock. Poland's Dar Pomorza was second, and Norway's Christian Radich, third.

After this, the ships lowered sail and cranked up auxiliary engines to complete the voyage—except for a breezy spell on Friday when sails again were briefly raised—and arrived in Newport Sunday the 27th, to begin the three-day regatta the following day.

The social activities at Newport were described as among the swankiest ever held at this coastal city, a playground famed for extravagant affairs. Tanned and bearded captains in immaculate whites were wined and dined at Belcourt Castle at a sitdown dinner for 850 under a two-acre tent. A Tall Ships Ball was held the next night at a 40-room French chateau called Rosecliff, where Paramount had filmed scenes for the recent remake of "The Great Gatsby," by F. Scott Fitzgerald. On hand were European royalty such as Crown Prince Harald and Prncess Sonja of Norway; Margaux Hemingway, Ernest Hemingway's 6-foot granddaughter who is now a New York actress and model; Norwegian explorer Thor Heyerdahl, famed for his voyages by raft and other primitive craft, and others, with names like Auchincloss, Biddle, Grosvenor, Pierpont, Remington and Vanderbilt.

NOAA's part in all this hospitality came in a working session with the ships' officers preparing them for the trip along the coast to New York Harbor. Commander Donald Florwick of the Environmental Monitoring and Predictions Office was on hand to distribute a National Ocean Survey "marine safety aid prepared especially for Operation Sail." This was a 46-page publication giving "selected tidal predictions for the period July 1 through July 5 for Block Island Sound and Long Island Sound, and tide and current information for New York Harbor from July 3 through July 5." Tide and current information for New York Harbor July 3, 4, and 5 also was published as a one-sheet flyer for distibution to thousands of recreational boaters. It gave predicted times of high and low tides, slack waters and maximum currents for seven locations: Hell Gate, Brooklyn Bridge, The Battery, George Washington Bridge, The Narrows, Ambrose Channel Entrance and Atlantic Highlands (Sandy Hook Bay).

Present at this session for the National Weather Service were Eastern Region Executive Officer William McKee, who was the all-NOAA focal point for aid rendered to Operation Sail, and Robert Lynde, marine meteorologist from the Boston Weather Service Forecast Office. McKee and Lynde loaned out to a number of the foreign ships portable NOAA Weather Radio receivers so they could obtain up-to-the-minute forecasts and warnings at any time of night or day while cruising in U.S. coastal waters or berthed in U.S. harbors.

Rear Admiral Harley Nygren, Director of the NOAA Corps, said that by fortuitous chance the NOAA vessel Delaware II was in drydock at Newport during this period and made available to the U.S. Coast Guard her radio transmitter as a near-in means of directing traffic in Newport Harbor. Admiral Nygren later acted as a special

observer of Operation Sail aboard the U.S. Merchant Marine Academy's "Kings Pointer."

On June 29, Robert Junghans, of NOAA's Environmental Monitoring and Predictions Office, served on a panel of a symposium to explore ways in which tall ships and other vessels of British and American Sail Training Associations could—among their activities—participate in oceanographic studies aimed at solving global ocean programs. Panel moderator was former Massachusetts Governor Francis Sargent.

On July 1, a fog predicted the night before by the Weather Service delayed the scheduled 8 a.m. departure of ships from Newport by several hours. The ships were bound for selected berths and anchorages nearer to New York Harbor and began to slip out of Newport Harbor about non.

At this time the National Weather Service Forecast Office at 30 Rockefeller Plaza in New York City began adding to its services to the fleet. A "Special Operation Sail Weather Roundup" was begun on July 1 and continued through July 5 at one to three-hour intervals, from dawn to until dark each day. On July 2, tide and current information for New York Harbor was added to the weather roundup, and broadcast on NOAA Weather Radio Station KWO-35 for spectators and visitors alike.

Special U.S. Coast Guard Notices to Mariners were also broadcast over NOAA Weather Radio. Among these were a notice that vessel traffic in the vicinity of Hell Gate on the East River would be restricted to one way southbound to avoid interference with incoming visitors from Long Island Sound, notification of a 50-yard security zone around the U.S.S. Nashville when it was expected to receive a distinguished visitor from Washington, and a request to recreational boaters and other vessels to leave Coast Guard Channel 16 free for urgent communications. So effective was this last request that the Commander of the Third Coast Guard District later wrote Eastern Region Weather Service headquarters thanking them for this assistance. He said that Channel 16 was cleared within a half hour after the Weather Radio broadcast. Weather Service officials said this was a welcome testimonial to the size and responsiveness of the NOAA Weather Radio listening audience afloat.

On the morning of July 3, formations of warships of the International Naval Review entered New York Harbor and proceeded to designated anchorages. That afternoon, about 100 Class B or smaller vessels of Operation Sail rendezvoused at Throgs Neck bridge and departed for New York Harbor via the East River. Throngs of spectators observed their passage, single file, against the Manhattan skyline. Only vessels with masts less than 125 feet tall were able to take this route because of the height limitation imposed by the 127-foot Brooklyn Bridge. Among these was the Sir Winston Churchill, personed by an all-woman crew and pursued by its own armada of camera-clicking spectator mariners. The true tall ships with masts towering 150 or more made their approach along the southern shore of Long Island, to anchorages in lower New York Harbor near some of the larger warships.

As the last of the Class B sailing ships made their way down the East River a thundershower made its appearance. Harold Gibson, Meteorologist in Charge of the New York office, described it:

"For several days before the ships got within range of our Forecast Office we had had a tremendous amount of rainfall associated with an upper-level trough moving toward us very slowly from the north. On Saturday, when the ships were coming into New York Harbor, that 500-millibar trough was directly overhead. Although the main shower activity occurred well to the south of us that day, the cold high-level temperatures made the air unstable enough so that we had air-mass thunderstorms developing very rapidly after 1 o'clock in the afternoon, in critical places. Later in the afternoon we issued two special marine warnings. One was based on a report from a pilot approaching Kennedy Airport who said he had observed a waterspout with one of the thunderstorms off Jones Beach, Long Island. The other was based on a radar indication of a severe thunderstorm 25 miles southeast of New York City, heading toward the south shore of Long Island. We estimated it had winds of 40 knots or more."

Marine meteorologist James Travers, on loan to the New York office from Eastern Region headquarters during Operation Sail, was working the afternoon and evening shift. He said: "There was a lot of hail reported with those thunderstorms, so it was a bit tense for a while."

Fortunately, the thunderstorms had no real effect on the festivities. Travers commented afterward that he thought the remarkable absence of mishaps was the result of vigilance and warnings of the various Federal agencies involved, such as the Coast Guard, Federal Aviation Administration and NOAA, along with those of local public-safety organizations, and that their effectiveness was the result of widespread dissemination to the public by newspapers, radio and television of the precautions to take.

"Everybody seemed to cooperate beautifully."

On the next day, July 4, the activities and the vigilance reached a peak.

The National Broadcasting Company dispatched NBC TV Science Editor Dr. Frank Field from his usual post in New York City, where he gives the local weather forecasts, to the Weather Service's National Severe Storms Forecast Center in Kansas, City, Mo. There he sat side by side during theday with the Center's Director, Allen Pearson, and the satellite service's Edwin Ferguson, so that the network could provide live coverage of storms that might be affecting celebrants all around the nation.

As it turned out, skies were clear over most of the United States that day, except for isolated thunderstorms and a band of rainfall extending from Texas to Georgia. As thunderstorms approached New York City in the late afternoon, when Operation Sail was nearing its finale, Pearson consulted with Gibson several times by telephone, discussing the degree and duration of the storm that might be expected. At 3:30 p.m. the New York office issued a "special marine warning bulletin . . . for thunderstorms, with hail and wind gusts to more than 40 knots, over the lower Hudson River, New York Harbor, and western Long Island Sound," saying that radar indicated that several heavy thunderstorms were moving toward the area from the southwest.

Again, Nature was kind. The line of thunderstorms was only about 10 miles wide, and soon dissipated.

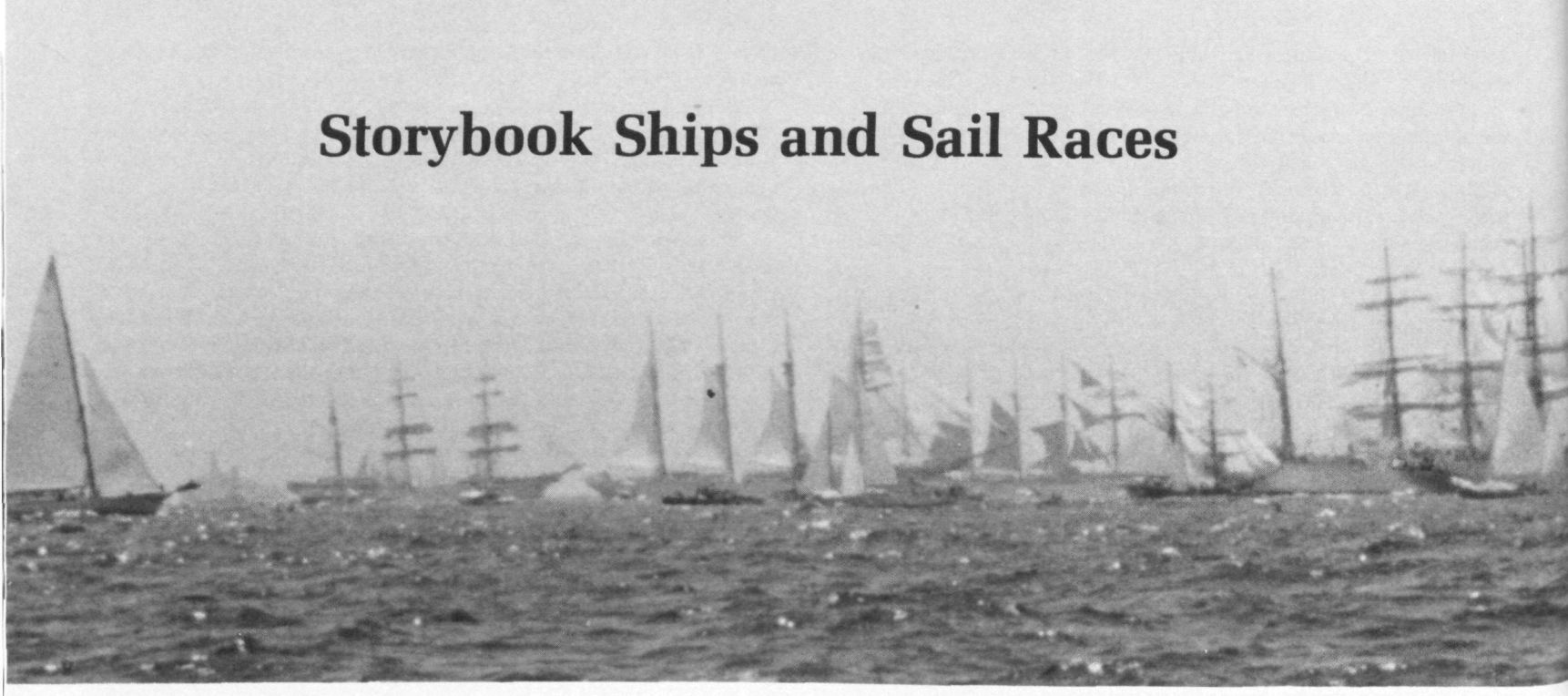
The result was that, almost from start to finish, Operation Sail was a tremendous success. Right on schedule at 11 a.m. the Coast Guard host ship Eagle led the parade under the Verrazano Bridge, trailing behind her in single file 15 other tall ships. Altogether, the column totaled more than 200 sailing vessels under 30 flags. On some of the square riggers, cadets in immaculate whites stood at attention on the yardarms, making a strikingly beautiful sight. The Statue of Liberty, with her torch held high, welcomed them all.

The fleet of 53 warships from 22 countries provided another kind of greeting, saying, "Happy birthday, America," with a 21-gun salute promptly at noon. Vice President Rockefeller, aboard the U.S. missile cruiser Wainwright, sailed downriver preceded by fireboats, in the official review of the warships, and simultaneously received cheer after cheer from cadets aboard the tall ships, as they glided upriver, one by one. President Ford, after speaking at Independence Hall in Philadelphia and at Valley Forge, Pa., arrived by helicopter on the deck of the carrier Forrestal, at anchor in the outer harbor. At exactly 2 p.m. he rang a Bicentennial brass bell 13 times, symbolizing that the 13 colonies had declared their independence from England 200 years before that moment. This was the signal for bells of celebration to be rung out all over the nation.

Somehow, it seemed that the tall ships, with their graceful hulls, towering masts and billowing canvas, struck precisely the right note for a nation celebrating 200 years of history. Like gallant ladies out of the past, they captured the hearts of Americans as few visitors could. Although their day of glory is gone, they bespeak a yearning among people everywhere for beauty for its own sake.

Auf Wiedersehen. □

Storybook Ships and Sail Races



Although the 16 tall ships that visited the United States in July look like they sprang to life from illustrations in a historical novel, actually all but one of them were built in this century. Five were constructed in the same shipyard in Hamburg, Germany, within the past 45 years.

These "five sisters," as tall-ship captains know them, are the U.S. Coast Guard's Eagle, West Germany's Gorch Fock, Romania's Mircea, Portugal's Sagres II, and Russia's Tovarishch. Four were taken from Germany as World War II reparations payments. The Gorch Fock was built by West Germany in 1958. All are three-masted barks between 240 and 270 feet long.

Sailing enthusiasts find it lamentable that the United States, the world's leading naval power, has only one deep-water sail training vessel operating full time, while other countries, particularly the Soviet Union, have many. For the U.S., the only participant is the Coast Guard bark Eagle, plus a handful of smaller vessels engaged in intermittent or perhipheral programs. (Among these is the Westward, operated by the Woods Hole, Mass., Sea Education Association, whose primary purpose is oceanographic education rather than sail training, although the curriculum includes both.)

Britain found herself in the same embarrassing situation as the U.S. in 1964, when Operation Sail of that year took place in New York. England then had to borrow a 72-foot yacht and hastily recruit a crew of youngsters for the voyage to Bermuda and thence to New York. The aftermath was that this proud maritime nation raised funds from all over Britain to build the Sir Winston Churchill, a three-masted schooner and "the first true training ship built for the sole purpose of taking young people to sea for character building." Two more ships have been added since then.

In America, to fill a similar vacuum, the American Sail Training Association has been brought into being at Newport, R. I. The ASTA ran its first races in 1973, with Coast Guard's Eagle and 10 schooners participating. A similar contest was conducted in 1974, and a lesser one in 1975. The Association's goal is a membership of 100,000 persons. On its 20-member board of directors are representatives of the U.S. Navy, Coast Guard, state maritime academies, and prominent schools, museums and oceanographic institutions. The ASTA was a co-host with the British Sail Training Association for the 1976 Transatlantic Tall Ships Race and was responsible for all activities at Newport.

What follows are capsule descriptions of the 16 tall ships that visited the United States on its 200th birthday, taken largely from a guide published on behalf of the American Sail Training Association by Cruising World Publications, Inc., of Newport, R.I.

Amerigo Vespucci—Built to resemble a fighting ship of Admiral Nelson's era, the Amerigo Vespucci is black with two white horizontal stripes. Black squares in the stripes are imitation gun ports. She is a 330-foot three-masted bark and was built in 1931. Named after the Italian navigator who led a Spanish expedition to South America in 1497, Amerigo Vespucci is used for training midshipmen.

Christian Radich—A full-rigged ship built of steel in Norway in 1937, she is 206 feet long and displaces 773 tons. Seized by German troops in 1940 and used as a submarine depot ship until the end of World War II, she was found submerged and without spars. Thereafter she was raised, repaired and refitted. She has taken place in many sail training regattas and won in her class four times.

Danmark—A full-rigged ship launched in 1932, Danmark was visiting the United States for the 1939 World's Fair when World War II broke out. She stayed in the U.S. for the duration. While she was on loan to the U.S. Coast Guard during the war, 5,000 cadets were trained on her. After the war, Danmark was returned to her mother country. She is 213 feet long and displaces 845 tons.

Dar Pomorza—Commissioned in 1910 as the German sail training ship Prinzess Eitel Friedrich, this vessel after World War I was handed to the French as a war reparations payment and renamed Colbert. In 1929 she was purchased by Poland with donations from the population of the province of Pomorza, and renamed again. She was interned in Sweden during World War II. She is 267 feet long and displaces 1,784 tons.

Eagle—The U.S. Coast Guard training bark is a three-masted vessel 266 feet long and displaces almost 2,000 tons. Launched in Hamburg, Germany in 1936 she was then called the Horst Wessel and used for training German naval cadets. She was brought to this country in 1946 as a war reparations payment. Eagle can achieve 17 knots under sail.

Esmeralda—Launched in 1952 in Spain, this Chilean naval training vessel is a 305-foot four-masted barkentine purchased by Chile in 1954. She displaces 2,276 tons and is almost identical—except for a slight variation in rigging—to the Spanish schooner Juan Sebastian de Elcano. Her figurehead is a South American condor.

Gazela Primeiro—Smallest and oldest of the tall ships, Gazelo Primeiro is the last of the Portuguese Grand Banks schooners. Built in 1884, she plied her trade until 1970, when she was bought by the Philadelphia Maritime Museum. During her years with the fishing fleet, she was mother ship for 31 dories. She has a copper-sheathed wooden hull. Her timbers are from pines planted in Portugal centuries ago by Prince Henry the Navigator. Now rigged as a barkentine, she is 155 feet long and displaces 445 tons.

Gloria—Newest of the sail training ships, Gloria was built in 1969. She is a three-masted barkentine 250 feet long and displaces 1,300 tons. She is a training vessel for Colombian naval cadets.

Gorch Fock—Launched in 1958 in Hamburg, Gorch Fock is named after the German poet Johann Kinau, who wrote under the pseudonym Gorch Fock. She is a 266-foot three-masted bark displacing 1,727 tons, and is used as a training vessel for West German naval cadets. She won the 1976 Sail Training Race between Bermuda and Newport for Class A vessels, and is capable of reaching speeds up to 16 knots.

Juan Sebastian De Elcano—Named after the man who completed the first circumnavigation of the globe by concluding the expedition started by Ferdinand Magellan in

1522, Juan Sebastian de Elcano is a 304-foot four-masted topsail schooner displacing 2,478 tons. She is a sail-training vessel for the Spanish Navy and carries a crew of 407.

Kruzenshtern—Largest and heaviest of the tall ships, Kruzenshtern was built in Hamburg in 1926 as the last four-masted bark ever constructed for cargo carrying. Originally christened Padua, she worked the nitrate trade and grain runs from Australia, and then was laid up in Germany from 1932 to 1939, sailing intermittently. After World War II she was handed over to the Soviet Union and recommissioned under the name of Adam Johan Ritter von Kruzenshtern, a 19th-century Russian explorer of German extraction. She is 342 feet long and displaces 3,185 tons.

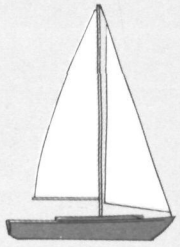
Libertad—A full-rigged ship launched in 1963, Libertad broke the world speed record for a crossing from Canada to Ireland under sail in 1966, doing 1,741 miles in six days, 21 hours, averaging 18 knots. She is 298 feet long, displaces 2,587 tons, and carries a crew of 366. She is used as a training vessel for Argentine naval cadets. Among distinctive features are her olive-drab sails, specially treated to resist mildew.

Mircea—Named after a prince of Romania who in the 14th century won back territory taken by Turkey, this three-masted bark is one of the five sisters. Built in Hamburg in 1938, she was temporarily in Russian hands after World War II, and then given to Romania. She is 269 feet long and displaces 1,065 tons. Her figurehead is a bust of Prince Mircea.

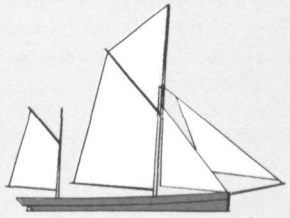
Nippon Maru—This four masted bark is one of the larger sail training ships. She is 318 feet long and displaces 3,000 tons. She was built in Japan before World War II. During the war her rigging was removed and she became a coal carrier. After the war she was restored and returned to sail training.

Sagres II—Another of the five sisters, Sagres II was launched in Hamburg in 1937. She was damaged by mines during World War II. Afterwards she was given to the U.S. as a war reparations payment and then handed to Brazil, who used her as a sail training ship until 1961, when she was sold to Portugal. She is named after the Portuguese port which launched many great explorers. She is 268 feet long and displaces 1,784 tons. Distinctive features are crosses on her sails.

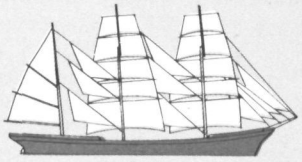
Tovarishch—Built in 1933, this three-masted bark was formerly the Gorch Fock I, and is also a product of Hamburg. She was sunk in 1945 and later salvaged in 1948 by the Soviet Union, who refitted, recommissioned and renamed her in 1951. Tovarishch means comrade. She is 240 feet long and displaces 1,505 tons.



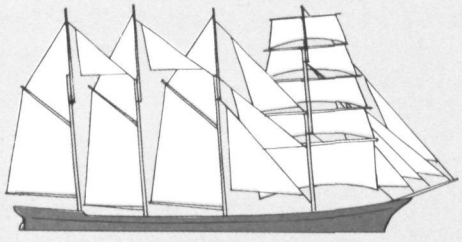
Sloop



Ketch



Bark



Barkentine

Sloop — fore-and-aft rigged with one mast, carrying a mainsail and foresail.

Ketch — fore-and-aft rigged with two masts, the after mast being shorter than the foremast and placed forward of the rudder post.

Bark — having three, four, or five masts with the after (jigger or mizzen) mast fore-and-aft rigged and the other masts square-rigged.

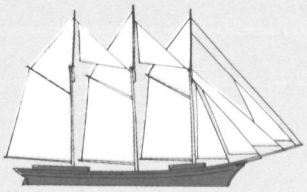
Barkentine — three- or four-masted with the foremast square-rigged and the other masts fore-and-aft rigged.

Schooner — having two or more masts, fore-and-aft rigged. With two masts, the foremast is shorter than the after mast.

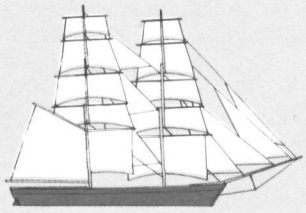
Brig — two-masted and square-rigged, with a fore-and-aft mainsail (spanker) in addition to, or instead of, a square mainsail.

Brigantine — (also called hermaphrodite brig) two-masted with foremast square-rigged and after mast fore-and-aft rigged.

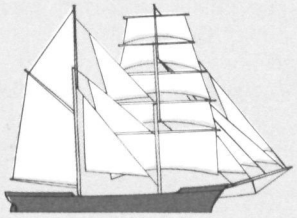
Ship — having three or more masts, each with a complete set of square-sails.



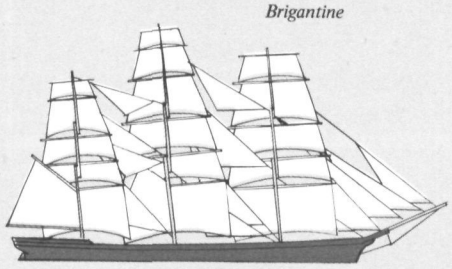
Schooner



Brig



Brigantine



Ship

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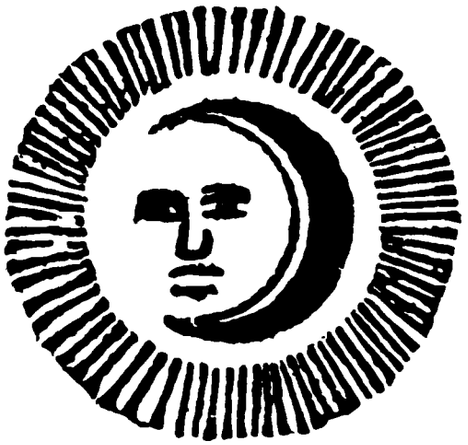


autumn on the sun

BY LOUISE A. PURRETT

It's nearing a kind of autumn on the sun, when the stormy season of sunspots and solar flares has passed, the magnetic field weakens, and few sunspots mar the solar disk. It is the solar minimum, the low point in the sun's 11-year cycle of activity.

But, as in autumn on earth, the apparent peace is deceptive. Profound and as yet unknown changes take place within the sun, in a kind of magnetic rebirth. Processes are set in motion that culminate years later, as the sun's magnetic field reverses polarity, its south pole becoming north.

Over the past few years, scientists have been learning much about the sun's magnetic field and the nature of the changes that occur at solar minimum. They have learned much that is startling, and some things that seem downright impossible. This solar minimum should provide a test of developing theories about the sun.

Scientists at NOAA's Space Environment Laboratory, one of the Environmental Research Laboratories in Boulder, Colorado, keep a constant watch on solar activity, and will be in an ideal position to monitor the changes that will be taking place over the next couple of years.

Like the earth, the sun has an enveloping magnetic field. Superficially, says Patrick McIntosh of the NOAA laboratory, it resembles a bar magnet, with a north and south pole, and lines of force in ever-widening arcs between them. The sun's corona, the halo visible during eclipses, shows hair-like filaments rising from polar regions. This seems to support the bar magnet analogy, says McIntosh. But he thinks all this is "one of the coincidences of nature, leading us to think we understand something when we don't."

The sun's magnetic field is infinitely more complex than a bar magnet. The complexity begins, but does not end, with sunspots.

Sunspots seem to be caused by a warp in the sun's magnetic field. The birth of a sunspot group apparently begins when magnetic lines of force rear up from the surface of the sun in a huge loop spanning some 18,000 miles (30,000 kilometers) at its base. This magnetic arch is thought to have "roots" extending downward into the sun that deflect the heat boiling upward from the solar interior. Thus cut off from their source of heat, the areas around the bases of the arch become cooler than the rest of the sun and, in contrast to the surrounding brilliance, they appear darker. These "dark" areas are sunspots.

In white light images of the sun as many as 50 individual spots, usually grouped in two clusters, may be visible in such an active region. But often there is just a pair of spots. Just as the magnetic loop has a positive and negative pole, one sunspot (or sunspot cluster) is positive and the other negative. And there is a faithful pattern to which is which. During the present solar cycle, all the sunspot pairs in the southern hemisphere of the sun are oriented with the negatively charged spot to the east and the positively charged spot to the west. Sunspot pairs in the northern hemisphere are the mirror image of the southern hemisphere arrangement. In the next solar cycle, these polarities will all be reversed.

Sunspots are evanescent features, lasting only a few days, but some last long enough for astronomers to watch their progress across the face of the sun and reappear, two weeks later, as the sun's 27-day rotation brings them into view again. They fade in a ritual as consistent as the way they form. The easternmost spot is the first to die, followed by the other; the plage, a ring of increased brightness around the spot, may persist for several months.

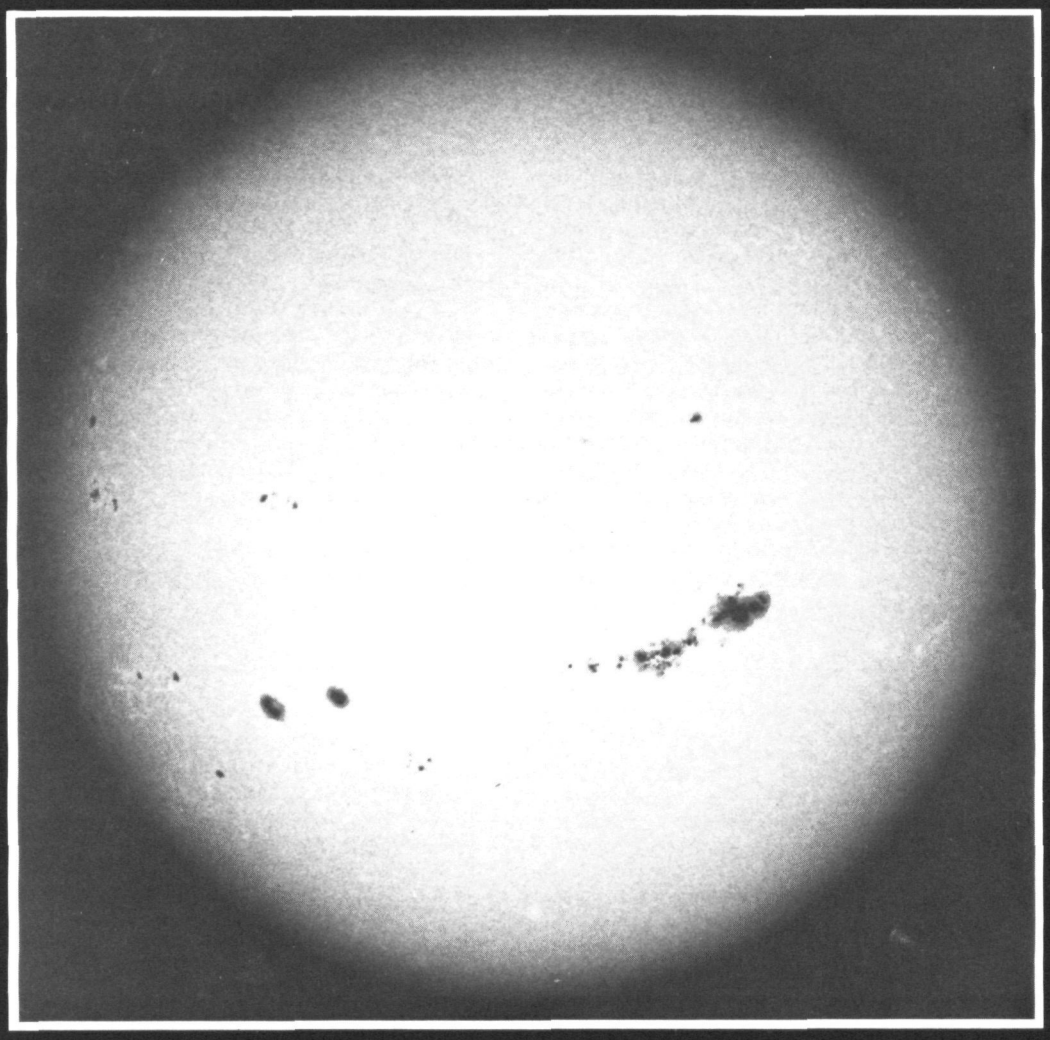
Over the months that follow, the remnant magnetic field of the eastern spot spreads out and drifts toward the nearest solar pole. Gradually, as the magnetic skeletons of subsequent sunspots accumulate at the pole, they form a weak but uniform magnetic field there that is opposite to the original polarity of the pole. There is a theory that the accumulation at the poles of the magnetic residues of sunspots causes the observed reversal of the sun's magnetic field, says Gary Heckman, acting director of the Space Environment Services Center.

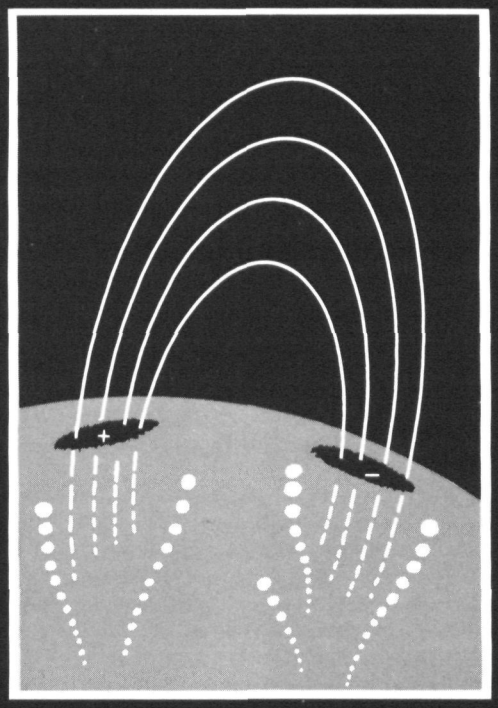
Superimposed on the overall magnetic field of the sun is a swirling, slowly changing pattern of positive and negative areas on the sun's surface, perhaps the solar equivalent of continents. These magnetic continents are invisible, though astronomers have gained a sketchy impression of their general configuration through earthbound instruments that measure certain components of the sun's magnetic field. McIntosh has gone further, and developed a technique for mapping them in great detail using visible features on the sun.

Hydrogen-alpha images of the sun reveal a wide variety of features. McIntosh has analyzed H-alpha photographs dating almost to the beginning of this century, to define the relationship between the various features and the otherwise invisible magnetic convolutions.

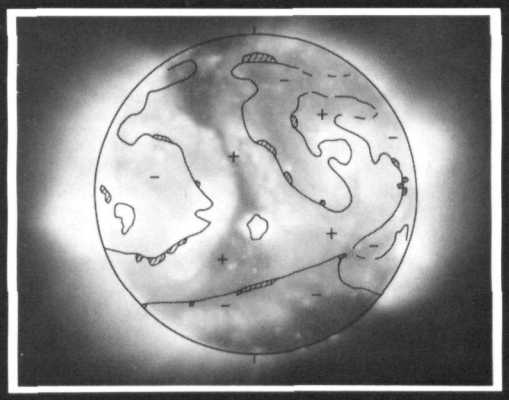
Giant ribbons of darkness that worm their way across the face of the sun were found to mark the boundaries between positive and negative areas. These dark strips, or "filaments," are striking features, tall fencelike clouds of gas that may be up to 30,000 miles (50,000 kilometers) high and as long as the diameter of the sun. Hairlike linear structures that give the impression of iron filings in a laboratory demonstration of magnetism, trace the lines of force lying parallel to the solar surface. Together, such solar features form a cohesive, interconnecting system in which one type of feature evolves into another with a regularity that suggests predictability.

Using five basic solar features as tracers, McIntosh, working with colleagues at the Applied Physics Laboratory of Johns Hopkins University, has mapped 145 rotations—solar days—a period of 10 years on earth. The process is tedious; a single map, showing the magnetic patterns for a solar day, may cost 60 hours of eyestrain. But the maps are worth the effort; they reveal an ever-changing pattern, in which enormous irregular areas of positive and negative polarity flow across the surface, their sinuous boundaries expanding, contracting, changing shape. Areas, or "continents"

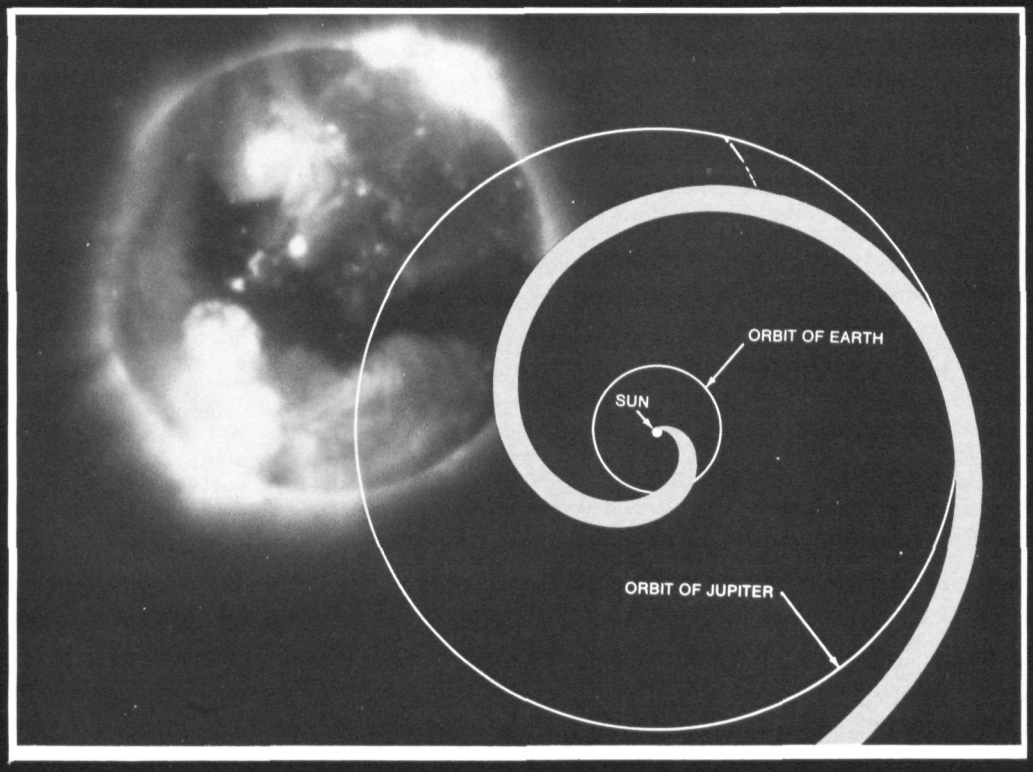




Sunspots tend to form in pairs or pairs of clusters (left). As magnetic lines of force rise in an arch from the surface of the sun (above) like a huge magnet, the roots of the arch deep within the sun repel heat bubbles rising from the solar interior. This produces relatively cooler areas at the base of the arches, areas that show up visually as dark—the sunspots. Like the bars of a magnet, one cluster is positive, the other negative.



Superimposed on the overall magnetic field of the sun is an ever-changing pattern of positive and negative areas, the solar magnetic "continents". Outlines of magnetic continents superimposed on an X-ray image of the sun show how a coronal hole (the long dark swath) opens up between continents that are pulling apart.



As a coronal hole opens up (the large dark area in this X-ray image taken from Skylab), streams of energetic particles escape through it. This great increase in the "solar wind" causes magnetic storms on earth. The sun's 27-day rotation brings the increased stream of particles back each time until the coronal hole disappears. Scientists are investigating the links between coronal holes, magnetic continents, and the magnetic lines of force associated with sunspots.

of the same polarity may meet and fuse, and then divide again.

These changes take place slowly; an individual continent may maintain its identity for months or a year. McIntosh believes the magnetic continents are the result of convection on a gigantic scale within the sun. Energy rises by convection from the interior of the sun, like bubbles rising in a pan of boiling water. These energy bubbles reaching the surface are what gives the sun the granular appearance we see in hydrogen-alpha light. The convection process occurs on three scales. The smallest granules, about 1,000 miles in diameter, have a lifetime of about 10 minutes. In the early 1960's, astronomers discovered "supergranules," the result of large convection cells. These, some 18,000 miles in diameter, have lifetimes of 24 hours. Extrapolating from the granules and supergranules, scientists a few years later postulated giant convection cells with lifetimes of months or years. McIntosh thinks the magnetic continents, some of which cover a quarter of the visible disk of the sun, are the surface traces of these giant cells.

McIntosh's magnetic maps cast some light, too, on how the sun's magnetic field reverses.

Working backward through a sequence of his magnetic maps, he traced the history of a large area of positive polarity that nearly surrounded the south pole of the sun in the summer of 1973. He found that it had started a year earlier as a much smaller area on the equator, and that its original location was near a major active region of sunspots and flares.

The surprise was, says McIntosh, that it took only a year for that positive area to grow and travel from the equator to near the pole. According to the most popular theory, the transport of magnetic fields into polar regions—the process of reversal of the sun's magnetic field—should take an entire solar cycle. It had been assumed that the process moves in one direction, building up to a point where the field flips, says McIntosh.

"Maybe the reversal phenomenon occurs in pulses. It might not be a case where the pole is positive one day and negative the next. Maybe the polarity oscillates and finally settles down on the opposite sign. Bubbles of polarity may rise from within the sun, move off to the poles, and this whole grand circulation is what makes up the cycle. We've been limited up to now in seeing this only in very fragmentary form. Sunspots alone are poor tracers of what is going on in the solar cycle. They are too limited. They cover only a small part of the sun's surface and are tranitory."

One of the things that happens as the solar minimum approaches is that recurrent magnetic storms on earth become more frequent. During these storms, an increase in the flow of energetic particles from the sun, the solar wind, disturbs the earth's magnetic field, sometimes stimulating the aurora, disrupting radio and long-line telephone communications, and, perhaps, even affecting the weather.

Two different types of solar event can set off a terrestrial magnetic storm. One is a very large solar flare—not the common garden variety, but a "great" flare of the type that occurs only a few times a year. But there are less severe, recurrent storms that seem unrelated to solar flares and repeated every 27 days with the sun's rotation. These weaker storms are particularly prevalent during the declining years of a solar cycle. In fact, cessation of recurrent activity is a signal that solar minimum has arrived. The recurrent storms cause less disruption on earth, but in their unspectacular way they probably inject more total energy into the earth's environment than the major flares.

Scientists on the National Aeronautics and Space Administration's Skylab mission from the end of May 1973 to February 1974 found something that gave a clue as to how these recurrent storms occur evidence of openings in the sun's corona. X-ray photos of the sun taken from a rocket in 1970 had revealed a large dark area that astronomers termed a hole or cleft in the corona. Then, the astronauts on Skylab obtained the first movies of the life cycles of several coronal holes, showing their birth, development, and death. Once the coronal holes were discovered in X-ray photos from space, says McIntosh, astronomers could then correlate their positions with other types of solar images collected by instruments on earth. The ground-based measurements, which have been collected for decades, can now be used to study coronal holes.

Out of these coronal holes, scientists have found, comes most of the solar wind. During the Skylab period, 34 high-speed streams of solar wind were detected emanating from the sun. The vast majority of these, about 90 percent, seemed to be spurting from four coronal holes. The solar wind streams from coronal holes at rates of over a million and a half miles an hour (700 to 800 kilometers a second). Elsewhere on the sun, the solar wind flows at the more moderate pace of 670,000 miles an hour (300 kilometers a second).

These high-speed streams are apparently

CYCLE 20

Cycle 20, the present cycle of solar activity, is nearing its end. But no one is sure just when that end will come, and there is even some question about how to define the end of a cycle. Already, however, Cycle 20 is the longest of this century, and has caused more magnetic activity on earth than any cycle in recorded history.

The turbulent sun goes through an 11-year cycle of activity that is usually defined by the changing choreography of sunspots dancing across its face. The cycle is irregular, but persistent. Astronomers have been recording it for over two centuries.

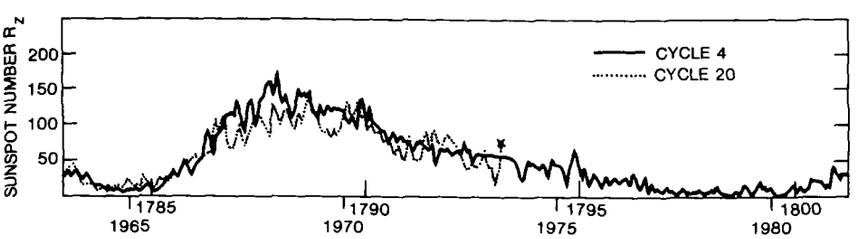
Galileo was the first to discover that the bright disk of the sun was not flawless, but occasionally marked by dark spots. Unfortunately, shortly after he made his discovery the sun entered an extraordinarily long quiet period and it was another hundred years before astronomers realized that Galileo's sunspot was not an oddity but part of a regular pattern of solar events.

Over the 200 years that sunspots have been recorded, they have increased and then decreased in a regular fashion. The time between solar minima, when sunspots are at their low point, averages out to 11 years. No two cycles have been exactly alike, and, in fact, the 11 years is merely a statistical average; cycles have lasted anywhere from 10 to 14 years.

Estimates of when Cycle 20 will end vary from sometime this year to a year from now. The traditional way of plotting a solar cycle is by sunspot number, an index of solar activity that combines number and size of sunspots, averaged over time. This method produces a simple, dramatic curve that rises to a peak where the sunspot number is about 10 times that at solar minimum, and then falls again. The trouble with this method, says Gary Heckman, is that you don't know when you've reached the solar minimum until it's past and the sunspot curve starts upward again.

Statistical methods, based on previous cycles, predict that Cycle 20 should have ended in 1975 or early 1976. Patrick McIntosh has tried a slightly different method. He studied all the past solar cycles since 1749, seeking the one that followed a pattern most like the present. He had to go back a long way: the best match was Cycle 4, from 1785 to 1800. If the present cycle continues to mimic that one, it won't end until next year.

As the solar cycle progresses, not only the numbers, but the locations of sunspots change systematically, and this may give a key to pinpointing the end of the solar cycle. The first few sunspots of a new cycle appear at solar latitudes of between 20 and 30 degrees. As the cycle develops, new spots form nearer and nearer the equator. The magnetic polarities of old and new cycle spots are different, as well. So a change in the position of sunspots should herald a new cycle. But again, the change is not clear cut. For a period of time around the



linked to magnetic storms. In 1974 and part of 1975, Skylab workshop participants found, a huge coronal hole was repeatedly facing earth as the sun rotated, and throughout this period there were strong recurrent magnetic storms.

The effect is something like a solar sprinkler system. The sun rotates, spitting out a stream of solar wind from a coronal hole. If the hole is facing earth, we get "sprayed" every 27 days as the rotating sun brings the stream around to point in our direction. This increase in energetic particles sets off magnetic storms on earth.

Everything seems to come apart at the coronal holes. The magnetic field apparently opens up and the normally closed lines of force diverge. Even the magnetic continents seem to separate. If the total amounts of material are to remain the same on the sun as a whole, there must be convergence somewhere else on the sphere. By looking at a series of images of the sun photographed in a type of red light known as hydrogen alpha, McIntosh can infer regions where features seem to converge. A scientist at a conference on coronal holes compared the divergence-convergence on the sun to continental drift on earth. And, just as convergence on earth—places where continents collide—pushes up mountains and gives rise to volcanoes, they are the seats of activity on the sun. "We find that 75 percent of solar activity occurs in areas of convergence."

Skylab movies and images from the Orbiting Solar Observatory #7 reveal the comings and goings of coronal holes over a three-year period. Comparing them with his magnetic maps, McIntosh thinks he has found where coronal holes fit into the pattern of magnetic continents. He finds a consistent sequence of events that leads up to their formation and believes it may be possible to predict them.

The sun rotates faster at its equator than at high latitudes, he explains, and since the sun is not a solid body but a plasma of hot gases, it does not rotate as a whole. It's as if the sun were horizontally divided into rings that rotate at different rates. "You get areas of shear, or slippage, where latitudinal zones with different rotation rates move past each other."

Because of this differential rotation, a series of magnetic continents in a rapidly rotating zone may be carried past another continent in a slower zone. When areas of the same polarity meet, they fuse and flow together, and the magnetic lines of force along their mutual boundary must open up, with the broken ends of one border joining hands to form one big ring. Eventually, the differential rotation may divide what it had joined, pulling the continents in two again.

McIntosh says the Skylab scientists may have seen the magnetic effects of this rifting process. Instruments on the spacecraft detected numerous large magnetic loops rising rapidly from the sun and expanding far out into space. Finally, when they had stretched to a distance of something more than 2½ million miles, they apparently broke open, their severed ends streaming outward from the sun.

Whatever the meaning of the mysterious magnetic loops, they seem somehow to be related to coronal holes. McIntosh has found that the coronal openings tend to form in the wake of rifts in magnetic continents. They seem to be pushed shut again by convergence on the surface of the sun. This suggests that, by watching the changing patterns of magnetic continents, it may be possible to predict where and when a coronal hole will open, and, in turn, when earth might expect the magnetic storms that they cause.

The pattern of coronal hole formation and destruction that McIntosh found broke down toward the end of the Skylab period, however. The last coronal hole that the instruments on the space vehicle recorded in late 1973 apparently persisted for two years. The average life span of the few other coronal holes that have been observed was about a year. "The movement of continents seemed to slow down as if the large-scale evolution went into slow motion and the sun's heartbeat slowed," says McIntosh. "Something may have changed in the solar circulation, and that change may be the key to understanding what brings on the solar minimum."

The shear process caused by differential rotation, adds Gary Heckman, is closely connected to the occurrence of sunspots. There is a weakening in the solar fabric, caused by the shear, and sunspots form in the area of weakness.

It begins to look as if the so-called solar "minimum," when the sun's visible manifestations of activity are quiescent, is a misnomer. The "quiet" is illusory. Magnetically, something fundamental seems to happen on the sun, causing coronal holes to persist, the solar circulation to alter somehow, and the magnetic orientation of sunspots to flip.

Scientists will be watching this solar minimum, whenever it comes, with special interest. Magnetographs at Thule, Greenland, and at Vostok, the Soviet station in Antarctica, will be recording magnetic events. Whatever they find, the approaching solar minimum may add much to our understanding of the sun and of the fundamental property of magnetism itself. □

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solar minimum, "new cycle" sunspots at high latitudes may be followed by "old cycle" spots near the equator. The first clear harbinger of Cycle 21, an active region of sunspots and flares at about 28 degrees north solar latitude, appeared last August. (Actually, a "new cycle" active region was first reported two years earlier, but it was short-lived and may have been an anomaly.) Seven months later, in March, there was some "old cycle" activity, a sunspot group near the equator. "The cycles actually overlap," says Heckman. "There is a period of jumping back and forth between the old and new."

Another way to attempt to predict the minimum, says McIntosh, is to measure the span of time between the first conspicuous "new cycle" activity and the official sunspot-number minimum for the previous cycles. For the last cycle, this time lag was 14 months. The first clear activity of Cycle 21, says McIntosh, was in August 1975. If the pattern of the previous minima persists, he says, the solar sunspot minimum should come in October of this year.

Theoretically, if the number of "old cycle" active regions steadily decreases, and the number of "new cycle" regions steadily increases, there should come a time when their numbers are even.

Plots of the signs of activity for the old and new cycles on a graph produce a line that slopes upward for the increasing numbers of spots in the new cycle and one that slopes downward for decreasing old cycle spots. Where the lines cross—where, in essence, the average of new cycle activity equals the average of old cycle activity—should be the solar minimum.

All of these methods provide only a statistical, rather arbitrary way to mark the end of a solar cycle. None of them may, in fact, hit upon the time when the changes that really distinguish one solar cycle from another occur—the changes in the sun's internal structure that are reflected in sunspot patterns and reversal of the sun's magnetic field. At the last solar minimum, McIntosh says he saw symptoms of change several months in advance of the sunspot-defined solar minimum.

Whenever it finally ends, Cycle 20, now in its 12th year, is already longer than average. McIntosh points out that the mean length of solar cycles is 11 years, and so far all of the cycles in this century have fallen short of that. "So maybe it's time to catch up." Cycle 4, he adds, was exceptionally long—nearly 15 years.

Cycle 20 has distinguished itself in another way. By the visible measures of sunspots and flares, it has been an unusually quiet cycle. It has had only half as many sunspots as the previous cycle, and only ¼ as many flares. Throughout the past 11 years, the sun has burst out in only two active regions that produced major flares, in the summers of 1972 and 1974. Most cycles produce half a dozen or more major flares. Cycle 20's flares, few in number, distinguish it in another way; the 1972 flare is thought to be one of the most violent ever.

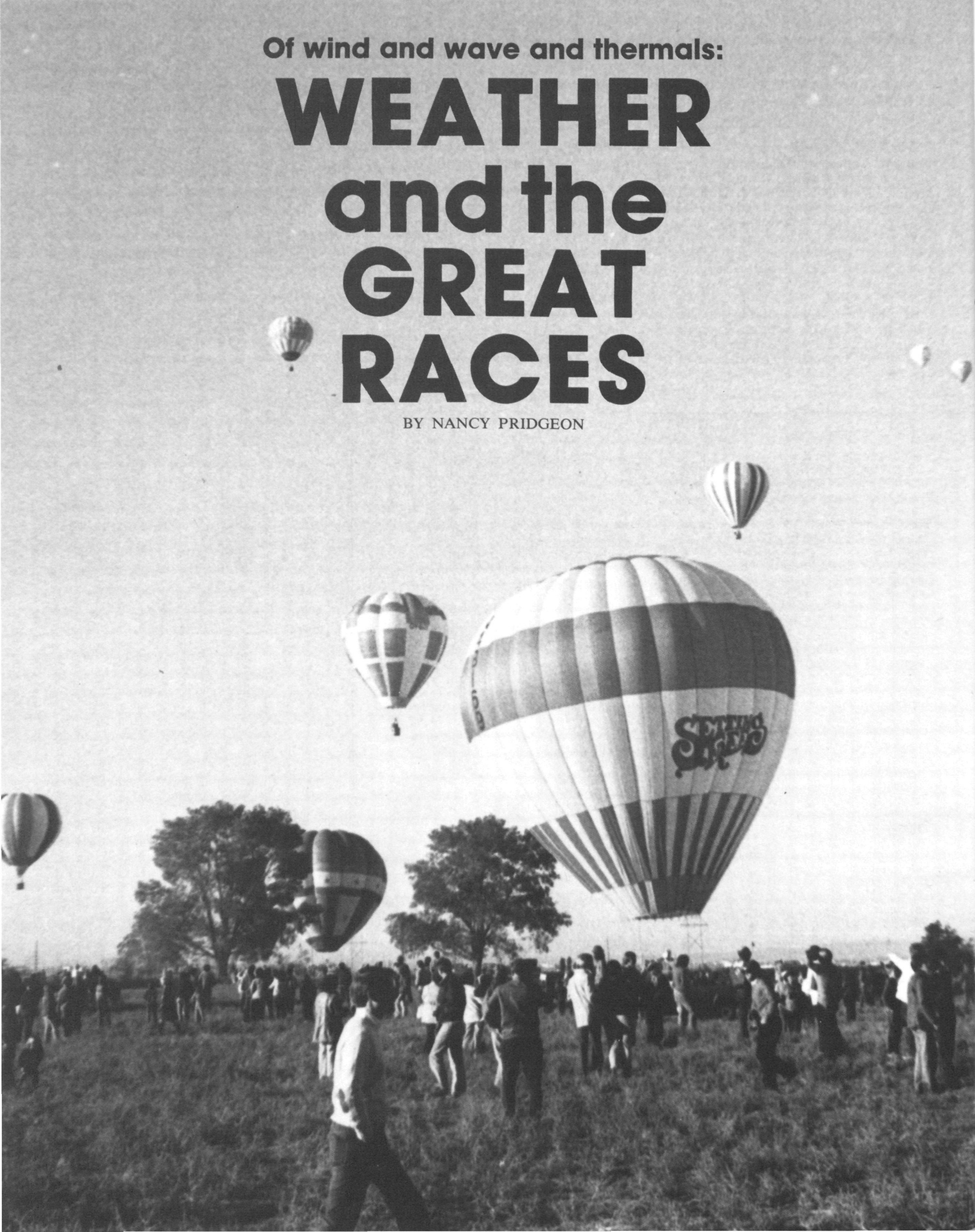
Cycle 20 has also been a record-breaker magnetically. Increases in the flow of energetic particles from the sun—the solar wind—cause magnetic storms on earth. Solar flares are responsible for only a small part of this magnetic disruption; most comes from recurrent surges in the solar wind that are unrelated to solar flares. In this type of unspectacular magnetic activity, Cycle 20 has exceeded all others. One year of the cycle, 1974, produced more magnetic activity than any in the past 200.

The resemblance between Cycle 20 and Cycle 4 also raises some questions about what to expect during this solar minimum. A relatively long period of solar inactivity followed Cycle 4. The minimum itself lasted for six years, and the next couple of cycles were so quiet that they amounted to little more than minima. Will the minimum of Cycle 20 be similarly protracted? Both cycles 4 and 20 are even-numbered cycles, with the same magnetic polarity. There is a theory that even-numbered cycles tend to be followed by droughts on earth. McIntosh thinks it would be a good idea to look at historical records to see what kind of drought, if any, followed Cycle 4. Cycle 20 is not over yet, and it may still hold some surprises.

Of wind and wave and thermals:

WEATHER and the GREAT RACES

BY NANCY PRIDGEON



Americans are a racing people. They find ways to race almost anything that moves, from supersonic jets to cars to boats to horses to jumping frogs. Many of our more spectacular events command global attention and some have been known to muscle wars off Page One.

Winners are idolized, at least temporarily, and consistent winners become folk heroes. Even the supporting cast knows the taste of glory. Thus far, however, the gates of the Hall of Fame have not opened to one of the most important players: the weather forecaster. Weather is a major, sometimes even a governing, element in most big races, as much a part of the planning as spinnakers or crankshafts. And one of the most challenging jobs undertaken by the National Weather Service is forecasting for these events.

Sailing, for example:

National Weather Service Offices along the Nation's coastlines keep the boater's safety in mind at all times. Marine advisories are a part of the coastal zone forecasts. Forearmed with this information, skippers and their crews can take the necessary precautions.

As long as he has the special radio equipment aboard, a skipper can receive the NOAA Weather Radio broadcasts on 162.40, 162.475 or 162.55 megahertz. The broadcasts include marine advisories in their 24-hour-a-day, 7 days a week forecasts.

The Coast Guard also regularly broadcasts up-to-date NWS forecasts, and the National Bureau of Standards' WWV and WWVH time signals carry superimposed storm warning information for high seas mariners.

When special racing competitions are scheduled, the Weather Service forecasts include special wind and wave information tailored to that particular race.

One of the oldest yacht races in the world is the America's Cup. The America's Cup races are run whenever the current cupholder is challenged. Now an international trophy, it was first won in England in 1851 by the schooner, America.

The early America's Cup races featured large 120-foot yachts, but 12-meter (about 40 feet) yachts are now used. The United States has a new aluminum 12-meter competition yacht, the Independence, launched in August, 1976, at Long Island, N.Y., and another, the Enterprise, soon to be ready.

The America's Cup competitors race a fixed course about eight miles off Newport, R.I. This brings them within the sea-breeze zone—where ocean air meets and mingles with air from the land. Forecasts for race days include wind direction and—with the aid of satellite photos—the duration and extent of such adverse conditions as fog banks.

The forecasts are also given daily to the New York-based North American Yacht Racing Union, the association that prescribes the rules for all official races, and to foreign competitors, as well.

Robert Lynde, marine focal point for the Boston, Mass., Weather Service Forecast Office, has done the forecasting for many sailboat races, including the America's Cup. Some of the races have large numbers of yachts participating.

The Newport-to-Bermuda race this year had about 165 yachts entered, ranging in size from 30 to 80 feet. To brief the more than 300 people who came in to get the weather outlook, Lynde set up an overhead projector, with the latest information from the National Meteorological Center.

Photo: Rhode Island Development Council

"On the slides, I showed the current weather, the next day's prog, and the five-day series," said Lynde. "This got them the weather to within a day of Bermuda."

The Gulf Stream, its position and condition, is important to the Newport-to-Bermuda skippers. So part of the pre-race weather briefing concerned the Gulf Stream, with the National Environmental Satellite Service, the Woods Hole Oceanographic Institution of Woods Hole, Mass., the Coast Guard, and the Weather Service cooperating to pinpoint the area where the yachts would cross the Gulf Stream and where it lay on either side of their rhumb (straight) line courses.

The warm Gulf current as it meanders northward through the Atlantic has warmer air above its surface. Where the warmer air approaches the cooler air over the surrounding ocean, squalls and rough seas can result. Yachts have been dismasted or have been capsized or sunk in heavy weather around the Gulf Stream borders.

If a tropical storm were brewing out in the Atlantic, it could menace the deep water sailors, too. The Washington, D.C., Weather Service Forecast Office and the Miami, Fla., National Hurricane Center cooperated while the racers were underway to send out forecasts as the racers got within range. The yachts were radio-equipped to receive the broadcasts.

There are other major sailing competitions each year in addition to the Bermuda race. One is from Marblehead, Mass., to Halifax, Nova Scotia. Another is held on the Great Lakes as experienced yachtsmen enthusiastically set sail from Chicago, Ill., and race to Mackinac Island at the northern tip of Lake Huron. The race takes three or four days if the yachts have "a fair wind north."

The Chicago forecast office sends a forecaster to the gala dinner held the night before the race. The forecaster is prepared with an extensive briefing, followed by a question-and-answer session.

The yachts move out on the appointed day. From there on the Chicago forecasters watch very carefully. The yachts carry the proper radio equipment, so they can tune in KWO-39, the NOAA Weather Radio station broadcasting from the Chicago Weather Service Forecast Office, and get marine advisories as they race.

Meanwhile, on the Pacific coast, the Transpacific Races have begun. Three races this year were the forecast responsibility of the San Francisco (Redwood City), Calif., Weather Service Forecast Office until they were handed on to the Honolulu, Hawaii, WSFO.

The Los Angeles, Calif., to Papeete, Tahiti, course had four entrants and was by far the longest race, Tahiti lying about as far south of the Equator (20°) as Hawaii is north. The Equatorial seas, particularly in the Intertropical Convergence Zone (ITCZ), can be filled with stormy weather, so the skipper must know where the storms are most likely to occur and where a corridor between them might be.

Satellite photos help, and this year's skippers were armed with copies. They had weather information from WWV and WWVH as long as they were within range. But for several days, they were out of radio contact, dependent on their skill in navigating the weather conditions, winds and sea states as they found them.

The two other long-distance sailing competitions across blue Pacific waters were from Los Angeles to Honolulu and from Victoria, B.C., to Maui, one of the Hawaiian Islands. The British Columbia to Maui race included more than 40 sailboats, many of them small

by oceangoing standards. But the pace was swift and they crossed in only a few days. Here again, the San Francisco and Honolulu forecast offices cooperated to give the sailors the greatest measure of safety possible.

Weather forecasts for ocean travel always have been conscientiously prepared. But fine data—precise measurements of wind and sea conditions—have not always been available. With the advent of satellites, beaming down photographs from high above the Earth's surface, the forecast picture improved. But winds won't show on a single satellite photo—it takes elapsed time to pinpoint wind direction and speed from successive photographs. Nor will a single photo show the sea state—wave height and swells.

"The limitations of forecasting are such that we can only give the prevailing winds," said Robert Cole, Deputy Director of NWS's National Hurricane Center, Miami, Fla., who briefs for SORC—the Southern Ocean Racing Circuit—where sailboats each year race around the Florida peninsula and out to sea as far as Nassau and Jamaica.

"The SORC forecasts are for wind and sea," said Cole. "But the sea is very complex and we are only forecasting averages. We don't concentrate on the extremes."

In one briefing for a SORC race this past year, Cole did predict gale force winds (30 to 35 knots) and waves as high as a one-story building (15 to 20 feet).

In spite of the forecast, 40 sailboats started the race—the largest a 60-footer and the smallest just 22 feet long. More than half the boats turned back, or dropped out as the peril increased, but a dozen or so finished the race, among them the 22-foot sailboat.

"Boat racers do like all the wind they can get," said Cole. "The races are held each year way ahead of the hurricane season and stop about the time it starts, so we don't have to worry about that.

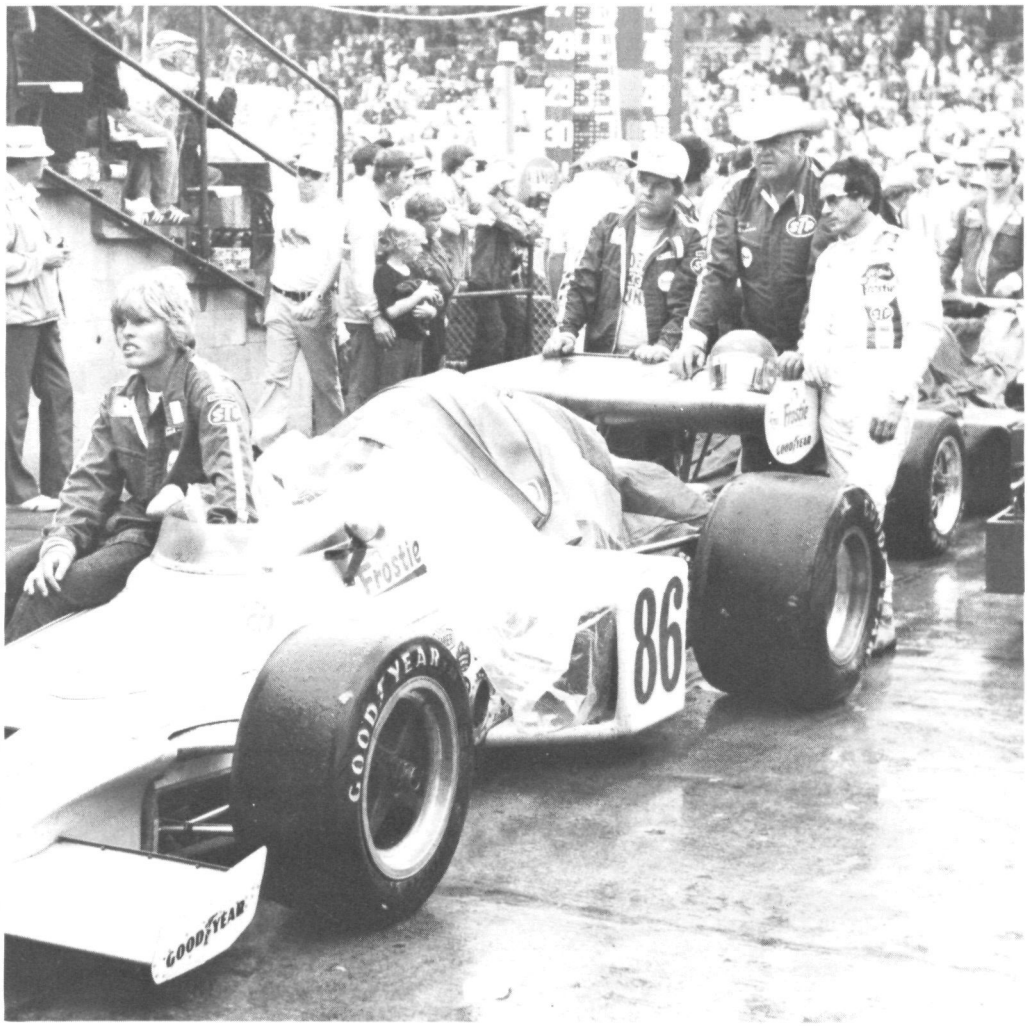
"But the racers take chances and sometimes end up losing masts or sinking. We've been fortunate so far in keeping boat deaths and injuries to a minimum."

While the sailboats are beating into the wind around the Florida coastline, the Spring auto races are starting up on the Florida shores. Two of these are the Daytona Beach and the Sebring Grand Prix endurance races—grueling 12-hour runs that test the stamina of driver and machine.

"For many years, it was a practice that someone from the Weather Service would be an official observer at special events," said Carl Reber, Executive Officer of the NWS Southern Region Headquarters. "That was because most contests have rain insurance. This was ruled inappropriate so meteorologists no longer act as official observers."

But they do still make special forecasts for some events. These exceptions to the rule usually are when amateur organizations request Weather Service support for competitions that are highly weather-dependent, or when large numbers of people will congregate temporarily in a certain area.

Large crowds of auto racing fans turn out in every state to see demolition derbies, stock car races, and racing car competitions. There's even a race to the top of a Colorado moun-



Photos: Indianapolis Motor Speedway

Start of the 1976 Indianapolis 500 race. Rainy weather has plagued the race the past three out of four years. Odds are the next race day will be fair.

tain—the Pikes Peak Hill Climb—held every 4th of July.

Atlanta, Ga., hosts two major auto races each year—the Atlanta 500 and Road Atlanta.

Road Atlanta is not the usual oval racing track. It has a lot of curves and takes great skill to drive the course. Different classes of stock cars are raced. The total miles to the checkered flag vary with the race. It's one of the racing events sometimes driven by Hollywood stars—guaranteed crowd-pleasers.

Two or three days before the Road Atlanta or Atlanta 500 races, the Atlanta Weather Service Forecast Office puts an outlook for the race days on the Weather Wire, to be picked up by sportswriters and relayed to the racers, managers, and the people coming in from surrounding areas.

Rheinhart W. ("Bill") Harms, Meteorologist-in-Charge at Atlanta, feels that real pressure is put on the forecaster in any sporting event to call just what the weather will be for a three- or four-hour period.

"We cannot call it that close," said Harms. "Part of the difficulty is not being able to forecast with pinpoint accuracy."

He points to a forecast that may call for a front to pass a given point within the next 12 hours, say between 6 a.m. and 6 p.m. If the front were to move through early, with early morning showers, the chances are good that the sun will shine by noon, and the afternoon will be ideal for racers and spectators alike.

"The forecaster tries not to be too pessimistic," said Harms. "But we don't make the weather, we just try like heck to forecast it."

By mid-April of each year, the Indianapolis, Ind., Weather Service Forecast Office is beseiged by sportswriters and the media for a forecast for what has been called the world's largest sporting event—the Indianapolis 500 auto race held on Memorial Day weekend.

The office does its best to comply, but Glen V. Sachse, Meteorologist-in-Charge of the Indianapolis WSFO, says that climatological probabilities based on past weather records are all that he can offer that far in advance.

"The records say that the chances for rain on that weekend are one in eight," Sachse said. "That is, in the past, there have been seven clear years to every rainy one. But three of the past four years were rainy. Odds are that the next race day will be fair."

The forecast office also forecasts the weather for the time trials, held two weeks prior to the big race. The weather is just as important to the racers during time trials. The Indianapolis 500 race has averaged about one death a year, many of them during the time trials.

"This type of auto racing is more sensitive to rain than almost any other type of land sport," said Sachse. "Any moisture on the track can stop the race. They are racing right on the ragged edge and their lives are in the balance."

Despite the risk involved, the top race-car drivers of the Nation feverishly compete for the honor of driving the race. And close to half a million spectators converge on Indianapolis each year for the thrill of watching.

Three days before the race, the meteorologists try to point a forecast toward the big day. Every morning a special forecast is updated and issued. Since people are arriving from all directions, by air as well as by overland transportation, the forecasts widen out to the surrounding areas.

More than 1,000 planes will land at Indianapolis's Weir-Cook Municipal Airport the day before the race. Most of them are private planes, executive jets and charter planes to be parked at the airport until the race is over. No plane may fly within a mile and a half of the track while the race is in progress.

On the morning of race day, the Weather Service Forecast Office is deluged with phone calls from radio stations all over the country.

"They ask for forecasts and record the forecaster giving it so they can say, 'We called the weatherman at Indianapolis and here's what he said . . .'," said Sachse. "We have to have a special staff standing by just to handle this."

At the race track, track officials have a "drop"—a tie-in—on the Weather Wire. The decision to stop a race in case of rain must be based on the latest weather information.

For the 1976 race, the forecaster had called for a 30 percent chance of rain, but by race time, the chance of rain had been upped to 60 percent. The race officials stopped the race temporarily when it rained and then waited two hours to allow the track to dry out.

But the rain began again, and, based on the forecaster's assessment that the rain would continue, the race was stopped for good. This year, there were no deaths at the "Indy 500."

Rain, as critical as it is to the Indianapolis 500, isn't the only kind of weather that worries Sachse. The possibility of a tornado striking in the midst of thousands of spectators worries him more. Indiana is in a high-risk area for spring and summer tornadoes.

One solution has been used by the Indiana State Police. If a tornado watch is in effect for the area, they post a lookout at the top of the racetrack tower. The lookout scans the sky in all directions. If a tornado approaches, the troopers have a prearranged plan to evacuate the area.

A tornado could be in the area and still not pose a threat to the people in the grandstands. In that case, the lookout would do everything in his power to avoid a panic among the spectators and to quiet the alarm of any who might be aware that a tornado was close by.

"This happened one year during time trials," said Sachse. "There were thousands of people watching the trials when a tornado dipped down east of the track. The tornado moved away so the lookout didn't raise an alarm."

As though answering broadcasters' requests, counseling track officials on weather conditions, and keeping a sharp eye out for

Photo: Nancy Pridgeon, NOAA

The first three planes to arrive at the Wilmington terminus of the 1976 Powder Puff Derby were just ahead of sunset on the evening of the second day. Enroute, the pilots used their RON time to plot courses and check weather forecasts.

Photo: AWTAR, Inc.

possible tornadoes weren't enough, the Indianapolis forecasters have yet another important project on race day.

During the morning of the race, the forecasters make up a forecast of averages for a radius of about 300 miles from the area, complete with a drawing of the 10 a.m. surface map. The forecast is completed by noon.

Then a police escort, with lights flashing and sirens wailing, takes one of the forecasters and the map to the airport manager's office. There, enough copies are made for one to go into each flight kit intended for the parked aircraft.

Airport employees then hang a kit—containing the weather map and complete flight instructions for takeoff—on the door handle of each parked plane. Pilots have been encouraged to file outbound flight plans upon arrival, so no further briefing is necessary. The planes leave in a hurry when the race is over.

By the time the spectator planes had roared out of Weir-Cook this year, preparations were nearly complete for another kind of race, the All-Woman Transcontinental Air Race—the Powder Puff Derby.

This—the 29th annual—was the last race of the cross-country Derby that began in 1947 with just one plane entered. This year, 235 entries were received, but since it was the final race—it was being cancelled because the women felt racing was too wasteful of fuel—the official limit of 150 was raised to 200 and the remaining 35 were assigned standby status.

The planes flown in the race were all stock model small planes—Beechcraft, Piper, Cessna were the favorite models—with speeds averaging 200 miles an hour.

The route this year was 2,915.70 miles from start to finish. Sacramento, Calif., was the starting point. Scheduled stops were Fresno and Riverside in California, Grand Canyon, Ariz., Santa Fe, N.M., Lubbock, Tex., Oklahoma City, Okla., Little Rock, Ark., Nashville, Tenn., Parkersburg, W.Va., and Wilmington, Del.—the finish line.

The Derby rules specify that the race must be flown in daylight hours only. All flying is done under visual flight rules (VFR) so there could be no reliance solely on instrument flying (IFR) during any part of the race. Poor visibility at takeoff, landing or anywhere in between would prevent a plane from getting off the ground.

To a pilot about to embark on such a race, the weather is a critical factor. The best of conditions would be clear skies and a tail wind—to push the plane faster.

Unfortunately, ideal weather seldom extends from coast to coast for very long at a time. Fronts move, thunderstorms form and die, contrary winds blow. The pilot must master the obstacles along the way.

Weather briefings were mandatory by the Derby rules. And Weather Service Offices along the route prepared extensive weather information for the pilots' use. Many of the Derby pilots, however, prided themselves on being weather-wise. Some of the contestants hired private meteorologists and called them long distance each day before taking off.

After the race is over

The Other Days of the Year

Race weather forecasting is a great once-a-year challenge, as Marian Renfrew Meteorologist-in-Charge of the National Weather Service Office in Wilmington, Del., who forecasts for the finish of the Powder Puff Derby, can attest.

But the rest of the year is pretty busy, too.

"One of the toughest decisions a public official may face could be the one that involves a weather-related threat to the community. Prompt and effective response to warnings could mean the difference between life and death, sometimes for large numbers of people."

So says Marian to mayors and city officials, State government agencies, schools and community groups throughout the State.

She sees her main job as liaison with communities in their efforts to prepare for natural disasters—hurricanes, tornadoes, floods. She also works for the safety of the boaters, swimmers, anglers, and fun-in-the-sunners who flock to the Delaware shores for summer outings.

As part of her preparation for this role, Marian has taken the late Dr. Benjamin F. McLuckie's storm-warning preparedness course, "Warning—A Call to Action."

(Dr. McLuckie, an Assistant Professor of Sociology at the University of Delaware, was posthumously awarded the Weather Service's "Public Service Award" in 1975 for his work on human response to disaster. The course he developed helps to understand crisis behavior and keep storm-related deaths and injuries to a minimum.)

The course is just one of the steps Marian has taken to be where she is now. Her goal is to be able to do more, to spend more time preparing people to take the proper action in weather emergencies.

As Meteorologist-in-Charge, Marian supervises the work of six meteorological technicians—"met techs"—whose routine includes hourly and special observations of current weather, visibility, temperature, wind, pressure, humidity, and other meteorological parameters.

Each hour, observations are logged, teletypewriter messages are sent, and voice recordings are made for the regular telephone announcements. Marine recordings are updated every two or three hours. Incoming teletypewriter messages are frequently scanned.

Information and warning messages are torn off the machines and posted on the special display boards, ready for use. Radar observations are plotted, pilots are briefed, and phones are answered.

With a weather emergency, the pace quickens. Cooperating observers scattered around the State call in special reports. A severe weather statement from the Weather Service Office may be released. Key personnel in the local warning network are phoned to alert them to the threat. The situation is now monitored carefully. If "certain values" are reached, a warning is issued by the person on duty at the time.

"I'll be glad when we get AFOS," Marian says. "I'm looking forward to it." She sees

AFOS—the Weather Service's automated high-speed data handling and display system that will eventually replace the present more cumbersome communication methods—as a way to get the message to community officials and the public even more quickly.

When the office is short-staffed—during vacations, for instance—Marian takes one of the three 8-hour shifts that are required for round-the-clock staffing, seven days a week. But even if she's worked the night before, she's ready to come back if a weather emergency arises.

Before Wilmington, Marian was the Meteorologist-in-Charge at Trenton, N.J., a two-person office in New Jersey's capital city. There she worked on a service program that improved working relationships between her office, civil defense officials, State agencies, news media and the public.

In helping people, Marian is doing what she wants most to do. She's known for a long time that this is the life she wants to lead.

"When I was 12," she said, "Bell Telephone had a science series with a cartoon character named 'Meteoria,' the goddess of weather. I was fascinated.

"When I got to high school, I knew exactly what I wanted. I took all the science and math courses required to become a meteorologist."

She graduated from Penn State in 1967 with a Bachelor of Science degree in Meteorology. Her only disappointment: That there will be no hurricane named "Marian." (The name does not appear on the 10-year list of hurricane names.)

Marian and her husband, Dr. Dwight Renfrew, live in a suburb of North Wilmington. When Dwight was in medical school, they lived in Philadelphia and Marian commuted. Now it's his turn—he commutes each day to the Philadelphia hospital where he's an intern.

What advice would she give to young women considering a career in meteorology?

"She'd have to be dedicated," Marian says. "Meteorology is a demanding career. She'd have to know that it involves shiftwork and crisis situations—that when the weather is bad that's when you're there working the hardest—and she'd have to thrive on it.

"I thrive on it!"

"But I can't find a weatherman that does any better weather than I do," said Esther Grupenhagen, who was the first one to land in Wilmington, but, because of handicapping, not the winner. Grupenhagen explained that she studies the weather information and then decides where she dares take a chance.

The Derby flyers ran into adverse weather right away this year. By the time most had gotten into Riverside, fog had blanketed the area and the planes were grounded.

Further along the route, bad flying weather—for planes depending on VFR—halted progress. At each stop, forecasters briefed. And the ham operators, who had volunteered their services at each station along the route, relayed weather information and touchdown locations to other hams all along the race course.

At the Wilmington terminus, only three planes had managed to get through by the evening of the second day. The majority were bunched up along the midline of the route—38 at Lubbock and 66 at Oklahoma City. Twenty had reached Little Rock, five were in Nashville, and one lone plane remained overnight (RON) at Parkersburg. Farther back on the line, 33 were at Santa Fe, and 32 were still at the Grand Canyon, where a temporary field and facilities had been set up just for the Derby.

The atmosphere at the Wilmington airport was tense as heavy rains and thunderstorms lashed the area. Radar reports showed large thunderstorm cells with towering tops over the Appalachian mountains. For the waiting Derby officials, the official timers, the ham operators, and the well-wishers who had come to see the planes cross the finish line, the action ebbed and flowed around the big map in the lobby of the Terminal Building—where Civil Air Patrol volunteers moved numbered push pins as pilot locations were received over the ham radio.

Earnest people studied the map or reviewed the weather information—updated and posted each hour on a clipboard fastened to the map. Others visited the Weather Service Office, wanting the prognosis. The Wilmington FAA Chief worried about wind direction. And the chairman of a scheduled party worried about a circus tent he'd ordered set up the next day.

At last, there was a break in the cloud cover and the rain slackened. The waiting planes, held on the ground at various check points, began to fly toward Wilmington. Smiles proliferated as they began to arrive.

The joy of the occasion was marred when one pilot, after radioing that she was running out of gas, went down near Parkersburg. She and her co-pilot were seriously injured in the crash which demolished the plane. Since none of the planes carried extra fuel, running out of gas was always a hazard if the plane had to fight head winds or was blown off course.

The Washington, D.C., WSFO and the Wilmington, Del., WSO provided the weather support for the last part of the Derby. Marian Renfrew, Meteorologist-in-Charge of the Wilmington WSO, and her staff barely had time to breathe from the time the Derby began until it was over. Renfrew attended the dinner meeting the night before the pilots flew back out and gave a briefing on the weather for the return flights.

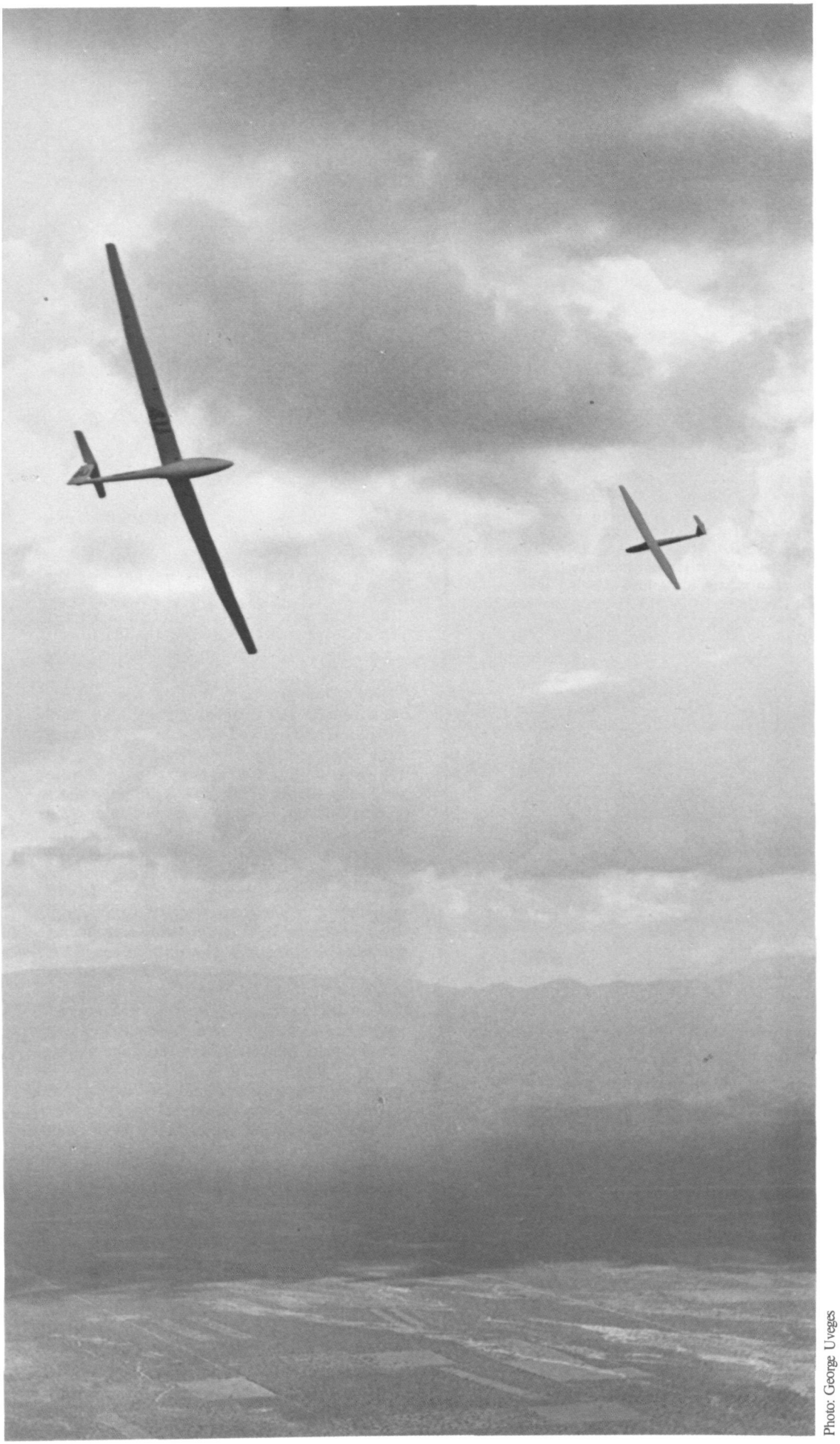


Photo: George Uvegas

Two sailplane competition pilots share the same thermal lift.

Even so, her office gave 261 individual pilot briefings—between 7 a.m. and noon—the next day when most of the airplanes left. More than 350 people visited the Wilmington Weather Service Office that day.

Just as the power pilots of the Powder Puff Derby challenge the weather to let them pass, so the pilots of another type of plane depend on their ability to scan the sky and hitch a ride on the wind.

These are the sailplane pilots whose specially-built planes weigh about 400 pounds and have a wing-span of about 50 feet. Soaring races and contests are popular all over the country with different areas featuring different kinds of weather to take advantage of.

Once the sailplane is towed aloft and set free, a soaring pilot must find a way to use the air that flows over and around the Earth's surface features to remain skyborne.

According to "Aviation Weather," a joint publication of the Federal Aviation Administration and the National Weather Service, soaring pilots may depend on fronts, thermals, sea-breezes, ridges and hills, and mountain waves for soaring.

In areas close to water, sailplane enthusiasts can sometimes ride the sea-breeze front that forms near land's end as cool onshore breezes flow over the warmer seashore. This air flow causes an upward motion of the warmer air, and, where the two meet, may form cumulus clouds. This type of soaring can be found not only along the ocean shores but also in the Great Lakes area when conditions are just right.

Along the crest of ridges and across low hills, strong currents are often found. With upslope winds of 15 knots or more, enough lift may be created to support a sailplane—often allowing it to rise two or three times the height of a hill.

Mountain wave soaring poses special problems for the sailplane pilot. Strong winds blowing across high mountains, such as the Rockies, can provide continuous lift to great heights—flights of more than 35,000 feet are not unusual. But where high altitude currents spill over the steep slope of a front range, downward rushing winds can be deadly.

The soaring pilot's mainstays, however, are fronts and thermals. Fronts are where two or more air masses of different temperatures meet, sometimes violently. Thermals are columns of warm air rising from heated surfaces such as city pavements on a hot day. The wider the area warmed, the broader the thermal that is rising. Thermals often form cumulus clouds over the rising current of air and the strongest thermals are found below developing cumulus clouds.

"Think of a smoke stack," says Charles Lindsay. "The higher the stack, the stronger the draft."

Charles V. Lindsay, Forecaster at the Washington, D.C., Weather Service Forecast Office, typifies the Weather Service meteorologist who volunteers to forecast for a special event. The most interested meteorologist often is involved in the sport as a hobby.

Lindsay, who is on the meteorology committee of "Soaring Magazine," and writes extensively on soaring and weather, is one of the contributors to the World Meteorological

Organization's (WMO) "Forecaster's Manual for Soaring Pilots."

"It takes very accurate upper-winds forecasts for soaring pilots," Lindsay says. "They need to know the amount of cumulus clouds and their height, any information we have about the thermal layer, and, of course, visibility."

Lindsay has done on-site forecasting for soaring meets for many years. In the past, he took a teletype machine and a facsimile receiver with him to the site. NOAA has a facsimile receiver that "floats around the country," on loan to any site where needed.

But with the increasing sophistication of communications equipment, forecasters can now make special soaring forecasts from the Weather Service Offices. There, computer products are available and the latest radiosonde data.

For best results, it's a "last possible moment" forecast, and Lindsay says the forecaster is "busier than a four-armed paperhanger" in the last few minutes. When the forecast is completed, it's broadcast to the pilots over a loudspeaker system at the site.

For the past five years, sailplane enthusiasts have held the Smirnoff Derby—a cross-country race designed to travel from Los Angeles, Calif., to Washington, D.C., relying on the plane's ability to ascend the currents of air and the pilot's skill in finding the next one to ride a little farther. This year, there were six entrants.

The race was a leisurely one, across parts of California, Arizona, New Mexico, Texas, Oklahoma, Missouri, Indiana, Ohio, Pennsylvania, and Maryland, taking more than a fortnight to complete. At each airport along the route, the pilots stopped by the Weather Service Office for a pilot's briefing. The forecaster, who had been notified in advance of the pilots' estimated time of arrival, briefed on the upper winds forecast and the special conditions the pilots needed to know.

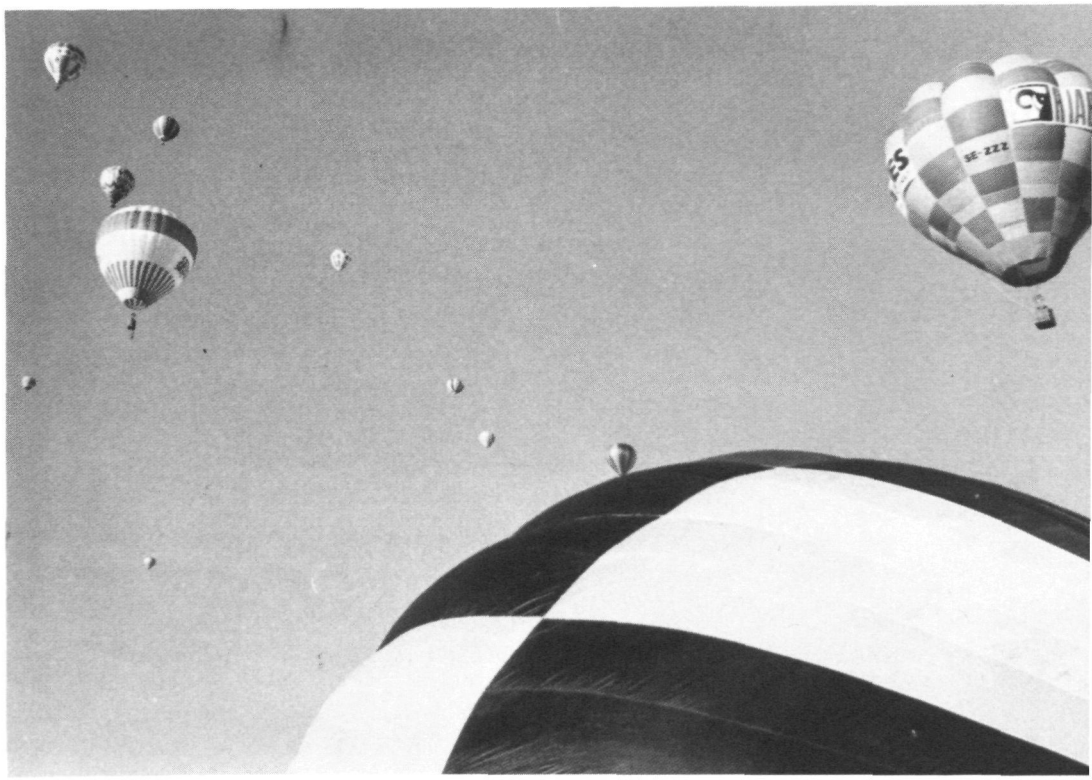
This year's race began where the Los Angeles area has a sea-breeze front as Pacific air blows toward the California coast, and two strong convergence zones from mountains to the north and south. From there, a lift across the mountains to the east brought the sailplanes into the range of thermals rising in the American Southwest.

Across the Great American Desert, great columns of warm air rise above the sun-warmed sands. The warmth continues into Texas where the flat terrain features strong thermals and a prevailing southerly wind to carry the planes northward.

Across the grasslands, and up and over the Ozarks of Missouri, the soaring weather held for this year's race. But by the time the contestants had reached St. Louis, Mo., the weather was decidedly uncooperative.

The sailplanes were trucked to Indianapolis, Ind., and thence to Columbus, Ohio, before the pilots were able to resume their wings. They flew into Dulles International Airport, on the outskirts of Washington, D.C., three days after they were originally scheduled to arrive.

If a brisk breeze is a joy to sailor and sailplane pilot alike, it's something less than that to the pilot of a hot air balloon. Any wind-



speed higher than 10 miles an hour makes a hazard of the sport.

Balloons have been a popular flight vehicle for centuries. Some depend on lighter-than-air gases—hydrogen or helium—to give them the buoyancy needed to rise and float above the Earth. But today's sporting balloonists depend on heated air for the lift they need to become airborne.

Like an awakening giant, the filling balloon struggles upright until it towers as high as a five- or six-story building and tugs at its ropes to be free. The gondola, like an open basket, dangles below, carrying the generator and the crew skyward when the mooring ropes are thrown off. Firing the generator causes the balloon to rise. Forcing cold air in to dissipate the hot air causes the balloon to sink. Gaily decked out, an inflated racing balloon can delight even the most jaundiced eye. But let any wind except the very mildest begin and it can quickly become as unmanageable as a bucking bronco.

In October, Albuquerque, N.M., hosts the Albuquerque International Balloon Fiesta and the Annual World Hot Air Balloon Championships. There, above desert sands and high altitude short-grass plains, the balloonists participate in events designed to demonstrate their skill in maneuvering their buxom craft.

One event features a white flour "bomb" dropped from the foremost balloon. The balloons following then land as close to the spot as possible. The "Roadrunner Race" is a follow-the-leader test where each must follow in the tracks of the balloon leading the way.

Most balloon events in New Mexico take place in the fall of the year when winds are lightest and skies most likely to be sparkling clear.

"Some cloud cover or even light snow doesn't discourage the balloonists," said George Gregg, Meteorologist-in-Charge of the Albuquerque Weather Service Forecast Office, who has furnished meteorological support for the balloonists for the past few years. Gregg remembers one time when he could hardly see the balloons as they floated through snow squalls.

"The best time for racing is in the early morning," said Gregg. "The winds are almost non-existent then, but they'll usually pick up in the afternoon."

On Fiesta days, the Forecast Office arranges for a special pre-dawn radiosonde launch. The radiosonde is a free-rising weather balloon about six feet in diameter with an attached instrument package that transmits temperature, pressure and humidity data as it ascends through the successive layers of the atmosphere.

By the time the forecaster arrives at the site, the Fiesta committee already has set up a tent and a trailer is ready to be used for communications. The radiosonde report is telephoned to the on-site forecaster and this information is updated by a pibal—pilot balloon—released at the site.

The pibal—a free-rising uninstrumented balloon about three feet in diameter—is used by the forecaster to measure wind speed and direction. A briefing of the forecast—with emphasis on the upper air flow—is then given to all the participants.

If the little balloons tell the big balloons that the conditions are favorable, the big balloons get set to go and the forecaster heads back to the office.

"I'm back before 8," said Gregg.

And as the meteorologist settles down to the day's work, the majestic red and white and purple and orange balloons rise to greet the morning sun as it climbs from behind the Sandia Mountains and bathes the land in the pink and gold of a desert sunrise. □

U.S. observers monitor Japanese, USSR fishing operations

LIFE WITH THE FOREIGN FLEET

BY ROBERT R. FRENCH, MARK A. MILLER AND LARRY K. NELSON*

From San Francisco to Siberia, U.S. fishery scientists sample the catch of foreign fishing vessels plying the waters of the North Pacific Ocean and the Bering Sea. Their platforms: Japanese and Soviet vessels which fish various stocks off the west coast from California to the Aleutian Islands and throughout the eastern Bering Sea from Dutch Harbor to Cape Navarin in Russian Siberia.

The United States observer program was created by a need to get accurate information on the number of halibut and crab taken incidental to other operations by foreign trawl vessels. Since its inception in 1973, over 60 biologists working through NOAA's Northwest Fisheries Center in Seattle, Washington, have made the trips. Most of the sampling has been done aboard Japanese groundfish motherships and stern trawlers and crab motherships; additional observations have been made aboard Soviet groundfish vessels.

Japan and the Soviet Union harvest most of the catch which, in 1971, totaled over 2 million metric tons. While dragging their nets on the ocean bottom catching groundfish species (those living near the bottom) such as walleye pollock, yellowfin sole, rockfish, and Atka mackerel, many other species are taken incidentally or in addition to the target species. Of the many varieties of fish incidentally landed, Pacific halibut, king crab, and snow crab are the most important to the United States and Canada.

During the period of massive expansion of foreign fisheries in the Bering Sea in the 1960's, halibut landings by U.S. and Canadian fishermen declined from about 5,000 metric tons taken by 104 vessels in 1963 to only 200 tons by 10 vessels in 1973. Because of this, the United States negotiated for a program to place U.S. scientists and technicians aboard foreign trawl vessels—that operated in the Bering Sea and-northeastern Pacific Ocean—to determine the incidental catch of both halibut and crab.

In early 1973, Japan became the first nation to accept observers aboard their groundfish vessels operating in the Bering Sea to monitor catches for incidence of halibut and crab and to collect biological data on these and other species. The U.S. agreement with Japan permits us to place observers on two motherships and four stern trawlers each quarter of the year. Each sampling period lasts approximately 30 days, and each observer spends two to three months on these trips, including travels to Japan, and to and from the host ships via cargo vessels.

A second program involves monitoring the Japanese crab fishery in the eastern Bering Sea to verify catch statistics and adherence to bilateral agreements. Observers are onboard the crab factory ships for the entire fishing season, which lasts up to four months.

The third effort was a limited observer program on USSR vessels, from November 1974 to March 1975, and consisted of observation periods lasting about 14 days. Five cruises were completed, compared with nearly 50 on Japanese vessels to date. Transportation to and from the Soviet vessels was via U.S. Government and chartered vessels from Alaskan ports.

Observers are selected primarily from employees of the National Marine Fisheries Service, including two NOAA Corps officers assigned to the Northwest Fisheries Center. Participants also include one scientist each quarter from the Alaska Department of Fish and Game and the International Pacific Halibut Commission. After selection, the observer spends from three to five days at the Center, training and preparing for the cruise.

The observer destined for a Japanese vessel flies to Tokyo where he enters into one of the world's most populous cities, dominated by crowds of people and screeching taxis. He is immediately confronted with an unfamiliar language and strange currency.

During the one to five days the observer spends in Tokyo, several meetings are arranged. As a representative of the United States Government, he attends courtesy meetings arranged by the U.S. Fishery Attache, with members of the Fisheries Agency of Japan and with representatives of the host fishing company. As a guest of the host fishing company, the observer receives the benefit of traditional warm Japanese hospitality prior to his departure. The trip to the fishing grounds is normally via cargo vessel or, rarely, on the host fishing vessel itself if the observer's and vessel's schedules happen to coincide. It is usually a time of conditioning and preparation for life at sea. The observer also becomes acquainted with the Japanese diet of fish, rice, vegetables, and tea which will be his for the next two months.

Upon reaching the fishing grounds, the observer leaves the carrier ship for his new home on the fishing vessel. Transfer is via a wicker basket or a simple wooden frame encircled by netting lifted by a crane. The initial impression of his home for the next month or so is one of immaculate cleanliness and precise arrangement of each item. The desk is laden with carbonated drinks, beer, a hot cup of tea and rice crackers as signs of welcome. Even the sink is equipped with a new toothbrush and a bathing pail.

Shortly after arrival the observer is invited to a meeting with he ship's officers to discuss sampling. Fortunately, one or more of the Japanese staff has some command of English, but conversation is slow, laborious and limited. The hosts eye the observer in an atmosphere ranging from cordiality to indifference, sizing up the personality of the American who will be their guest for the next month. The diplomatically-oriented observer understands the scrutiny and acts accordingly, trying to assure the success of the sampling process and confidence of his hosts. With toasts of sake and beer, the meeting ends in agreement over sampling plans and methods.

Sampling begins the next day, after the observer has acquainted himself with the work area, the fishing schedule, and the various dos and don'ts of the particular vessel. The main objectives of the observer on groundfish vessels is to determine the incidence of halibut and crab in trawl landings, determine the species composition, and obtain biological data from various species. The incidence of halibut and crab is obtained in two ways: first, by monitoring a passing conveyor belt

* *The authors are affiliated with NMFS' Northwest Fisheries Center, Seattle.*

NOAA biologists sampling the catch on foreign fishing vessels may lift and handle up to two tons of fish daily. At left, Dick Major shovels random samples into baskets to be weighed. Roger Habbestad (right) weighs and measures an individual sample.

full of fish, the observer counts the halibut and crab, and estimates the total tonnage of fish during a given observation period. Second, basket samples are taken from either the fish bins or conveyor belt, counting the number of halibut and crab therein. From these collections the observer determines the number of halibut and crab per metric ton of catch, which is then extrapolated to the total days catch to estimate the number of halibut and crab landed as incidental catch.

The species composition of the catch is estimated by weight. To obtain this estimate, the observer collects several basket samples of fish daily, obtaining the total weight of each basket and the weights of each species group within the basket. An observer samples between one and two tons of fish each day by this method. Results are extrapolated to the vessel's total landed catch per day to obtain special composition.

Biological data are collected from the target, or primary, species and other fish species of interest, including length and weight measurements and removal of otoliths (fish ear bones) and scales. Both otoliths and scales are read, much like the rings of a tree, to determine the age of fish. These data are analyzed at the Northwest Fisheries Center to determine the biological attributes of the fish being removed by the fishery and are used in studies on the conditions of the stock.

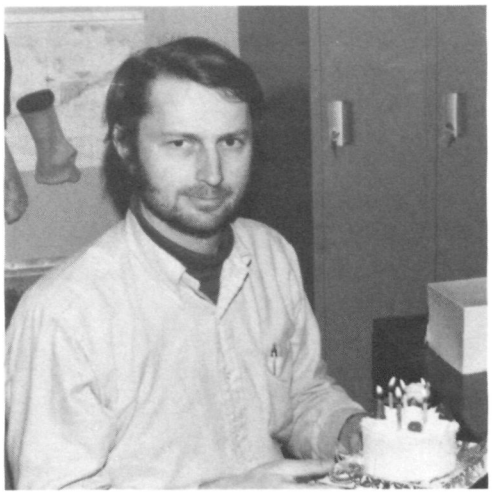
The objectives of observers on Japanese crab factoryships are to verify the catch statistics and obtain biological data on the catches. To verify catch statistics the observer records the weight of each bag of crabs landed and obtains the total tonnage of crabs by area. Crab samples are measured and weighed daily.

Working conditions aboard the ships vary, with the observer fashioning his sampling around vessel landing operations, weather conditions, and social customs. Fishing may continue for most of a 24 hour day. To obtain a reasonable sample of the entire catch, sampling must be proportioned throughout the day. Once begun, the sampling may be delayed frequently due to tea breaks and factory shut-downs. The observer must also curtail operations to meet the meal schedules, where promptness is a necessity.

Weather conditions often severely handicap the observers as they work on the exposed deck. From autumn to spring, icy winds, snow, or freezing rains can be expected in northern waters. Frequently the observer must duck into sheltered areas to thaw his extremities. Here Japanese workers prepare hot cups of tea or coffee and/or tasty samples of octopus, snails, or fish, over a small pot-bellied coal burner. With the many delays and fishing operation schedules, the observer works long, hard hours matching his schedule with vessel operation.

The dinner hour is a welcome break. Meals for the observer are traditionally Japanese, with as many as seven or eight courses featuring fish soups, fish, rice, pickled vegetables, "tempura" (fritters), and a wide range of curry dishes. Smoked squid and octopus are considered delicacies; but the most prized meal, served a maximum of once a month, is the tender Kobe steak, the finest beef available in Japan. Twice monthly, hot sake is given to each member of the table. It doesn't take long for the observer to learn to handle the "hashi" or chop sticks.

After dinner (if the observer is not at work), entertainment begins with video-tape television programs. Most programs are the comedy-variety show type, but "sumo" wrestling and variations of the "Samurai" movie are popular. Even the Japanese version of Ted Mack's Amateur Hour has wide appeal. To the language-restricted observer, the theme of each is quite clear, as the themes of love, romance,



Shipboard scenes on foreign vessels include a special Christmas surprise baked by Japanese cooks for observer, Larry Nelson (top left); a Japanese bath setup (above left) featuring a large, salt water soaking tub; and (right) the ice laden deck of a carrier vessel alongside a mothership provides tricky footing for the crew.

and courage dominate Japanese television in the same manner as in his native country. Unfortunately, commercial advertisements are even more abundant on Japanese TV programs than in the U.S., but at least they expose the Oriental culture to the non-Japanese-speaking American observer.

Relaxation continues, after another brief sampling period to monitor night catches, with an assigned bath time. Unlike American custom, the Japanese bath is a unique, relaxing experience alone or in numbers. At the appointed time, the kimono-clad observer enters the bathing area, leaving his sandals as an "in service" message to passers-by. A large tub full of hot salt water and a smaller container of fresh water await him. By adjusting steam valves, the bather regulates the water temperatures. Dipping into the fresh water with a plastic bathing pail, the observer douses, soaps, and completely rinses while sitting on a small stool before comfortably settling into the warm, saltwater bath. To the usually active American, the first soak in the salt water seems a small waste of time, but as the cruise progresses, the bath becomes the relaxation focal point of the day. Not only does the hot water limber the muscles, but the salt water makes the skin feel as soft as wet chamois. After 20 minutes to an hour, the observer again rinses in fresh water, dries, and dons his kimono coat before returning to his room.

Arriving at his room, the observer notices several pleasant changes. An evening snack of strawberries in cream, fresh melon, or hot tea and rice cookies are on his desk. A fresh pitcher of ice water and snacks stand guard over the prepared game of the evening—be it chess or "go" (a traditional Japanese game). The American is usually pitted against a team of Japanese who argue among themselves as to what moves are best.

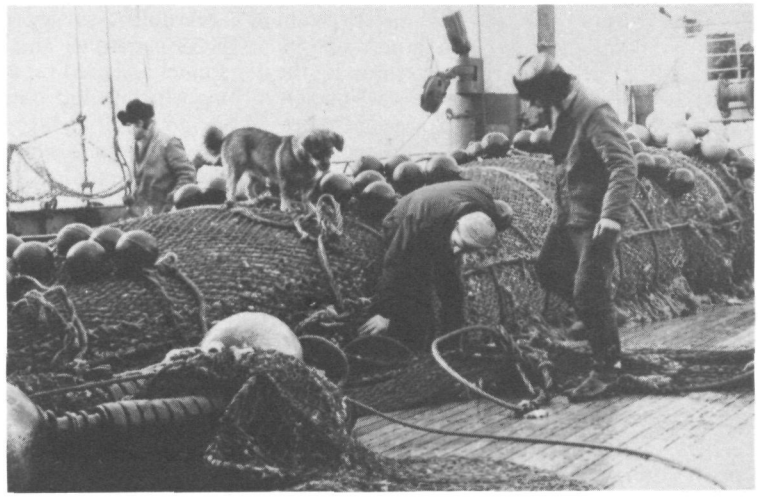
The evening hours are also used for education. Across the language barrier, a bridge of broken English and Japanese phrases are supplemented with dictionary recitals and hand-sign language. Sometimes music enters the picture where the memorization of ballads and Pat Boone melodies take on the same seriousness as the recital of the national anthems of each country. At these times, exchanges or gifts of cassette tapes are made gladly.

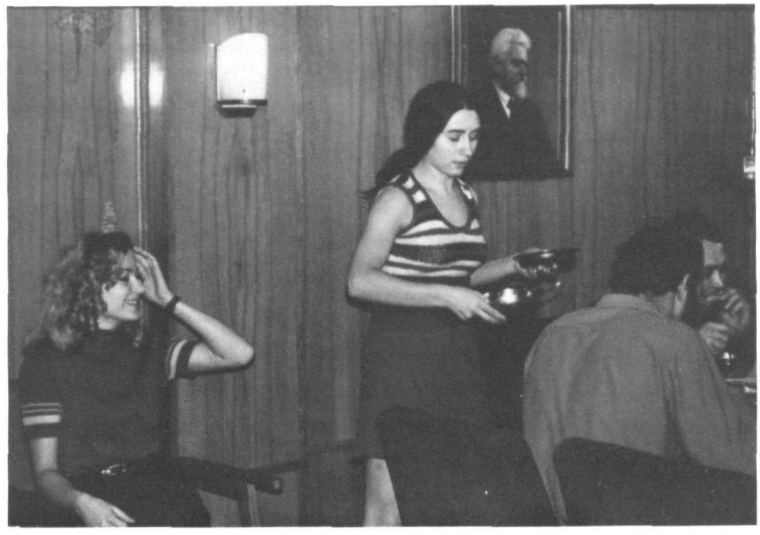
The end of the cruise is marked by an honorary "sukiyaki" dinner. Chard, onions, "tofu" (soy bean curd), bean sprouts, and beef are cooked individually by each man in his own pot. Shrimp and sole tempura abound, and aged brandy, the finest, flows freely.

In contrast to the lengthy Japanese observations were the abbreviated observer trips on Soviet groundfish vessels. The objectives and sampling methods aboard the Soviet vessels were the same as on the Japanese ships, although each observation trip was limited to two weeks. Observers embarked and disembarked from Alaskan ports aboard U.S. government or chartered fishing vessels and were spared the long voyages aboard cargo vessels common with the Japanese trips.

The diet aboard Soviet vessels was simple, consisting mainly of borscht, dark bread, and dark tea, four times daily in varying amounts. The quarters were plain and adequate. In general, as on Japanese vessels, the Soviet hosts tried to make the observer comfortable and provided whatever was necessary for accomplishing the sampling.

One of the major contrasts with the Japanese vessels was the





On the lighter side, (clockwise from upper left) Mark Miller (without hat) with some Japanese friends; the ship's mascot joins a Soviet crew; men and women crew members relax on a Soviet fishing vessel; and Dick Bakkala dines in the place of honor (directly to the fleet commander's right) using the traditional "hashi" or chopsticks.

presence of women—nearly 10% of the crew's complement on the Soviet fishing vessels. They took part in nearly all shipboard duties although their work was concentrated around the galley. Political meetings were scheduled periodically, supplemented with a movie. Evening entertainment consisted of the viewing of Soviet films or playing a game similar to dominos.

Since 1973 the Northwest Fisheries Center has completed approximately 70 vessel trips aboard foreign fishing vessels for a total of about 2,800 man days of sampling. The large volume of data emanating from this sampling program are carefully checked after each trip and transferred to automatic data processing cards for computer analysis. Basic data listings include the (1) incidence of halibut and crab by area, season, and type of vessel; (2) species composition of the catch for each vessel by day and cruise; (3) length frequency of target and other species; and (4) age composition of target and other species. The basic data pool becomes the source material for scientific documents and publications to be used by Center scientists at bilateral and other international meetings.

The observer program of the Northwest Fisheries Center has been valuable for a number of reasons.

First, the Center and the International Pacific Halibut Commission have been able to estimate the incidental catch of halibut by area and season in the Bering Sea and the northeastern Pacific Ocean. Armed with this knowledge, the Halibut Commission has recommended certain conservation measures and the Fishery Agency of Japan, as a domestic measure, has prohibited trawling at certain times and in certain areas. (Japan in recent years has closed, from December to May, a portion of southeastern Bering Sea to trawling by her vessels).

Second, the Center, in 1975, was able to verify the crab catch by Japanese crab fleets and the adherence to quotas established through bilateral agreements. The Center was also able to estimate the incidental catch of crab (over 100 million crabs annually) by Japan's groundfish fishery in the Bering Sea and is in a position to consider ways and means to conserve this resource.

In addition, through the foreign fisheries sampling program, the Center has been able to determine size and age composition of the various target species and use these data to help in evaluating stock conditions.

The American observer program will continue in the coming year. The regular Japanese groundfish and crab programs will be augmented by an experimental gear program designed to test off-bottom trawls as a means of conserving halibut and crab. A new program aboard Polish vessels along the western shore of the continental United States is planned for the spring and summer, and observations aboard Soviet vessels could be renewed.

With the arrival of extended jurisdiction, the U.S. will have responsibility for managing a major portion of the North Pacific Ocean and Bering Sea fishing grounds. Observer programs constitute a logical step toward providing more extensive biological statistics on all species landed, assuring that the proper information is available on which to base the management of the fisheries resources off North America. □

A rugged project Down East

THE BUILDING OF THE BILBY

Pike Hill Station, the geodetic survey team calls it. It is a clearing in a pine and oak woods, on top of a high ridge overlooking the little town of Norway, Maine—a sparsely populated area 45 miles morthwest of Portland. Pike Hill Station in operation consists of a Bilby tower at the top of a dirt road, a couple of trucks full of equipment, and not much else.

When the crew arrived to erect the tower and set up the station, their first job was to clear away a few overhanging limbs to make room for the tower. Permission had been granted by the property owner. Vernon "Slim" Hughes, Chief Builder for the National Geodetic Survey party in the state, reached into one of the trucks, pulled out a brush cutter, and with several deliberate whacks took care of the problem. Then the building crew set to work.

One of more than a hundred built during the NGS/Maine Cooperative Survey project, the Pike Hill tower was used last summer by the survey team to see over obstacles such as trees and the curvature of the earth. Called Bilby towers after their inventor, Jasper Bilby, the demountable steel structures can be erected by a crew in a matter of five or six hours and dismantled in even less time.

Each is actually two towers in one. Sections are color coded—red and blue—to differentiate between the outer and inner tower. The inner tower (red) holds only the delicate surveying instruments. The observer who takes the readings and the recorder who writes them down stand on the outer (blue) tower platform so they won't disturb the instruments.

Because the thick surface rock formations at the Pike Hill Station prevented digging adequate anchor holes, tower stability would be secured through the use of sandbags and guy wires.

Chief of Maine's National Geodetic Survey party is Lt. John Oswald of Middletown, Ohio, an officer in the NOAA Corps, one of the seven uniformed services of the Federal Government. He received his assignment last winter, and with his wife Sandyk, who was eight months pregnant, towed their 20-year old Spartan Royal Mansion trailer from Gallipolis, Ohio, to Alfred, Maine—25 miles southwest of Portland and nine miles from a hospital in Sanford.

Oswald replaced Lt. Russell C. Arnold who had been chief of the field party for 17 months, and who had nursed the project through its earliest period when it began at Fairfield and continued south along Interstate 95 to Kittery, Maine.

The Maine survey is one of a number of cooperative programs established throughout the country by the National Oceanic and Atmospheric Administration's National Geodetic Survey to make effective use of Federal surveying resources. It covers about 2500 square miles from the New Hampshire border to Maine's southern coastal areas. An NGS project leader and key personnel are furnished; and the remainder of the survey crew is made up of Maine personnel. The project provides control points for transportation planning, mapping, construction and public works.

Arnold's survey party consisted for four NGS personnel and five State of Maine personnel assigned on a full-time basis for training which included methods and procedures of geodetic surveying, on-site inspections, and the computation of the surveys accomplished by state personnel. An additional 11 men were involved in running levels, and three others were doing reconnaissance and setting marks for side stations off the main traverse line.

On July 2, the Director of the National Ocean Survey, Rear Admiral Allen L. Powell, informed Maine officials that the State had met all the requirements described in the first phase of "our cooperative agreement with the uccessful completion of the traverse project along Interstate Highway 95 from Kittery to Fairfield, Maine." Phase two of the project was to establish control in three counties in southern Maine to meet present and future highway needs.

Along with Lt. Oswald's arrival on December 12, came Maine's first major snow storm, and by the end of December, there were between one and two feet in the project area near Alfred. Temperatures ranged from 45 degrees above 0 to 18 below, slowing down tower building and marksetting operations.

One cannot help but marvel at the extraordinary physical and mental disciplines involved in the construction of a tower. Besides the obvious agility and strength, there is a remarkable unity of purpose and camaraderie. A sense of humor, too, is a necessity. There is an unwritten law on a geodetic survey tower building party: if you fall off the tower while it is being erected, don't yell—you'll scare the rest of the building crew.

When the work schedule calls for a tower to be erected, it must be built whether it takes five hours or 24. The hazards are many; wind and rain, copperheads and rattlesnakes. Weather, though, appears to dominate.

In his activities report for January, Oswald wrote that three towers were erected during the first week with temperature ranging from -10 to 20 degrees. "To say the least," he observed, "we have some very determined and safe builders from the State of Maine."

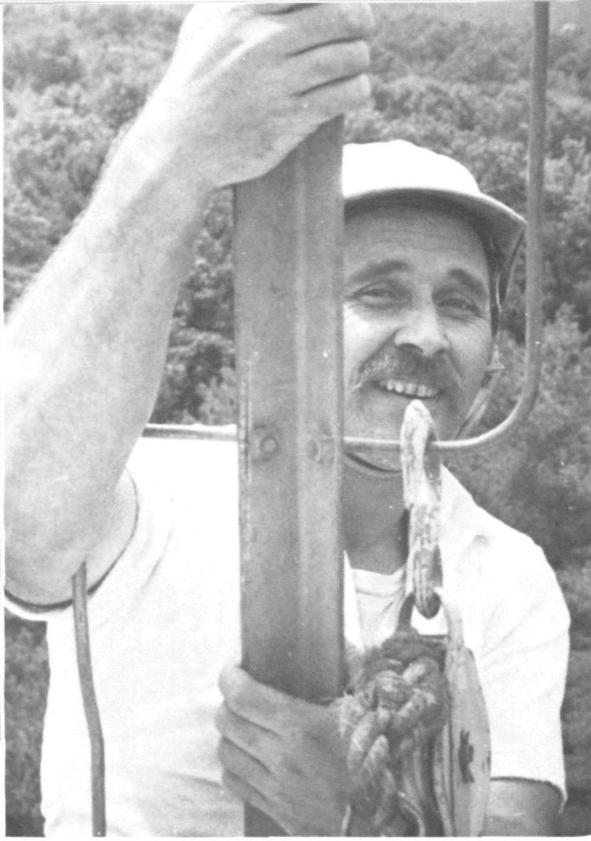
One 77 foot tower was blown down on January 14 during 100-mph westerly winds. Because of its remoteness and inaccessibility due to heavy snow, it could not be rebuilt until spring.

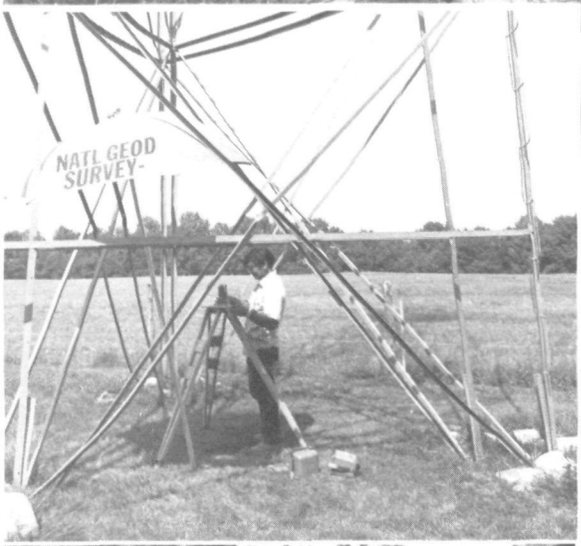
The mark setting crew also was slowed by the weather—the ice and heavy rains. It did, however, work 16 out of 21 working days, and set 86 marks, mostly concrete posts, at 23 supplemental stations. Eleven supplemental stations were observed, but again, weather set the pace. Various NGS/Maine training sessions were held during January, and a review of the project was held by officials from the Maine Department of Transportation.

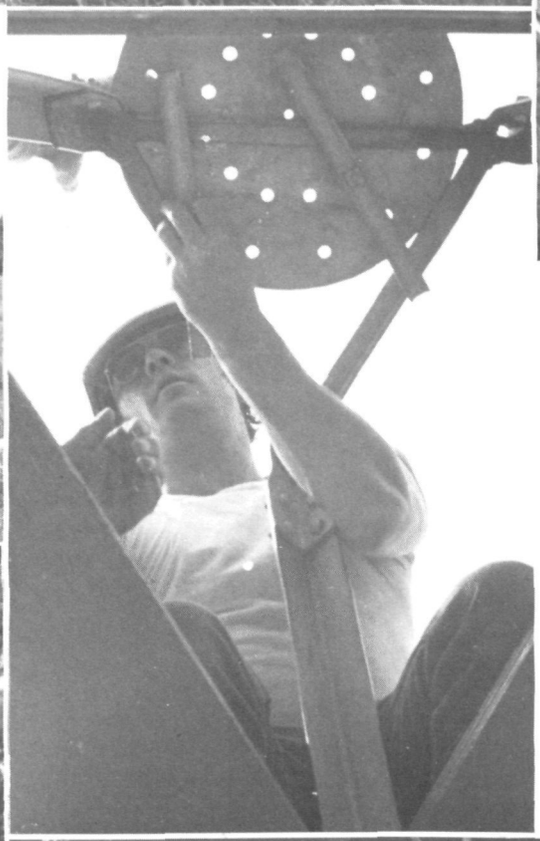
A major addition to the party was the arrival of Alfred L. Baugh, the computer, from the NGS party in Hull, Georgia. (Another major arrival, though not mentioned in Oswald's report, was that of Peter John Oswald at the Henrietta D. Goodall Hospital in Sanford, Maine, on January 14.)

They called Baugh "Cotton" because of his white, curly hair. With his Virginia accent, the nickname followed him from Georgia to

Above: Phil Parent, an observer for the Maine geodetic survey team, attaches a tower leg to the anchor--one of the first steps to building a Bilby; Right: Within several hours, the tower nears completion as the building crew secures the cage which supports the platform used by the observer.

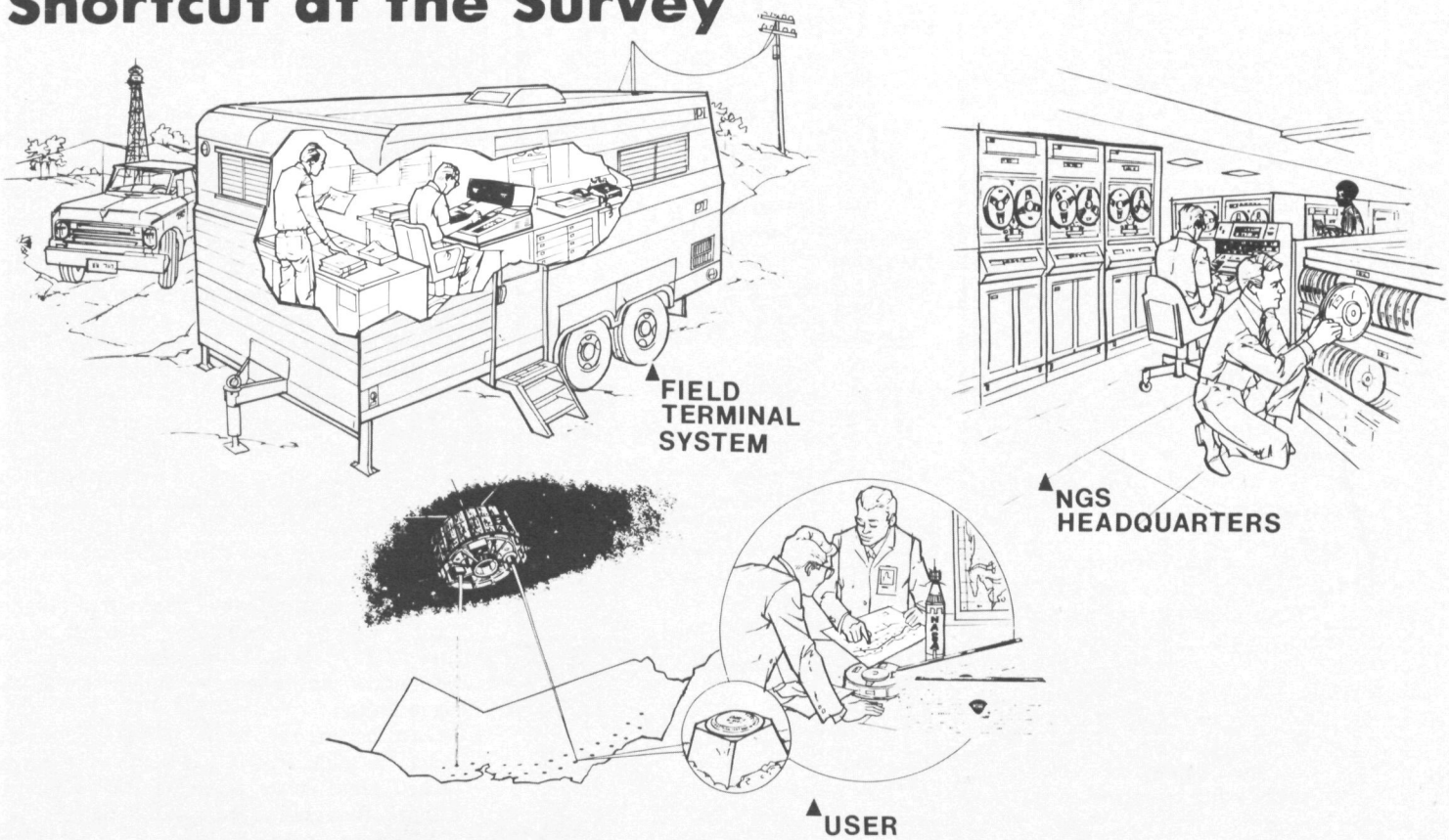






Upper left: Using a collimator, Lt. John Oswald, chief of the NGS geodetic survey party in Maine, determines the fix of the light plate near the top of the tower; Upper right: Phil Parent performs a final check on the leg ladder steps; Center left: At another tower site, NGS Chief Observer George Nelson sets a collimator on a tripod to align the observing (tri-back) plate; Center: John Higgins, Chief Maine observer, adjusts the light plate for vertical plumb; Lower left: Vernon Hughes, Dennis Hoar, and John Oswald hoist the platform boards to the top of the outer tower; Lower right: George Nelson and Rick Lane, Chief of the Maine survey party, take observations with a Wild T3 theodolite, an optical instrument for accurately measuring horizontal and vertical angles.

Shortcut at the Survey



NOAA's nomads—the geodetic field parties—are marching to a new drummer in Michigan, Georgia, New York, Connecticut, and Maine.

It all began in Morgantown, W. Va., in October, 1975 when a National Geodetic Survey field party successfully tested a new method of communicating basic data to its headquarters in Rockville, Md. This new method, called the Field Terminal System, is expected to revolutionize the NGS communications system to the extent that it will seem like moving from the Pony Express to automatic mailing.

Equipped with a computer terminal, NGS geodetic survey parties in the field are now making use of existing computer technology permitting the transmission of observed data from remote computer terminals. The information is sent to a centrally located master or host computer.

Capt. John D. Bossler, Project Manager for the New Adjustment of the North American Datum, suggested this system for NOAA's use after seeing a similar operation at Ohio State University several years ago. The Columbus campus coordinates remote terminals with a central information course for small classroom exercises. According to Capt. Bossler, "The National Geodetic Survey has for several years been experimenting with various techniques designed to modernize our system and to reduce the costly and cumbersome flow of hard copy from the field parties to the information users."

Robert (Sid) Safford and Marvin Whiting, with their theoretical background and experience in the field, developed a series of computer programs necessary for the system's first operation in Morgantown, W.Va. "In the first few days," said Safford, "we ran into a slight problem. We were trying to transmit data over a regular telephone line but were continually being cut off. The arrangements by the survey team prior to my arrival had been for a party telephone line, which is not uncommon here in West Virginia. Each time we tried to transmit, one of the other telephones was picked up, our transmission was cut off, and we lost all our data."

Traditionally, NGS field parties have worked independently and in relative isolation. Each party performs its surveying tasks in a certain prescribed manner like seasoned craftsmen. Aside from building and climbing towers, observing angles, and measuring distances (and, of course, constantly moving) their time is spent on routine paper work. Their observations are entered into record books, abstracts, summaries, lists, and descriptions. From these records, all data are typed, checked, and rechecked. Field computations are then made to insure the accuracy of the observations.

"The effectiveness of this new computerized system," said Bossler, "is illustrated in how a single piece of hard copy originates at the field party units and how it now flows to the eventual 'computer readable form' by using the new Field Terminal System."

Under the traditional procedure, a field party observes an angle, then records it in a record book where it becomes part of an abstract, then part of a list,and eventually part of the many types of test computations. It is then packaged and mailed to NGS Headquarters in Rockville.

When the recorded data arrives in Rockville, it is examined by a geodesist in the Control Networks Division. It is then coded, keypunched, checked, and a mathematical adjustment is performed to assure that all observations are internally consistent; finally, the data are recorded on magnetic tape.

With the utilization of the Field Terminal System, the data record is inserted directly into the keyboard of the terminal at the site of the field party. The recorded data are transmitted either by a "dial-up voice grade commercial telephone line" or the Federal Telephone System. At the terminal entry point, the data comes under the direction of a computer program that operates in the time-sharing environment called WYLBUR. WYLBUR interacts between the remote terminal at the field office and the host computer by providing a simple language, prompt response, and a text-editing facility. WYLBUR also acts as the agent for the host computer by calling into play, upon the user's command, the previously prepared computer programs.

The data record is transmitted via WYLBUR to the host computer where it resides until called into action by TENCOL—Terminal Entry Command Language—designed by Safford and Whiting to aid the surveyor in formatting the data records, making computations, performing analysis, and recalling previous data.

The field party, through its terminal, can utilize the computer programs to perform field computations formerly done by hand; and the NGS Headquarters staff, through its terminal, has immediate access to the data in "computer readable form." The new system is now operational and all future geodetic survey projects will have their data automated and accessible by other geodetic data users.

"The new system eliminates most of the hand transcribing and 90% of the desk-top calculator computations," according to Bossler. "We are able to make available to the field new decision-making capabilities that were impossible in the past, such as a method for evaluating observed quantities through a sequential approach which analyzes each observation and its effect on previous observations. This system enables us to invoke more sophisticated statistical analysis of the data both in the office and the field."

Maine—wherever he had been for the past 17 years with the National Geodetic Survey.

Cotton Baugh—the computer—had finally joined the Maine party; and no one except Peter John could have received a more exultant welcome. His mission: to cut away at the seemingly endless mountain of paper work—the computations, typing lists, descriptions, summaries, observation reports—all of which are part of the checking and rechecking of records necessary for the success and accuracy of a geodetic field party.

Baugh joined the National Geodetic Survey as a builder, switched over to a light keeper and, finally, learned to record field observations. His next step was to learn to observe and, when this was done, he became the assistant computer, a position he held for five years on an NGS field party in Georgia.

"When the computer man dies off," Baugh once remarked, "you move up." The Maine party, however, did not have to wait for a funeral; it never had a computer.

Baugh, his wife Ermy, and their three children have moved some 50 times since he's been with NGS. They waited until school had closed for the summer; then drove their mobile home from Athens, Georgia, to a trailer park near Lewiston, Maine, which is about 12 miles from the NGS field office at Danville Junction. His oldest son, however, returned to Georgia this fall, since he has received a partial basketball scholarship to attend Piedmont College in Demorest.

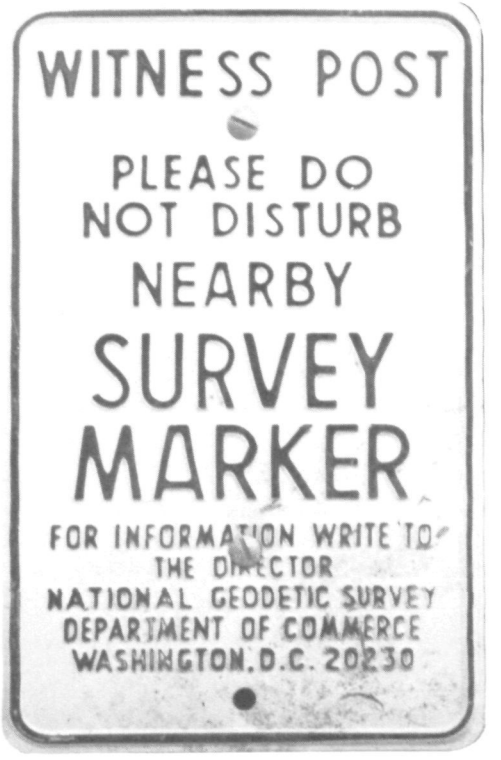
Before Baugh moved his family to Maine, he spent 4 weeks in Gallipolis, Ohio, learning to operate WYLBUR, a high-speed computer that transcribes field data and sends it to NGS headquarters in Rockville, Md, where it is stored in a host computer. When he returned to Danville Junction, WYLBUR was waiting.

Working with Baugh as his assistant is Greg Nelson, a highway surveyor from Gardiner, Maine. Familiar with all survey activities, Greg also has an aptitude for operating WYLBUR, which he admits is a challenge.

"The description of the field observations," said Greg, "are recorded on a cassette, transcribed to paper, checked, and then sent to the computer in Rockville, Maryland. It's there for your corrections, for you to work on and for you to change. Then, when it's ready for permanent storage in the computer file, you tell it to store it."

In late spring, the field party wound up its operations near Alfred and moved 30 miles north of Portland to Danville Junction on the Maine Turnpike. The weather changed for the better permitting an increase in electronic distance measuring (EDM) and theodolite observations.

Hired as a light keeper and builder on an NGS geodetic survey in New Mexico ten years ago, Nelson has since worked up and down the East Coast—from Maine to Florida. As chief NGS Observer, he helps train Maine personnel in theodolite observations and in the use of EDM equipment which includes laser and infra red measuring instruments. When wind, rain or fog makes observations impossible, he edits and corrects abstracts of field data and lists of directions, descriptions and cross references. But when weather permits, he's on



the tower taking observations for periods up to four hours or longer.

The Pike Hill Station building crew had already dug the foundations for the tower when L.M. Longley drive up on the ridge. Longley, who was the owner of the ridge, climbed out of his truck, quietly studied the builders for a while, and then looked at the grass growing around the tower site.

After a brief exchange of pleasantries with Oswald, Longley asked if he should have someone come up the ridge and cut the grass. Oswald said that it wasn't necessary, and the two chatted for several minutes until Longley had completed his appraisal of the construction team.

As he climbed back in his truck, Longley turned to Oswald and said, "It's going to be a hard winter—lots of pine cones and nuts on the trees." And with that he said goodbye and drove down the ridge toward the village where he and his sons owned the hardware store.

After the tower site was cleared of brush and the low-hanging branchs of nearby trees removed, a transit was set up and measurements made to find where the legs of the tower would be anchored. While the three leg men dug the anchor holes, the foreman and the takeoff man laid out the steel for the tower. Only after the base was set, the levels run to insure that the tower would be plumb, and the anchor holes filled would the building of the tower begin.

There are three legs in each tower and two towers, one inside the other. Between each leg is a tie; and all base sections have diagonal braces. On top of the tower, however, rods are used as diagonals. Using a winch attached to the rear wheel of the building truck, the foreman pulls the steel up the tower where the takeoff man unties the steel and hands it to the ladderleg man who lays it across the ties where it can be easily reached by the builders. When the three men have finished bolting their sections together, they move up the tower, repeating the routine as one, until the tower is completed.

The outer tower is finished first. Next, the last two sections of the inner tower are hoisted up and bolted on the top of the red or inner tower. To make sure that the top of the inner tower is centered on the mark, the Chief Builder sets up the collimator, an optical device that aligns the two points vertically. Adjustments are made at the top of the tower by the ladder leg man who checks and makes sure all bolts are tight. His final job is to check the ladder leg steps as he climbs down from the top of the tower.

On the ground, the builders begin shoveling sand into cloth sacks, weighing about 150 pounds each, which are placed at the base of each tower leg. In most cases, two-and-a-half tons of sand are used to secure each leg, but the amount will vary depending on how deep the anchor holes are.

"An experienced crew," said Slim Hughes, "can get up a tower in a day. Two can be torn down a day." Most of the Maine builders had been under the guidance of Hughes for at least six months.

Just before the building crew broke for lunch, a man driving a tractor with an attached grass cutter came up the ridge. Mr. Longely thought the grass should be cut.

Rick Lane, who holds a position equivalent to Lt. Oswald's, is the State coordinator for the NGS/Maine project. After doing route surveying for eight years he joined the party in August 1974 when it began in Fairfield. His official title is Chief of Party of the State of Maine Contingent.

Lane coordinates the specifics of the actual project and personnel interests with the Bureau of Highways, Maine Department of Transportation. His headquarters are in Augusta where he and his wife Elizabeth live.

During the spring and summer months, his unit drops to six members due to the demand for State highway construction personnel. In the fall and winter there are between 14 and 15 persons on the project.

"I have tried to let each man find his own position," said Lane. "John Higgins, Jerry Ellingwood and Phil Parent are observers; and Dennis Hoar is our building foreman and Chief EDM Observer.

"Our people can do most any job on the party, which distinguishes this cooperative project from the others. We are an integral part of the party, not a separate survey team."

The State of Maine finances the cooperative program through funds from the Federal Highway Administration. NOAA's National Geodetic Survey provides the expertise and equipment.

Lane says "it's a whole new field that I really didn't know much about . . . a one of a kind experience to work with and to be part of the National Geodetic Survey."

He paused a moment while the summer traffic buzzed north along the Maine Turnpike which was separated from the survey party's office trailers at Danville Junction by a horseshoe pit and a narrow row of trees.

"It grows on you," he said. □

Clockwise from top left: Cheryl Kuhl, Susan Anderson, Judy Yeager, Margi Barbee, and Norma Nygren.

The unusual lives of the NOAA Corps wives

Coping with the Corps

BY VALERIE ANDERSON

Photos By Libby Joy

"For my part, I travel not to go anywhere, but to go. I travel for travel's sake. The great affair is to move."

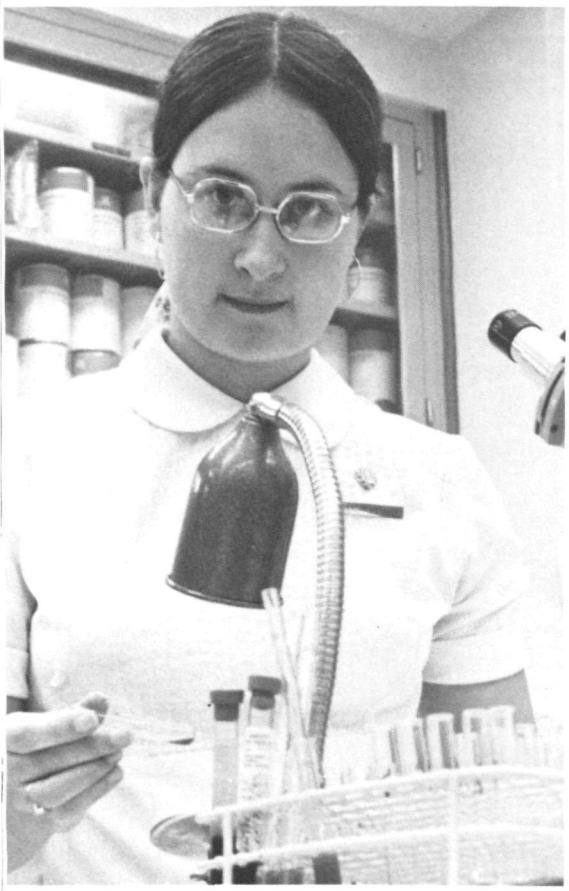
Robert Louis Stevenson expresses the feeling pervading the lives of many officers and families of NOAA's Commissioned Corps. In a 30-year career, NOAA Corps officers will spend about half their time in sea, mobile, or remote area duty, and may move more than 25 times. For the wives of these officers, this means either that their hubands are away at sea or that the whole family is traveling from place to place in a trailer with a field survey party.

The NOAA Corps is the Nation's seventh uniformed service. Its ranks and privileges patterned after those of the Navy, the NOAA Corps' men and women constitute a nucleus of officer-scientists for the Agency's broad spectrum of environmental assignments, from ship and aircraft commands, to leading survey teams in the field, to conducting research in NOAA laboratories. Obviously, it involves a great deal of motion.

But the wives of NOAA's officers enjoy the moving and say they wouldn't have it any other way. Commander J. Austin Yeager's wife, Judy, sums it up by saying "everytime we're reunited, it's like another honeymoon."

Norma Nygren, wife of NOAA Corps Director Rear Admiral Harley D. Nygren, says, "I grew up during World War II. That generation was accustomed to fathers, sons, and brothers being away for years at a time. When it comes to traveling with the NOAA Corps, it's child's play in comparison. I was a person used to not having my men around. This is much better . . . at least they're not getting shot at."

The traveling families of the NOAA Corps have obtained a knowledge of the United States and of living on the move that could not be matched. Margi Barbee, wife of Captain William Barbee, lived in a 30-foot trailer



Clockwise from above: Susan Anderson at work as a medical technician at Suburban Hospital in Bethesda, Md.; Margi Barbee keeps in shape with her daughter, Annie; Cheryl Kuhl takes a walk with her children; (from left) Margi Barbee, Sharon Genzlinger, Judy Yeager, Cheryl Kuhl (with child) and Norma Nygren get together to discuss their lives as NOAA Corps wives.

Photo: Harold M. Goodman, NOAA

Clockwise from top left: Margi and Annie involved in an intense game of cards; Judy Yeager displays the rug she made with the NOAA Corps emblem; one of the tasks the wives take over in the absence of their husbands; and Norma Nygren working in her garden.

for five years. In the first two, traveling every three months with two small children, she and her family moved from Washington, to California, to Oklahoma, back to California, to Seattle (while Captain Barbee went on assignment to Alaska), to Indiana, and then to Florida for the remaining three years.

In 1954, Mrs. Nygren lived in Albuquerque, N.Mex., with two small children and pregnant with a third while her husband traveled 25 thousand miles with a gravity party following the weather—going down south in winter and up north in summer.

Sharon Genzlinger, wife of Lt. Cdr. Lowell Ginzlinger, had a unique experience with traveling.

"We were married ten days," she recalls, "and suddenly had to go to Africa." She spent the first two years of her married life living in mud houses traveling around Africa. She bought her vegetables from natives on bicycles, and learned to communicate with sign language. With chicken wire for windows, the newlyweds slept under mosquito nets for two years.

"One of the problems with this arrangement was the washing of our clothes," she says. "We had a houseboy who would take our clothes to the river and beat them clean with rocks. As a result, our clothes didn't seem to last very long."

Mrs. Genzlinger looks back on the experience remembering the many people who had told her not to go. However, she does not regret it: "They told me it would be terrible . . . and it was," she says. "But I will never match the experience and it was worth it to be with my husband."

She feels that her generation is different from that of her parents who had grown up and lived in the same house for years. "We are a generation of moving people." she says. "In the Corps, you never stay in one place for more than three years and I think I would be bored if I had it any other way."

The wives agree that traveing has had a good effect on their children. Mrs. Nygren, the mother of four boys, says, "I think it makes them much more flexible. They learn to adapt to practically any situation almost immediately. Although they do lose some of the closeness of having a place to call home, they seem to become more restrained in behavior and easier to get along with."

Cheryl Kuhl, wife of Lieutenant (junior grade) Dennis M. Kuhl, is a young mother who is new to the Corps. She sometimes worries about not having a father image around for much of the first few years of her child's life. However, she is comforted by the success stories of many other mothers who have been with the Corps for years.

When the children grow older, a new set of problems arise. It is not unusual for children of the Corps to change schools five or six times a year.

Mrs. Nygren feels that her biggest problem has been raising boys in their teens.

"When their father was gone," she says, "they felt the restraints were removed and tried to see what they could get away with. However, they learned fast that Mom's the boss when Dad's away.

"Then when Dad would return," she admits, "you sometimes found yourself resenting the disruption to the schedule."

Mrs. Barbee agrees and feels it is important to keep up the family schedule.

"I always tried to cook a full meal every night and keep things going as usual when Dad was away. As a result, the kid's lives were not disrupted and they learned to deal with the division of authority."

While her husband was with a field party in Alaska, Mrs. Barbee recalls living in a trailer park and the effect on her children.

Living with the group, there were always all kinds of kids around—and no daddies. I think not seeing other Dad's at home every night made it easier on them."

Later, when one of her sons grew older and went to get a job, he was told that the company may want to move him about every five years. He reacted strongly by saying, "No way . . . I am going to stay put."

The wives agree that this kind of life is not for everyone. Sea duty for the husband is a recurring feature of a NOAA Corps wife's existence. The average officer will spend about nine years at sea during his career, which leaves the wife to cope alone with the normal crises of home and family.

As a result, these wives may be a special breed of people. They are unique because they learn how to adapt and handle any situation that may arise—"even if it includes fixing sewage lines," adds one wife. When the husband wasn't there to depend on, they learned to make the decisions.

Mrs. Nygren says on occasion she couldn't even call her husband. "There were times when I didn't even know where he was because it was all top secret. If an emergency did arise, I would call his office and in turn they would contact him."

The wives agree that it involves a lot of trust and respect on the part of the husband. Mrs. Nygren says, "He has to trust you to make all of the decisions when he is not around to help. You have to be self-sufficient and able to handle any situation."

Another breed of NOAA Corps wife is the career woman.

Susan Anderson, wife of Lieutenant Alan Anderson, maintains her own career while keeping up with her husband's. She was trained as a medical technician in South Dakota and has kept up her career wherever she and her husband have moved.

"I am the type of person that cannot sit back and just accept someone else's lifestyle," she says. "I need to keep my career to keep my sanity. I enjoy working and would not be happy at home. Fortunately, I have had no trouble transferring in my job."

She enjoys the advantages of traveling around the country and keeps her own lifestyle whether her husband is around or not.

She says that it is not an easy life and that she does get lonely. And, because of her job, she has not been able to become involved in the NOAA Corps Wives Club. But she has learned to live alone and is now beginning to enjoy being able to do what she wants.

"It is easy to give up when you're young and alone," she says. "But the other wives in the Corps have always been there when I needed them, even though I could not be a part of their group. They help you to rid yourself of a lot of tension and you can get

Sharon and Lt. Cdr. Lowell Genzlinger on their way to a NOAA affair.

a little sympathy and understanding from someone who is in the same boat you are."

The standard of living fluctuates for these traveling families depending on where they are at the time. Some of the wives think it is better to rent a furnished house. If they could not find one, they would but furniture and sell it when they moved again. They found this arrangement wasn't any more expensive than living in a furnished house.

Your furniture and belongings become a jumbled hodgepodge," says Mrs. Nygren, "as a result of living in several different places. But this adds variety."

The wives agree that their biggest moving problem is trying to match draperies and rugs with the house they are presently living in. Mrs. Yeager has accummulated shower curtains in six different colors.

The Barbee family found their solution to the moving problem. In 1964, they "traded" houses with another family. They were leaving Seattle to be stationed near NOAA Headquarters in Rockville, Md., and the other family was going to Seattle. She says, "It worked out great."

The wives also become involved in community activities. Many are active in Girl Scouts, Parent Teacher's Associations, church activities, and garden clubs. The Wives' Club in Seattle became involved in a guild that supports the Children's Orthopedic Hospital and Medical Center in that city.

The Washington, D.C., area Wives Club publishes a newsletter, the Right Angle, twice a year informing wives across the country about their travels and news about the Corps.

The social lives of most of the wives consist of NOAA Corps people. The small size of the Corps, and the singular quality of the life they share, have created a close-knit family feeling among its members. There is a removeable lack of rank consiousness.

As one wife put it: "You're never a stranger in any city. The NOAA Corps is so widespread that you rarely enter a new city without being greeted by someone you have already met or someone in the Corps."

Another summed it up another way: "The biggest advantage is that you never really say goodbye." □

SEAFARE

America's Seafood Heritage

This fall, health-conscious Americans, as well as dieters, will be serving fish and shellfish for stick-to-the-ribs family meals and after-game celebrations. They are nutritious, low in saturated fats, and high in protein. Try these treasured recipes that have become a part of America's heritage.

Creole Bouillabaisse

- 1 pound red drum fillets or other fish fillets, fresh or frozen
- 1 pound sea trout fillets or other fish fillets, fresh or frozen
- ½ pound raw, peeled, deveined shrimp, fresh or frozen
- 1 pint oysters, fresh or frozen
- 1 can (6½ ounces) crabmeat, drained and cartilage removed
- 2 tablespoons margarine or butter
- 2 tablespoons olive oil
- ¼ cup all-purpose flour
- 1 cup chopped onion
- ½ cup chopped celery
- 1 clove garlic, minced
- 5 cups water
- 1 can (1 pound) tomatoes, undrained, cut up
- ½ cup dry white wine
- 2 tablespoons chopped parsley
- 1 tablespoon lemon juice
- 1 bay leaf
- ½ teaspoon salt
- ¼ teaspoon saffron
- ¼ teaspoon cayenne pepper

Thaw fish and shellfish if frozen. Remove skin and bones from fish. Cut each fish into 6 or 8 portions. In a 4 to 5 quart Dutch oven, melt margarine. Add olive oil and blend in flour. Cook, stirring constantly, until light brown in color. Add onion, celery, and garlic. Cook, stirring constantly, until vegetables begin to brown. Gradually stir in water. Add tomatoes, wine, parsley, lemon juice, bay leaf, salt, saffron, cayenne pepper, and about ¼ of the fish. Bring to a boil and simmer for 20 minutes. Add remaining fish and cook 5 to 8 minutes longer. Add shrimp, oysters, and crabmeat. Cook another 3 to 5 minutes or until all the seafood is done. Makes 8 servings.

Crab Louis

1 pound Dungeness body crabmeat, or other crabmeat, fresh, frozen or pasteurized
½ pound Dungeness crab legs, or other crab legs, fresh, frozen or pasteurized
Salad greens
1½ quarts shredded salad greens
1 cup mayonnaise or salad dressing
¼ cup chili sauce
2 tablespoons finely chopped green pepper
2 tablespoons finely chopped onion
2 tablespoons finely chopped parsley
⅛ teaspoon cayenne pepper
¼ cup whipping cream, whipped
2 hard-cooked eggs, quartered
2 tomatoes, quartered
Ripe olives for garnish
Parsley sprigs for garnish
Lemon wedges for garnish

Thaw crabmeat if frozen. Drain crabmeat. Remove any remaining pieces of shell or cartilage. Line salad plates or bowls with salad greens; fill with shredded salad greens. Mound body crabmeat on lettuce. Combine mayonnaise, chili sauce, green pepper, onion, parsley and cayenne. Fold in whipped cream. Pour sauce over crabmeat. Garnish plates with crab legs, eggs, tomatoes, olives, parsley sprigs and lemon wedges. Makes 4 servings.

Winnibigoshish Walleye and Wild Rice

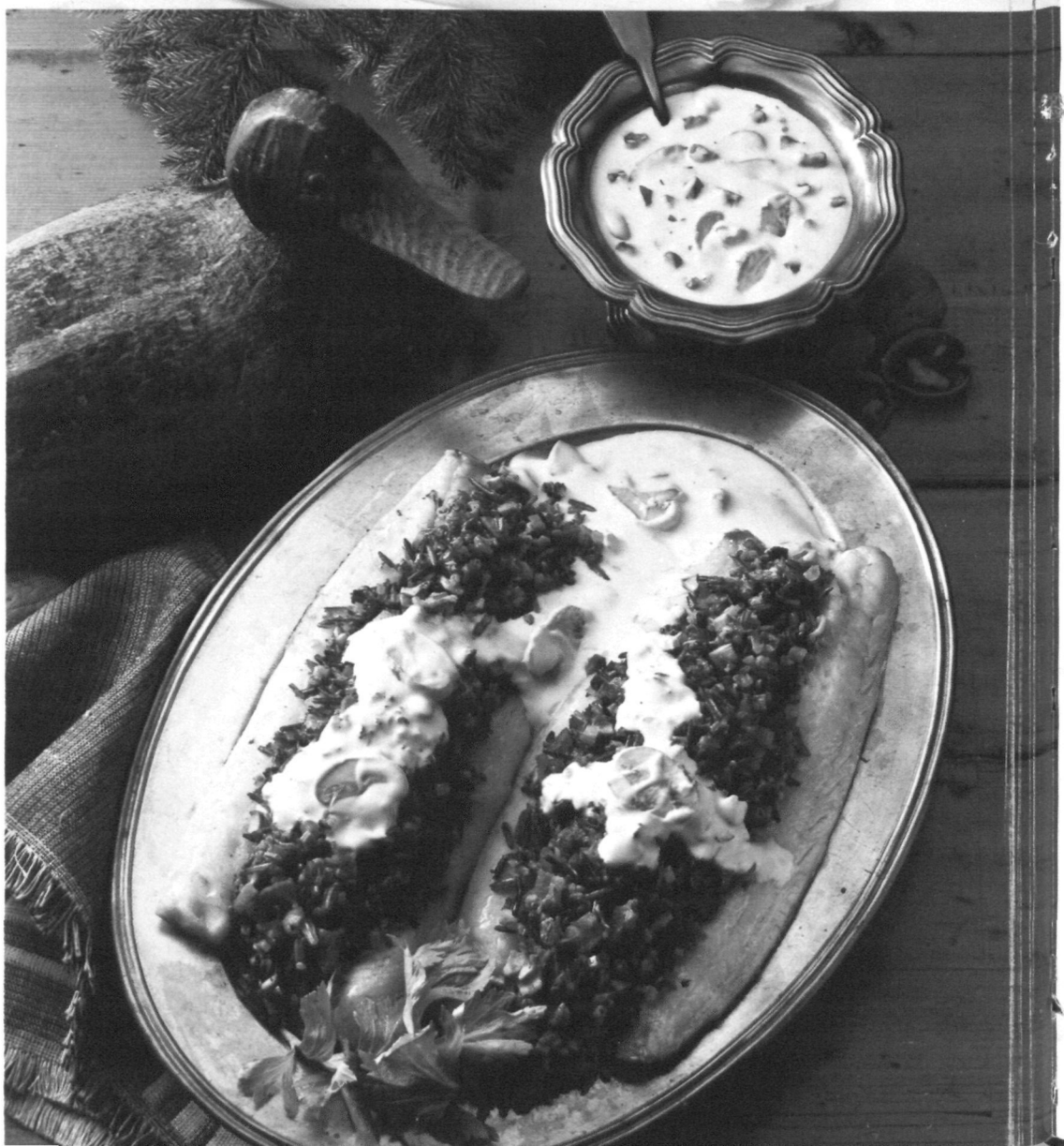
2 pounds walleye pike fillets or other fish fillets, fresh or frozen
1 teaspoon salt
¼ teaspoon pepper
3 slices bacon, diced
1 cup chopped fresh mushrooms (about ¼ pound)
¼ cup minced onion
¼ cup minced celery
2 cups cooked wild rice
½ teaspoon salt
2 tablespoons melted margarine or butter
Mushroom-Walnut Sauce

Thaw fillets if frozen. Cut fillets into serving-size portions. Season fillets with 1 teaspoon salt and ¼ teaspoon pepper. In a skillet, cook bacon until lightly browned. Add mushrooms, onion, and celery; cook until tender. Stir in cooked rice and salt. Place pike fillets in a well-greased baking pan. Place approximately ½ cup rice mixture on top of each fillet. Drizzle the 2 tablespoons melted margarine over rice. Cover. Bake in a moderate oven 350°F., for about 20 minutes or until fish flakes easily when tested with a fork. Serve with Mushroom-Walnut Sauce. Makes 6 servings.

Mushroom-Walnut Sauce

3 tablespoons margarine or butter
1 tablespoon minced onion
1 cup sliced mushrooms (about ¼ pound)
3 tablespoons flour
½ teaspoon dry mustard
½ teaspoon salt
¼ teaspoon thyme
2 cups half and half
¼ cup toasted walnuts

In a saucepan melt 3 tablespoons margarine. Add onion and mushrooms, and cook until tender. Stir in flour, mustard, salt, and thyme. Gradually stir in half and half. Cook over medium heat until thickened, stirring constantly. Stir in nuts. Serve sauce over fish and wild rice. Makes approximately 2½ cups sauce.



Svenskie Smelt Fry

20 medium smelt or other small fish, fresh or frozen (about 1 pound)
1 can (2 ounces) anchovy fillets
¼ teaspoon salt
⅛ teaspoon pepper
½ cup all purpose flour
3 tablespoons margarine or butter
3 tablespoons cooking oil
4 slices rye bread, crusts removed, toasted
Svenskie Sauce
Sliced tomatoes and cucumber (optional)
Lemon twists and dill sprigs for garnish

Thaw fish if frozen. Remove heads from fish, clean and bone. Drain anchovies, reserving oil for sauce. Cut anchovies in half lengthwise. Place one half anchovy inside each fish. Sprinkle fish with salt and pepper. Roll in flour. In large skillet heat margarine and cooking oil to a moderate temperature. Add fish and fry until crisp. Place 5 fish on each slice of rye toast. Spoon sauce over smelt. Serve with sliced tomatoes and cucumbers. Garnish with lemon twist and dill sprigs. Makes four servings.

Svenskie Sauce

Reserved anchovy oil
2 tablespoons minced onion
1½ tablespoons flour
½ teaspoon salt
1⅓ cups half and half
1 egg yolk, beaten
1 tablespoon lemon juice
1 tablespoon chopped fresh dill (or ½ teaspoon dried dillweed)

In a saucepan cook onion in anchovy oil until tender. Blend in flour and salt. Gradually stir in half and half. Cook until thickened, stirring constantly. Add a little of the hot sauce to the egg yolk; add to remaining sauce, stirring constantly. Heat until thickened. Add lemon juice and dill. Makes 1⅓ cups sauce.

Scallop Remoulade Appetizer

1½ pounds bay scallops or other scallops, fresh or frozen
1 cup water
½ cup dry white wine
2 slices onion
2 sprigs parsley
½ teaspoon salt
¼ teaspoon thyme
Shredded lettuce
Remoulade Sauce
Hard cooked eggs, optional

Thaw scallops if frozen. Remove any remaining pieces of shell. Rinse with cold water and drain. In saucepan combine water, wine, onion, parsley, salt, and thyme; bring to a boil. Place scallops in poaching liquid; cover and simmer 2 to 5 minutes or until tender. Drain scallops and chill. Arrange scallops on a bed of shredded lettuce in individual seafood shells or in cocktail glasses. Spoon about 3½ tablespoons Remoulade Sauce on top of each serving. Garnish with chopped hard cooked egg, if desired. Makes 6 servings.

Remoulade Sauce

¼ cup tarragon vinegar
2 tablespoons prepared brown mustard
1 tablespoon catsup
1½ teaspoons paprika
½ teaspoon salt
¼ teaspoon cayenne pepper
½ cup salad oil
¼ cup chopped celery
¼ cup chopped green onion
1 tablespoon chopped parsley

In small bowl combine vinegar, mustard, catsup, paprika, salt, and cayenne. Slowly add salad oil, beating constantly. (May also be done in a blender.) Stir in celery, green onion, and parsley. Allow to stand 3 or 4 hours to blend flavors. Makes 1¼ cups sauce.

Ceviche

1 pound sole or other skinned fresh fish fillets
½ cup olive oil
½ cup salad oil
¼ cup chopped fresh coriander leaves
or
2 teaspoons coriander seeds, cracked
2 cups minced onion
1 cup sliced pimiento-stuffed green olives
⅔ cup lime juice
3 garlic cloves, minced
3 bay leaves
2 hot mexican pickled jalapeno peppers, minced
or
½ teaspoon ground pepper
Shredded lettuce and chopped celery

Cut fish into bite-size pieces, about one inch square. Mix olive oil, salad oil, and fresh coriander. If using coriander seeds, cook and stir seeds in a little of the oil 2 to 3 minutes over low heat; add remaining oil. Combine oil mixture, onion, olives, lime juice, garlic, bay leaves, and peppers. Pour marinade over fish and chill, covered, for two days before serving. Serve fish on a bed of shredded lettuce and chopped celery. Makes 3-4 entree servings or 6-8 appetizer servings.
Note: The best place to find fresh coriander is in Mexican markets or as Chinese parsley in Chinese markets.

Sourdough Fried Fish With Blueberry Sauce

2 pounds Alaska pollock, true cod, sea bass, rock cod, lingcod or other thick fillets
1 teaspoon salt
¼ teaspoon pepper
½ cup flour
½ cup sour dough starter*
1 cup luke-warm water
1¼ cups all-purpose flour
¼ cup milk or cream
1 egg, beaten
1 tablespoon sugar
1 tablespoon vegetable oil
½ teaspoon baking soda
½ teaspoon salt
Fat for frying
Blueberry Sauce

Thaw fish if frozen. Cut into serving size portions and sprinkle with salt and pepper. Coat fish with flour. Mix starter, water and 1¼ cups flour. Cover and let stand overnight. When ready to use, stir in milk, egg, sugar, oil, soda and salt. Let bubble for 10 minutes. Dip fish in sourdough batter to coat. Fry in a large, deep skillet with fat approximately 2-inches deep, turning once to cook both sides until it is golden brown, and fish flakes easily when tested with a fork. Serve with Blueberry Sauce. Makes 6 servings.

**Sourdough Starter:*

In a large crock or mixing bowl, soften 1 package active dry yeast in 1 quart lukewarm water. Add 2 tablespoons sugar and 4 cups all-purpose flour; beat to mix. Cover and let rise. Let it stand several days to develop the slightly sour flavor desired. Then refrigerate it and keep for further use. As starter is used, add equal parts of water and flour to equal amount used. The starter will need additions of flour and water about once a week if not used.

Blueberry Sauce

2 cups blueberries
½ cup water
¼ to ⅓ cup sugar
2 inch stick cinnamon
2 tablespoons fresh lemon juice
1 teaspoon cornstarch
1 tablespoon water

In a saucepan combine blueberries, water, sugar, and cinnamon. Heat to simmering, stirring until sugar is dissolved; simmer 5 minutes. Stir in lemon juice. Blend cornstarch and water together. Add to sauce, stirring constantly. Heat to boiling, stirring constantly. Boil 2 minutes. Makes 1¾ cups sauce.

Potlatch Salmon

2 pounds salmon steaks or other fish steaks, fresh or frozen
1 tablespoon juniper berries
¼ cup salad oil
2 teaspoons salt
⅛ teaspoon pepper
Lemon or lime wedges for garnish
Mayonnaise for garnish

Thaw fish if frozen. Lightly crush juniper berries. Push 6 to 8 berries into each steak. Coat fish with oil to prevent sticking. Sprinkle fish with salt and pepper. Grill over hot coals 5 to 6 minutes on each side. Fish may be broiled or pan-fried for approximately the same length of time. Garnish with lemon wedges and mayonnaise. Makes 6 servings.

CLIMATE & HEALTH

Special Section

Climate and Government: A Fresh Look

Weather, Climate and You

Climate To Order

Dear Asheville/Asheville Answers

Sickness From The Sky?

Climate and Bill Hodge

Ambulance Weather

Brainstorming in North Carolina:

Climate and Government: A Fresh Look

The weather, which can cut down people by the thousands, commands universal awe. But Nature has a quieter way of killing and enfeebling millions, of others. It is called climate. Climate can be defined as the weather —with all its variations—over a long period of time, and when climatic extremes occur death, critical illness and misery bloom behind them, although the root cause is seldom listed on coroners' certificates. Even without weather pyrotechnics, millions live out shortened, invalid lives, their physical frailties unequal to the environments in which they find themselves.

Beyond that, mystery.

Is climate the villain in those sudden behavioral swings reflected in the random euphoria of an individual or the collective madness of rioters in the streets? Or in simple, day-to-day wellbeing or depression? Does climate relate to human health and happiness in ways more direct and significant than we know? No major attempt appears to have been made to find out.

All that may be changing. At NOAA's Environmental Data Service, there is a strong and growing conviction that the time has come to have at it. And so, in June, EDS sponsored a unique workshop in Environmental Protection Agency facilities at Research Triangle Park, North Carolina. Scientists, physicians, administrators, and others spent two days grappling with these things.

The group emerged with recommendations which might start to define—and perhaps change—the complexities that stand between man, his health and the climate. They were designed, first and perhaps most easily, to educate professional and public audiences with information and services available to them; then to satisfy the more immediate research needs; and finally to attack the longer-range issues.

Proposals ranged from multi-million-dollar relocations of weather stations to the simple, fascinating concept of making people themselves into mobile weather stations; from limiting football practice on high-pollution days to pushing the establishment into some kind of scientific uniformity in the matter of issuing air quality warnings.

Only a few of the ideas that bubbled up survived to become recommendations. The more questions asked, the more emerged. In the end, the questions covered much of the entire spectrum of climate-related health. They were addressed to many agencies, and few appeared susceptible to the easy answer.

Dr. Thomas Potter, Director of EDS' National Climatic Center, led the workshop. Sessions were divided into two subject areas: immediate and long-range. Dr. Paul Leaverton, Assistant Director for Research of the National Center for Health Statistics, headed the first group; Dr. Carl Shy, Institute for Environmental Sciences of the University of North Carolina, the second.

That mechanisms for getting climatic information to those who need it most are inadequate hardly needed to be said. It was quickly agreed that government is not communicating internally as much or as well as it should. The real scope of the problem became apparent after participants had the opportunity to compare notes on what climate is doing to people and how, if only the way were known, people might be helped.

The need for more public and professional education on climate-and-health relationships emerged quickly. It was agreed that NOAA should more actively inform the health community of the availability of climatic information with such aids as pamphlets, exhibits and the like; and that environmental physiologists, doctors and others should broadly assess the developing needs of the health community for knowledge in this sector. The group proposed establishment of a technical information minicenter, to be staffed by "translators"—individuals who can communicate clearly with doctors, meteorologists and statisticians. Such a center, it was believed, could develop the expertise necessary to build useful data banks, evaluate requests, and answer them quickly.

Story followed story of the potency of climate: of heat stress triggering existing illness to fatality; and of sharply rising deaths from cardiovascular disease on "snow days" and one or two days afterward. Frequently, climate and weather (and air quality) tended to become indistinguishable. The workshop soon fastened on temperature—and sometimes its *rate* of change rather than simply its change—as possibly enhancing the effects of pollutants on ill-health responses; promotion of precursor substances in the air and its undisputed direct effect on death statistics.

For many, climate means the effect of one's environment upon the particular infirmity with which one lives. William T. Hodge, Senior Scientist at the National Climatic Center, said that approximately 1300 requests for climatic information directly related to disease are received annually there. Arthritis and rheumatism lead the list, with 21 percent of all queries; asthma and emphysema follow, with 17 percent each; bronchitis furnishes 12 percent; heart trouble, 8 percent; allergies, sinus and "others" total 25 percent.

Hodge is concerned with the fact that too many patients and too few physicians query the Center. "Patients don't know how to get the right information," he said. "Doctors should do more of this."

Arthritics want climates with the least-severe pressure changes; bronchitis and emphysema victims want to be warm and dry; heart patients require climates where the summers are not too hot nor humid nor the winters too severe.

"A great number of people can move—but only once," he said. "It's essential that we guide them correctly the first time."

How to do this? A better grip is needed on time and space unit data needs, in Federal and State agencies, with special attention to the compatibility of data banks for specified geographical regions, updting standard climatic sources, and the mapping of appropriate variables, notably temperature, humidity and solar variation.

The group was unanimous that the capability should be developed to convert current data bases into formats the health community can really use, probably in terms of counties. Climatic stress data, it was stated, should be provided in combinations of temperatures and other elements directly relating to health—such as wind chill, discomfort index, temperature-humidity index, and equivalent temperatures—in terms doctors and laymen can easily apply to everyday life.

Getting the real picture of what the climate is doing to people is a major challenge. Dr. Inge Goldstein, of Columbia University School of Public Health, seeks the relationship between asthma attacks and air pollution and weather variables. She has found that autumn's first cold spell has a marked effect on emergency room visits, and one of her big problems is the fact that New York's weather data (and that in a great many cities) come from information gathered at city-edge airports. This, she argued, is no way to find out what's going on in the middle of town: "New

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York cannot be interpreted by prevailing wind data only."

Ideas proliferated: why not move the weather stations intown? (Somebody mentioned tax-dollar priorities and that one sank without a trace.) Why not put up scores of small stations in hospitals, perhaps Veterans Administration facilities? Dr. Benjamin G. Ferris Jr. of Harvard's Center for Environmental Health, mentioned walking weather stations—people equipped with dosimeters: the idea was received with considerable respect.

How much data is needed to establish what is happening to people who live in cities (as opposed to airports)? Dr. Meyer Katsper of Herner & Company, Washington, took the view that no overall data base is necessary: "you need pilot studies on a spot basis where specific questions arise. Airport readings have nothing to do with Bedford-Stuyvesant; you can find 10 degrees' difference in 100 feet. One big factor in illness," he said, "is rapid changes in temperature. You need to accommodate to this. If you get enormous computers, they must be fed. What you really need is crude, simple measurements over a 10-mile grid in the city. Sometimes precise data is a waste of time and money."

Finally, it was recommended that the relationship of airport weather data to urban localities should be evaluated and a statistical model devised; and that if the National Weather Service airport data does not represent urban areas, information is needed from within the heat island of the city. This, it was suggested, could be accomplished with one automated station per city. As to the relationship between people in their daily lives and data from NOAA weather stations, it was pro-

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posed that dosimeters be used to establish models and settle the question.

Dr. Bernard Brown, of the Health, Education and Welfare Department's Office of Child Development, urged a broad-brush approach to climate and health.

"Let's not think simply of mortality and morbidity," he said, "but of something doctors as a whole find it hard to addressthe well-being of people. If we knew as much about people as we do about pigs and chickens . . . emotional problems rise just as do physical problems in climate changes. Rising temperatures encourage riots. We should be able to help the service community as well as physicians. What about absenteeism? We know now that an approaching storm totally destroys classroom teaching, with low achievers and high achievers both hyperactive. Light can be used as a stimulant or a depressant in a school. Let's think of our constituents, especially children and the aged; let's avoid the narrow medical view and tackle the quality of life."

Brown's views were reflected in a workshop recommendation that quality-of-life factors be related to climate factors.

Zeroing in on specific ailments, the participants pointed to the need to relate climatic data to cardiovascular disease, asthma and other allergenic ills, musculoskeletal, respiratory, neurologic and psychiatric sickness.

In order of priority of climatic effects upon health, it was recommended:

—that mortality for cardiovascular disease be correlated with climatic factors, particularly heat stress, and that the effect of diuretics receive particular attention.

—That, in asthma and other allergenic diseases, climatological factors be separated from the effects of other environmental factors; that the rate of change of air temperature be studied in relation to asthmatic episodes; that the possible effect of cold fronts be disentangled from the effects of concurrent indoor pollutants (when heating units are turned on in the fall). It was asked whether a study of asthmatics in the tropics might be beneficial.

—That anecdotal studies relating arthritis and rheumatism to changes of pressure and temperature be quantified.

—That the so-called effect of cold temperature exposures on aggravation of chronic respiratory disease should be quantified and that the so-called beneficial effect of relocation to warmer, dryer climates should be evaluated.

—That feasibility studies are needed to determine how psychological responses, moods and emotions can be evaluated in relation to climatic variables. Looking farther ahead, the group recommended that NOAA assess the need for national advisory biometeorological bulletins; those now routinely used in West Germany by its national meteorological service were warmly praised as an example of making service relevant to life.

It was also suggested that the steering committee remain aware of continuing HUD efforts to study the effects of climatology on building standards and related health problems.

—That the effects of a controlled indoor environment on mood, work, school performance and absence be investigated.

And, it was stated—rather tartly—that "some appropriate body—e.g., EPA"—assess the medical and scientific basis for the uniformity of air quality warnings and indices across the Nation, a research program be established to insure a firm, uniform basis for such warnings, and release procedure be reviewed to insure that the warnings are timely and understandable.

It was recommended that government agencies and sources interested in the field be surveyed, toward better coordination.

Participants included Michael Garland, Bureau of the Census; Dr. Michael Hogan, National Institute of Environmental Health Sciences; Dr. Robert J.M. Horton, EPA; Ms. Joan Jordan, National Research Foundation; Dr. Wilson Riggan, EPA; Dr. Eugene Rogot, National Institute of Health; Dr. Richard Lehman, Dr. Jack Shuman and Laurence Truppi, all of NOAA. □

Do you feel the weather? More than you know.

Weather, Climate and You

BY H.E. LANDSBERG*

Are Mrs. Jones' aching, arthritic joints really beating the National Weather Service's computer forecasts? And what does Mr. Smith mean when he says he is "under the weather"? Is Bill O'Bryan making the right move, when he retires, to change his abode from Maine to Florida because "the climate is better"?

None of these questions has easy answers. All raise age-old scientific questions about how weather and climate affect human beings. The answers are being sought by the science of biometeorology. Workers in this field are trying to establish the interaction between two of the most complex systems on earth: the vagarious atmosphere and the mysterious functioning of living organisms.

The notion that human health and disease are closely linked with daily and seasonal weather probably predates written history. But it was nailed down in writing by the Greek physician Hippocrates (about 400 B. C.). In his book "On Airs, Waters and Places" he records different reactions of human beings to hot and cold winds. He also related epidemics to seasnal weather changes. Very little was added to Hippocrates' discerning observations for over two thousand years.

Careful scientific investigations have been made only over the past few decades. These have begun to unravel some intricate interactions. One of the great difficulties in these studies is the fact that no two human beings are exactly alike. We do not come uniformly and well calibrated from a factory. We have different genes, different statures, different states of nutrition. And above all we change with age. Quite in contrast, our information on the atmospheric environment is precise. Temperature, humidity, pressure, wind are all measured with precision and so are their changes from day to day or season to season. You can readily see that it first confuses and then exasperates the research worker in the field if, say, a sudden drop in temperature causes aches and pains in ten percent of a sample population, seems not to affect eighty percent at all, and exhilarates the other ten percent. However, the same people react almost invariably the same way to various weather stimuli.

None of us is immune to the atmospheric environment. Man is physically adapted to a narrow range of temperature. The "naked ape" is a creature of the intertropical regions. Our metabolic mechanism is in best harmony with air temperatures around 25°C (77°F). There is a limited range above and below this temperature where survival is possible. At lower temperatures greater muscular activity will raise metabolic heat. This can include involuntary shivering. At higher temperatures another mechanism can restore thermal equilibrium, and that is sweating. Evaporation of the sweat will use extra heat energy taken from the body. But this process will only work well when humidities are low. At high humidities the evaporative cooling will not work. Overheating occurs and heat stroke can result. Thus combinations of temperatures of 45°C (113°F) and 10% relative humidity; 35°C (95°F) and 40%; 30°C (86°F) and 60%; 27°C

Dr. Landsberg, former Director of the Environmental Data Service, is Professor Emeritus, Department of Meteorology, University of Maryland.

(81°F) and 100% define a danger limit. If exceeded, heat prostration, heat stroke, and heat death may occur. Infants, whose heat regulatory mechanism is not yet fully developed, and old people, with impaired circulatory system, are most likely to suffer.

On the cold end of the scale, wind becomes an important influence. It blows away a thin protective air layer near the skin. We try to keep this insulation intact by progressively thicker clothing as exposure to cold increases. Various combinations of air temperature and wind speed have been combined into a wind chill index, expressed in form of an equivalent temperature reflecting the cold sensation with calm air. Thus 10°C (50°F) and 4.5 meters per second (10 miles per hour) gives a wind chill equivalent of 4.5° (40°F) in calm air. Other combinations are: 0°C (32°F) and 8.9m sec^{-1} (20 mph) equivalent −14°C (7°F), −18°C (0°F) and 2.2m sec^{-1} (5 mph) equivalent −25.2°C (−13°F).

Between the dangerous limits of heat and wind chill, there are sensations of comfort and discomfort. These, again, are widely differentiated, often governed by the state of nutrition. Thus, obese persons suffer more from heat; malnourished individuals are very sensitive to cold.

Many of the weather-related ailments are transmitted via the skin. This integument separates the body from the external world. The skin senses and transmits to the body and the brain many of the changes taking place in the atmosphere. As long as the skin is unimpaired the system works well. But when the skin becomes scarred it may flash a pain signal. Temperature and moisture changes and possibly electrical conditions induce a tension between the healthy skin and the scar tissue. Deformed skin, such as corns, acts the same way.

Let's go back nearly a hundred years. It was the time after the Civil War. Many soldiers had suffered grievous wounds and amputations. They felt the weather changes. The first systematic study of these pains—often called phantom pains, because the brain imagined they came from the missing limb—was undertaken by S. Weir Mitchell, M. D., a distinguished Philadelphia physician, a member of the National Academy of Sciences. He wrote in the April 1877 issue of the prestigious American Journal of Medical Sciences an article: "The Relations of Pain to Weather, being a study of the natural history of a case of Traumatic Neuralgia." In this paper he related the case of Union Captain Catlin, whose foot was smashed in August 1864 by an artillery projectile. His leg was amputated below the knee and he made a rapid recovery—except for neuralgic pains. Catlin kept a detailed diary of onset and duration of his pains. Dr. Mitchell interpreted these pains in terms of the coincident weather conditions. He reached the conclusion that an approaching storm with the following combination of conditions: falling barometric pressure, rising temperature and humidity, followed by rain, was most frequently giving his patient pains. It was an astute deduction—unfortunately only too accurate for the many who followed Captain Catlin as victims of hostilities.

Enter now Claus Thurkow, a German soldier who lost his right arm in 1945 at the end of World War II because of multiple shrapnel wounds and Otto Hoflich, a Ph.D. candidate in meteorology at the University of Hamburg. The scenario is the same in this case: Thurkow kept records of his pains for five years and Hoflich looked at the meteorology. Unlike Mitchell a century ago, Hoflich had access to a computer and used sophisticated statistical methods to correlate the pain intervals with the meteorological conditions. The end result, now established beyond reasonable doubt by tests of significance, is almost identical to Mitchell's discerning analysis: falling pressure, reaching a minimum in 24 hours, and high probability of rain—the typical symptoms of a warm front—caused pain. But there were also pain reactions with cold fronts, shower rains, and [clearly moist adiabatic] vertical temperature structure, as well as possible relations to atmospheric electric phenomena.

Very similar meteorological conditions, which have been termed *biotropic*, affect the arthritics, an experience which has found folklore expression in the old English ditty:

"Hark how the chairs and tables crack,
Old Betty's bones are on the rack."

This is a clear allusion to humidity changes. But according to all observations rising humidities alone are not enough, the pressure has

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to fall too. In fact, this has been verified objectively by Dr. J. L. Hollander of the graduate Hospital of the University of Pennsylvania. He placed some arthritic volunteers in a completely controllable chamber. It was an isolated hospital room in which most atmospheric parameters could be changed at will. Changes simulating the passage of high and low pressure systems were induced in the room, where the patients were on a regular hospital routine. Lo, and behold, when pressure falls and humidity increases were programmed for the chamber, the patients noted pains. Even more convincing were the objective findings of coincident swollen joints. Yet we still don't know the precise mechanism whereby these atmospheric changes penetrate the body. Could it be that the membranes in a joint act like an aneroid barometer and exercise a pressure on fluids in the bursa, causing the pain?

The classical case of a disease allegedly related to weather is the common cold. Is it really a meteorotropic (i.e., weather-caused) ill? There is no easy answer. It is a virus-caused disease, with the virus spreading from person to person. Obviously enough, the virus does not survive in extreme cold. There are no colds in the isolation of the polar night. Colds are only imported there by visitors. But elsewhere in the moderate latitudes colds have a pronounced frequency peak in winter. That is the time people are confined indoors; schools are in session and the virus spreads epidemically. That makes it very difficult to discern the weather factor, if any, in the incidence of cold.

There have been experiments, albeit on very limited numbers of persons, where people were exposed to both cold and virus, while control subjects had only virus exposure. The number of those coming down with the miserable sniffles in both groups showed no significant difference. Also, there are no reliable statistics on daily numbers of individuals showing first cold symptoms, as are available for reportable diseases. Thus, all statistics are case information from clinics or individual physicians. Often in the analysis of such data use has been made of only the readily available meteorological observations, such as maximum and minimum temperature. These are decidedly inadequate. Also, the modern multiple correlation screening techniques have not been used on adequately large samples. However, a review of bulk information on cold incidence seems to point definitely toward the wind chill factor as a contributing weather element. Perhaps further work will yet verify another Granny tale.

With regard to the cold and other virus diseases, we know very little about virus transport by atmospheric currents and their survival times in relation to weather. In this respect we are much better informed about airborne allergens. The best known of these are various plant pollen. Turbulent winds carry these. On sunny days during the warm season the atmosphere is thermally unstable.

National Library of Medicine

National Library of Medicine

Strong vertical currents are common. These often exceed the fall velocity of pollen. Hence the pollen stay afloat and may be carried long distances. Those sensitive to them will get their so-called hay fever miseries or even asthmatic attacks.

More insidious even than pollen are spores of fungi. These are generally smaller than the pollen. They will, therefore, travel greater distances, sometimes 2,000 km (1250 mi.). Heavy wind storms may stir some of these fungi out of the ground and carry them along. One such fungus, which resides in both tame and wild bird excrement, causes histoplasmosis, a lung disease, often mimicking pulmonary tuberculosis.

The same atmosphere which stirs up these organic irritants also eliminates them. Washout by rain cleanses these as well as man-made pollutants out of the atmosphere. The more frequently it rains, the cleaner the air. In our regions, airborne dust generally stays airborne less than five days in the lower air layers.

Our changing weather, so welcome in many respects, also plays a definite role in affecting physiological and pathological conditions. Rapid changes seem to initiate responses in the body. These phenomena have been analyzed by classifying them according to weather phases. These follow the common sequences of weather in the realm of the westerlies. All told, six phases represent fairly well the complex totality of weather. Starting with cool, high pressure, with a few clouds and moderate winds (1); followed by perfectly clear, dry, high pressure and little wind (2); we get into considerable warming, steady or slightly falling pressure, some high clouds (3); then warm, moist air gets into the lower layers, pressure falls, clouds thicken, precipitation is common, winds pick up (4); then an abrupt change takes place, showery precipitation is accompanied by cold, gusty winds and rapidly rising pressure and falling humidity (5); finally with further rising pressure and diminishing clouds, temperatures reach low levels and humidities also drop (6).

Of course, these phases are not equally long either in one sequence or in the course of the year. In winter all of these phases may follow each other in less than three days. Some phases may be so short that it looks as if they had been omitted but they are usually there, even if in vestigial form. In summer it may take two weeks for a weather sequence to pass.

These weather phases have been very successfully correlated with the joys and tragedies of human life. In order to do that one has to rely essentially on hospital records. There everything is charted hour by hour and some of the weather phases may last only a few hours. But the reward of using this or a similar categorization of weather in human biometeorology is great.

You need little imagination to speculate that the quiescent weather phases 1 and 2, the "beautiful weather," stimulate the body very little. They generally make few demands on us and most of these can be met by proper clothing and adequate housing. Quite in contrast, weather phases 4 and 5 are often turbulent and violent. Somehow or other, they stir us up. Let's look at some of the statistics. You probably wouldn't believe that the precise date and hour of your birth was determined by the weather. The end of human pregnancy is uncertain by about plus or minus 10 days of the anticipated birth date. If we distribute the

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large numbers of cases of births among the weather phases it shows that in far more cases than statistical accident would permit, labor starts in days with weather phase 3, often followed by birth in phase 4.

These same phases seem to follow us toward the termination of life. Coronary thrombosis, the so-called heart attack, also shows a peak in weather phases 3 and 4. It shows a minimum in phases 1 and 6. Bleeding ulcers show their ugly tendency in phase 4. So do migraine attacks. Spasmodic diseases seem to be more prevalent in phases 4 to 6 than during the other weather conditions.

Weather does not only affect health and disease, birth and death, it rules our moods and behavior. This is generally, far more difficult to establish than precise events, such as birth and death. Unfortunately, moods sometimes lead to the latter event: suicide. Here again, weather phase 3 shows a clear jump in number over the others. It also leads in cases of behavior problems among school-children, according to a few available statistics. Comfort and discomfort, play a role here. When it is hot and sticky children do not learn well. This has been conclusively shown by comparison between air conditioned and non-air conditioned classrooms. Uncomfortable atmospheric conditions also are more conducive to riots than comfortable weather.

It remains to take a look at indirect effects of weather on human health. These operate primarily through weather effects on disease vectors. Some of these, for example the mosquito, can only survive where temperatures are sufficiently high and standing water (i.e., sufficient rainfall) permit them to go through their life cycle. Thus we have a distinct malaria climate where the mosquito species carrying and transmitting the disease can survive. Unfortunately this climate prevails over large areas of the tropics and subtropics, so that the disease remains an endemic scourge and the world's greatest public health menace. Other disease-carrying parasites have their own environmental needs and if their temperatures, humidity, and water needs are met they multiply rapidly and remain a scourge.

Sometimes more than one vector is involved. A good case is bubonic plague. The flea that carries the disease to man starts its life cycle on a rat. During the ill-fated campaign in Vietnam it was noted that after a prolonged dry spell there were more plague carriers and more plague cases. In contrast, after heavy rains, with some lag, the number of carriers and cases dropped markedly. It didn't take a Sherlock Holmes to figure out the answer. The rats lived along the rivers, especially the Mekong. After the rains the river rose and drowned them. When it was dry they established new colonies near the food-carrying artery.

It is clearly impossible to give more than a few examples of how the weather affects our bodies. We must also admit that only in a few instances have we unravelled the complete chain of events. Statistical correlations tell us nothing about causal linkages. They only alert us to the possible existence of a relationship that suggests cause and effect. Much painstaking research needs yet to be done to make the information useful for maintenance of health and for management of disease.

In this latter area lies a complex of questions which needs urgent exploration: the relation of weather to the effects of drugs. We live in an age of pill-popping and some evidence suggests that the same dosage will have greater or lesser effects on the ailment the drug is to control on one day than the next. Most of these drugs are taken for chronic diseases, with patients administering the drugs themselves. They only see their physicians infrequently so that no consistent information on drug action is available. In some drugs, weather-steered responses have been reported but we know very little which diseases and which remedies are affected. That's a real gap in knowledge.

More sensitivity to health-related information by those who issue forecasts is also something to be desired in the future. These forecasts, rightly so, include warnings against severe storms nd floods. In some localities air pollution alerts are issued when necessary. But would it not be desirable to give predictions of chill factors in winter or humithermal conditions in summer?

Weather-sensitive persons can also contribute to the clarification of the many puzzles alluded to above. They may also learn how better to cope with the atmospheric steering of their symptoms. And all of us will have to reckon with the fact that the atmospheric environment plays a major role in our "pursuit of happiness." □

Photo: EPA Documerica

From NCC

Climate To Order

I met a Californian who would
Talk California—a state so blessed,
He said, in climate, none had ever died there
A natural death

New Hampshire
Robert Frost

Frost's Californian always brings a smile and only a niggling pettifogger would gainsay his chauvinism by going to the records for the state's annual rainfall, average temperature, percentage of days with sunshine—or the mortality rate.

The records *are* available, however, and thousands of serious seekers of climatological information (as well as, perhaps, a few who may want to put down braggards) each year avail themselves of the services of NOAA's National Climatic Center, the largest facility of its type in the world.

The NCC, located at Asheville in western North Carolina, is a central source of historical weather information and related products for researchers in the atmospheric sciences, for aviation and agricultural interests, for construction engineers and city planners, for those about to start a business and those about to retire, for those who need to know about specific weather events in the past, for researchers in the atmospheric sciences, indeed for all for whom a picture of weather-past may indicate weather-future.

To appreciate the NCC's importance to climatological studies ranging from the fluctuating worldwide climate to the daily average high temperature at Daytona Beach, Florida, last year, one must consider the rather brief but burgeoning history of climatology in this country.

Before World War II (1941–1945), climatology was a function of the Nation's weather services. Sporadic attempts at systematic weather records date back to Pilgrim days when the Rev. John Campanius (also known as John Campanius Holm) made observations (without the use of instruments) in 1644 and 1645 near the present site of Wilm-

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ington, Delaware. In Colonial times such notables as Washington, Franklin, and Jefferson took a more-than-casual interest in the weather, but it was not until the late 1800's that official cognizance was taken of the need for a systemized, nationwide climatology of the United States. In 1890 the U.S. Weather Bureau was created as an agency of the Department of Agriculture and charged with ". . . the taking of such meteorological observations as may be necessary to establish and record the climatic conditions of the United States . . ."

The new Weather Bureau inherited about 180 weather stations from the Army Signal Service (which carried out the government's weather programs before 1890). The Bureau also received weather data for climatological purposes from about 2,000 public-spirited citizens who volunteered to operate cooperative stations.

(Today meteorological data for the U.S. comes from over 12,000 voluntary observers, about 300 National Weather Service facilities, numerous military installations, Federal Aviation Administration stations and others; additional data comes from environmental satellites, ships and buoys, automatic observing stations on land and at sea, and from foreign nations. The Environmental Data Service estimates more than 40 million observations are made throughout the world every year.)

It is difficult to imagine how these records could have been maintained in a useful form down through the years—literally tons of paper annually containing raw data, and still more paper as the data was edited, analyzed, and published. An early solution to the problem of the sheer bulk of the records being accumulated came with the birth of the punched card method of data processing and its application to climatological data in the 1930's.

The urgency of military demands during World War II lent impetus to the modernization of climatological data processing techniques. Standard methods of observing and recording weather elements by the civil and military meteorological services were devised. Machine processing of data was adapted in all phases of climatology. The collection and storage of weather records was centralized where possible. The value of the global procurement of weather data was realized.

The National Weather Records Center (NWRC) was established at Aheville, N.C., in 1951. In the early 1960's three other weather data processing facilities were consolidated at NWRC as the advent of larger and more powerful computers enabled the quality control, summarization, and publication of climatological data to be accomplished more economically and efficiently at a single location. In 1965 the Environmental Data Service was formed, taking over many of the climatological functions of the Weather Bureau. The North Carolina facility's name was changed to the National Climatic Center in 1970.

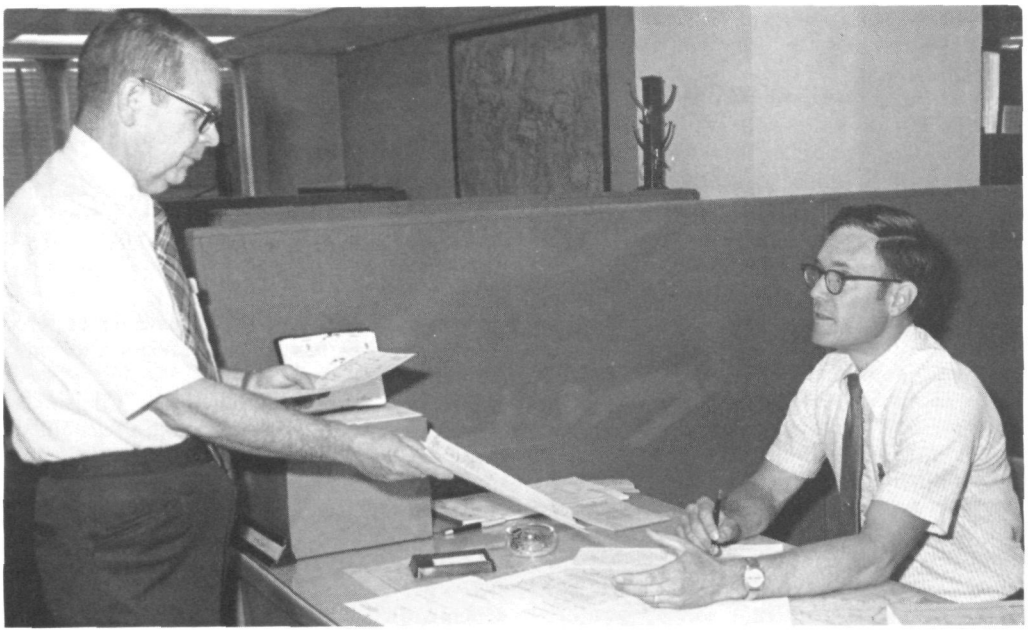
Photos: Bob Williams, NOAA

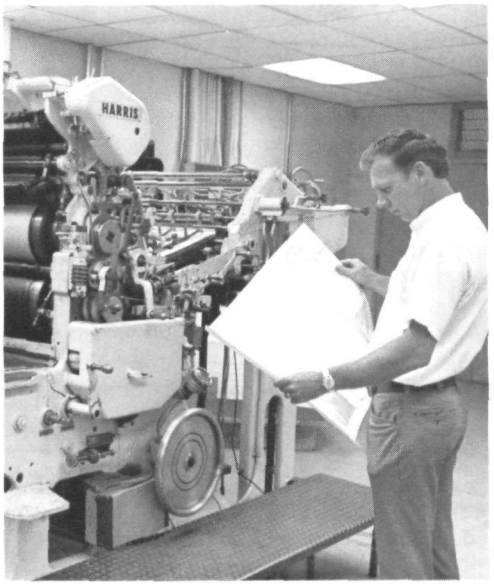
Automation is the watchword at the National Climatic Center where the amount and complexity of data reaches staggering proportions. At top are views of the Center's Data Entry and Data Digitizing Sections. Above, Jim Pressley and Virginia Dockery at a microfilm camera which can photograph both sides of a document as fast as the operator can feed it.

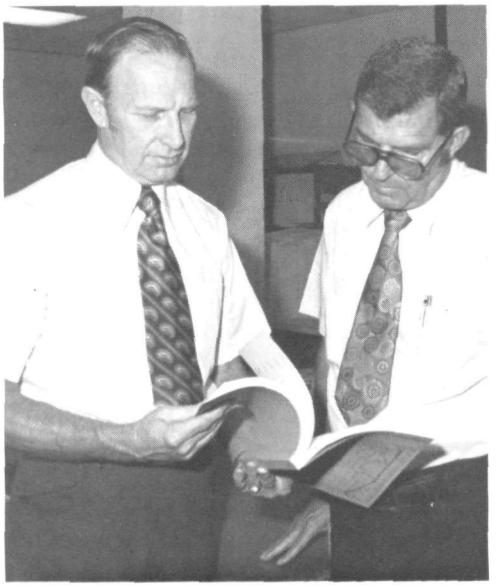
At NCC it all comes together—log sheets, recorder charts, radar photographs, satellite readouts—all mailed in for processing, checking, publication, and archiving.

Data is received by mail and, whether in manuscript form, on punched paper tape r on non-standard magnetic tape, is converted to industry compatible magnetic tape. It is then subjected to computer edit procedures which produce printer listings of suspect values—values that fall outside pre-determined tolerance limits. These error listings are reviewed by meteorological technicians with corrections made as appropriate to both the taped data and the manuscript records. When the data is determined to be as error free as possible, the tapes are used to provide their contents a computer-output-to-microfilm device that produces a properly formatted microfilm image containing the required data, headings, column lines and other material. The microfilm frames are then enlarged to page size negatives for printing by photo-offset methods (in much the same way as this magazine). More than 30 million pages of weather data bulletins are printed each year.

Manuscript records are then filed in the archives and the monthly data tapes are retained and merged on an annual cycle in serial format by station for storage in the center's tape library which now contains about 35,000 reels of tape.







Answering requests for data from NCC (top) are Ralph Woodiwiss, Chief of the Climatological Services Section and meteorologist Alva L. Wallis. In the Center's modern printing shop (above) Jim Clark examines a proof and Chris Harrison, Chief of the Printing Section and Thomas A. Modgling, Chief of the Technical Services Branch, inspect a newly printed publication.

Data formerly contained on over one-half billion punched cards is now available on magnetic tape. Although a small volume of punched cards are still received at the NCC each year from foreign meteorological services as part of exchange programs, the trend is to a much higher data compaction medium such as magnetic tape.

Data collected by satellites—both film and magnetic tape—have added greatly to the volume of environmental data reaching NCC for archiving. And this volume is still increasing as more satellites are being flown. A special unit, the Satellite Data Services Branch, has been established to devote full attention to managing this ever growing data collective.

The NCC estimates that nearly half its total effort—beyond gathering, processing, and archiving data—is spent responding to requests from researchers, industry, commerce, and others. These requests come in by telephone, mail, and sometimes are presented during a personal visit.

Often the request can be answered by providing a publication containing the needed data. A great deal of climatological data is published routinely. For example, perhaps the most widely known and used climatological publications of the Environmental Data Service are *Local Climatological Data*, *Climatological Data*, and *Climatological Data, National Summary*. (Contents described elsewhere in this section.) The information in these three publications answers, perhaps, 40 percent of the questions received at the NCC each year. Many other requests can be satisfied from the files of microfilmed records. A paper copy of a particular frame containing the information can be produced very simply with the aid of a reader-printer device. If necessary the entire reel of microfilm can be reproduced.

A smaller, but proportionally more difficult task performed at the Center is data tabulation. Special "hand" and machine tabulations often are necessary to bridge the gap between published data and original observations. That is, the data may be available in one form or another, but the requester requires special assistance in gathering it into a useful form for a particular need. Agricultural interests might need special data tabulations to determine various aspects of drought, evaporation, freeze data, and wind speeds. Those involved in air pollution studies frequently need special tabulations on inversions, lapse rates, mixing depths, etc.

While data tabulations and summaries are furnished at cost to anyone requesting them and the NCC will assist the requester in determining his data requirements, the Center is careful to avoid infringement in areas where a private (non-government) meteorological consultant might best provide assistance in interpreting the climatological information and applying the information to a specific problem.

And finally, the National Climatic Center carries out involved climatological investigations of major scope. These investigations require tabulations and summarizations of climatological data, but they go further. Interpretations of the results are applied to specific problems presented by NOAA components and other Federal agencies. Included in this category are studies for the FAA on high-altitude environmental conditions which might affect supersonic aircraft; wind speed and shear studies for NASA for planning where a rocket might be deflected from its planned path as it rises through the atmosphere, and methods for evaluating air pollution potentials for the Environmental Protection Agency.

And so the National Climatic Center is not merely a vast repository of meteorological records. Indeed, there *are* thousands of feet of shelf length at the Center holding the original manuscript observational forms and autographic traces created at Government (Weather Service and military) weather stations and cooperative observers since the systematic collection of meteorological data began—literally trillions of meteorological measurements.

What the NCC takes in, it also distributes—in the form of a million copies of monthly and annual climatological publications annually to regular subscribers alone, and answers to more than 50,00 additional data or information each year. □

Dear Asheville...

Here is a collection of letter fragments culled from the National Climatic Center's mail over a number of years. Some were in childish scrawl and some came in on impressive letterhead stationery. Some are merely amusing and others so serious as to deal with success or failure in a business venture. Still others—perhaps the most difficult to answer—are from those whose health is affected by their climatological surroundings. All received a thoughtful reply. These requests for climatological information to be used in all parts of the Nation in a wide variety of applications are NCC's *raison d'etre.*

I am very interested in obtaining literature concerning weather data of certain regions in the United States. The company I am associated with deals in air conditioning design of commercial buildings, hospitals, apartment complexes, etc. . . .

As part of the material needed for my Ph.D. dissertation concerning the longitudinal growth of normal children, I need temperature and rainfall records. . . .

We are considering the possibility of growing a tropical crop on a large scale in an area having certain rather specific climatological requirements. . . .

We are developing a new series of chemical deicers. . . .

I am investigating a blast incident in the City of Pittsburgh where-in an overpressure occurred which may have been recorded in the Airport recording barometer. . . .

We are presently involved in the planning and construction of a large scale indoor year-round garden area. The plant materials to be used in this interior area will be native to the regions around Miami, Florida, and Azusa, California. Information specifically related to mean seasonal temperature and relative humidity in these regions is particularly important in planning this project. . . .

In connection with the investigation of accident cases involving postal vehicles and privately owned vehicles, I have found that the use of Local Climatological Data charts has proven of great value in resolving weather conditions at the time of the accidents. . . .

This company is at present investigating the circumstances surrounding the loss by decomposition of a shipment of dried fish while in ocean transit. . . .

We have a production facility where we build and store television and stereo units. We are in the process of a study related to humidity and precipitation. . . .

We need some weather data to aid us in documenting the Breton Island oil spill for the FWPCA. . . .

I am trying to determine the cause for what I believe to be, a photo-sensitivity reaction to a particular drug being used by several of my patients. . . .

I am very much interested in the rainstorm of September 18. We know that it takes an intensity of at least one inch per hour to close our Eighth Street underpass and all three underpasses that furnish access between our business district and the residential district were closed. . . .

We are beginning a study of weather conditions and sea states in several offshore areas of the world where we may be conducting geophysical surveys and drilling for petroleum in the future. . . .

As part of a study of windshield wiper performance on passenger cars, precipitation information is needed. . . .

We have been retained by the Louisiana Department of Highways to make a feasibility study of long span bridges across the Mississippi River in the New Orleans area. Included in the Study will be a review of maximum recorded wind velocities. . . .

On July 14, 1970, between 3:00 PM and 9:00 PM, severe storm conditions occurred, which caused considerable damage to a high voltage transmission line. As consultants to the owner of this power facility, we are interested in obtaining as much weather data as possible in order to complete an analysis of the structure failures. . . .

This firm was recently awarded a government contract calling for equipment design and installation at Safeguard missile sites. . . .

I am in the process of designing my home and I'm specifically interested in the feasibility of harnessing the wind currents to pump water from a deep well, 120 feet, into a large holding tank. . . .

I would like to know if you know if there was any snow on the Pilgrims' first Thanksgiving. . . .

We are attempting to correlate annual and

Asheville Answers

It *sounds* logical!

If the weather or climate of one place seems to affect your health, simply move to another where conditions are less aggravating.

Emphysema and bronchial asthma sufferers might try the pure air and low humidity of the eastern slopes of the Rockies. For a child with rheumatic fever, the best climate might be the calm, warm portions of Arizona, California, or New Mexico. Elderly people with problems such as hardened arteries, diabetes, or cronic nephritis would surely benefit from the warmth and slow pace of a southern clime. And hay fever sufferers need only find out to which pollen they are sensitive and find a region where the plant doesn't grow.

Yes, it sounds logical. But what of the person who moves to the desert southwest because of its low humidity, only to find that the dust aggravates his condition badly as the humidity of his former home? And how about the family that spends a goodly portion of its life savings to leave the smoggy inversions of Los Angeles and discover that the clean, but cold and dry, air of the mountains bring on unexpected nose and throat irritations?

Is there an ideal climate, medically speaking? And if you—and your doctor—are relatively certain that your ailment is climate-related and that a change would be for the best, where in the 3.6 million square miles that is the United States does one begin to look for that perfect combination of conditions?

Here's how NOAA's National Climatic Center answers many requests received each year from people who are planning to move to another area and ask for climatic information:

"Obviously, one way to learn about the climate in a particular area is to spend some time in the area. Ideally, such visits should be made at different times of the year to ensure exposure to the entire range of weather conditions common to that locality. Another way of obtaining information about the climate of an area is to secure publications or other material prepared by NOAA which contain summaries of weather elements over a period of years. This information is available in a variety of forms, for both individual stations and groups of stations within the United States and worldwide.

"In seeking an 'ideal' climate, people frequently ask whether a move to a different area would be beneficial to their health. Although there is some evidence to support the idea that weather conditions influence human diseases, the effects of daily weather changes on the physiology and pathology of man are extremely difficult to ascertain. Some reasons for this are: (1) specific weather conditions do not affect every individual to the same degree, (2) all factors related to illnesses are not equal, and (3) weather observations taken at a single location do not precisely describe the actual atmospheric conditions at

monthly precipitation variations with changes in abundance of certain fish species along the Massachusetts coast. . . .

We are planning to shoot a motion picture in various areas of California. Weather conditions are most important to us. . . .

We are conducting a study to determine the feasibility of installing a winter ski facility in conjunction with our theme park. . . .

We are trying to find out the average, year-round difference in temperature between two cities. This is an important factor in our business for determining the amount of swelling and shrinkage of gasoline which takes place between the point of origin and its destination. . . .

We are conducting a nationwide vehicular accident investigation to determine the relationship of vehicle performance to occupant injury. . . .

I am conducting a study on the relationship of the occurrence and numbers of certain species of breeding birds in relation to precipitation and habitat conditions in prairie areas. . . .

As adjusters for the Underwriters at Lloyd's, London, we were assigned the investigation of a claim arising out of the death of a thoroughbred mare which is believed to have been caused by lightning. . . .

I am anxious to check on the accuracy of the recorded average speed of a group of homing pigeons. I wonder whether it would be possible to find out the wind speed and direction between dawn and dusk between the surface and, say, 2,000 feet above ground along the route. . . .

We are conducting experiments on the control of blackbirds using wetting agents on large concentrations in bird roosts. . . .

In connection with desert cricket migration studies, we are in need of climatological data. . . .

I would like to correlate winter cowbird movements with snowfall amounts for the period 1960–1970. . . .

This information is required for sizing of big compressors at the Rockaway Water Pollution Control Plant. . . .

We make a device that goes in a swimming pool during the winter to prevent damage to the pool. . . .

My brother disappeared while flying a helicopter. While it was indicated that he may have run into adverse weather conditions I haven't been able to gather sufficient weather information to help with my investigation towards organizing a search for the crash site. . . .

Some of our commercial fishermen are requesting data on the direction and velocity of winds off the shores of New Jersey and Delaware. . . .

We are currently involved in a lawsuit which was precipitated by a tent erected by our insured blowing down in the midst of a revival service. . . .

We are trying to tie up the quality of potatoes with the climate in which they are grown, a topic which has not had very much attention. . . .

I am investigating the feasibility of a floating runway. . . .

We rent Fiberglass portable toilets to contractors and are concerned about the chemical-water solution freezing during the months with periods of sub-freezing temperatures. . . .

Our international marketing activities are currently being expanded and intensified. A very important part of this activity is determination of geographic areas suitable for vertical take-off and landing by helicopters. . . .

We are developing a new xerographic machine in which some of the components are senstive to changes in barometric pressure. . . .

I am to be married in an outdoor ceremony this year. I should like to know the probability for a) rain, b) total or near cloudiness. . . .

Before the year is out I intend to make a high altitude, long distance, parachute jump. . . .

I would like to have all the information that you can get on the weather for the past 100 years. . . .

I am sensitive to wind, dampness, and extreme cold or heat. Even areas outside of the United States would be considered. . . .

Because I have Myasthenia Gravis, a grave muscle weakness, drastic climatic changes such as temperature, humidity, barometric pressure and quality of the air, etc., seriously impair my ability to function. . . .

I have arthritis and a local doctor told me this climate was too humid for arthritic victims. I am 62, disabled (because of several strokes) one heart attack for the past three years. . . .

Will you kindly send me what ever information you have on weather in the different areas of the United States. I have bullous emphysema. . . .

In contemplation of a move to Hawaii—and because of an existing respiratory condition (allergies)—it is imperative that I know the humidity conditions in that state. . . .

My mother has a heart condition. We spent a month in Florida the last two years, but she had serious problems which we feel were due to high humidity. . . . □

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all points in an area. Human comfort is a complex function involving many weather elements; however, neither their individual nor collective influence is always readily apparent. Some combinations of weather may have a pronounced psychological (or physiological) effect on some individuals and little or no effect on others.

"Since each person is affected in an individual way by his environment, probably no group could agree on an 'ideal' climate. Certain climates may be more healthful than others for some people, but it would be difficult to determine which element or combination of elements contributes most. If one were to specify the type of climate he prefers (in terms of temperature, wind, cloud cover, sunshine, rainfall, humidity, pressure, etc.), it might then be possible to make a comparison between those same elements reported in the vicinity of the proposed retirement site. To assist in making comparison of climate at various locations, there are both published and unpublished climatological information available from NOAA.

"The following sources of information have been found useful by many persons; they can be obtained by directing your inquiries to the Director, National Climatic Center, Asheville, NC, 28801.

"*Local Climatological Data* issued monthly for each of approximately 300 National Weather Service Stations. Each issue contains daily and monthly temperature data including cooling and heating degree days, dew point, precipitation (including snowfall), pressure, wind, sunshine and sky cover data. Subscription price: $2.55 per year including annual summary (if published). Single copy prices per station: 20 cents for monthly summary and 20 cents for annual summary.

"*Climates of the States* issued for every State or combination of States. Each issue contains a local climatological data summary for selected National Weather Service stations in the State, a freeze data table for 100–200 locations, and a narrative summary describing the climatological features of the State. Price is variable according to size: 10 to 60 cents per issue.

"*Climatological Data National Summary* issued monthly and annually. This publication contains a collection of climatological data including normals, means and extremes for approximately 300 locations in the United States. Subscription price: $10.20 per year including annual summary. Single copy prices: 70 cents for monthly summary and $1.80 for annual summary.

"The 'Normal Means and Extreme Tables' can be obtained annually as a separate. Price 25 cents. (In metric units.)

"*Climates of the World* a 28-page brochure containing temperature and precipitation data for approximately 800 stations throughout the World. Also includes brief descriptions of the climate of each continent and maps showing the world-wide distribution of temperature and precipitation. Price 35 cents.

"*Unpublished Summaries.* These are summaries of specific weather elements, or combinations of elements, for particular location. They often represent the nearest location to the point of interest for which summarized data are available. Copies of these summaries can be provided for the cost of reproduction.

"The prices quoted above are for the 1976 publications. Remittances should be payable to Department of Commerce, NOAA, NCC and mailed to the National Climatic Center, Federal Building, Asheville, NC 28801." □

The Library of Congress

Sickness From The Sky?

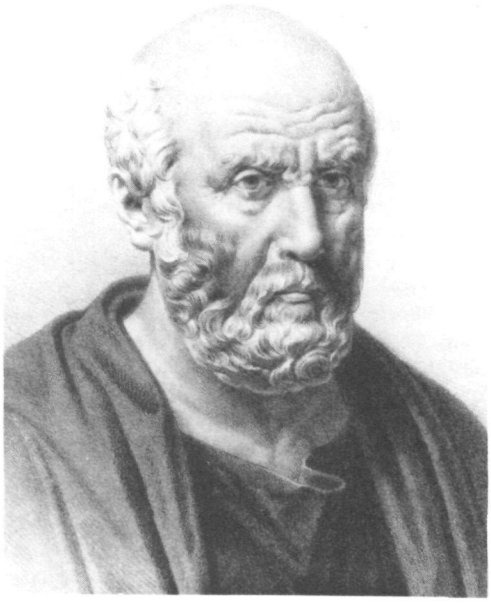
The ancients thought so.

Prehistoric man understood very little, but his discovery of clothing, shelter and fire shows that he realized his vulnerability to the weather. Without these things, he was restricted to the milder area; with them he could survive in harsher conditions. Does this make him the first applied climatologist?

Before the dawn of science, those who were sick believed their troubles were caused by the gods, who were identified with winds, planets and stars. This fatalistic approach was an obstacle to medicine for centuries. Life, as opposed to death, was associated with breathing air, though air itself was a mystery. Some diseases arrived with one season; others, with another. Cold, rainy spells were followed by a certain type of sickness.

In other early times, clusters of stars, the zodiac, were related to parts of the body, and were used in the treatment of disease. Priests and physicians of many early cultures—the Chaldeans, Egyptians, Babylonians, and Assyrians—watched the sky for implications of sickness. One early text said, "If the constellation of Cancer becomes obscured, a fatal demon will possess the land and many deaths will occur."

Greek science took another view. Pythagorus (580 to 500 B.C.) believed that incorrect proportions of the four elements—fire, earth, water and air—caused sickness. A little later, Empedocles was given credit for preventing an epidemic at Sicily. He is said to have prevented a "miasma" from entering the city, by sealing an opening in the mountains nearby. Hippocrates' writings are a major turning point from attributing disease to supernatural causes to natural causes, even though the latter were misunderstood. He said that to investigate medicine properly, one should consider the effects each season of the year produces. Then, he said to consider the hot and cold winds, local ones as well as general ones. His advice to travelers was, upon reaching a strange city, to notice the orientation with respect to the wind and sun. This will tell him what epidemics will strike the city in summer and winter. In his "Aphorisms" there are lengthy statements of the effects of season and winds on health. An example, "South wind induces dullness of hearing, dimness of vision, heaviness of head . . . But if the North wind prevails, cough, afflictions of the throat, . . . occur." Hippocrates stayed largely in favor for two thousand years.



National Library of Medicine

Hippocrates

Writers in the next several hundred years came up with other ideas. Celsus advised sea voyages and new climates for treatment of sickness. Mountain climates were advocated by Galen, who claimed also to find a difference in the strength and resistance of infants born in certain phases of the moon.

Ancient China was not without its weather-oriented medical philosophers. Examples of Emperor Huang Ti's thinking in 2650 B.C. are: heat impairs the heart, cold impairs the lungs; the west wind is bad for the heart, breast, and ribs; the north wind is bad for the kidneys and hips.

India's Susruta in 600 to 500 B.C. popularized health resorts by recommending that the king go to a dry locality during the dangerous rainy season.

As the centuries passed, astrology became intertwined with medicine, but astrology began to lose its importance in the Renaissance. In this period, Flemlose of Denmark quoted French and Italian physicians who had 399 weather signs which influenced health. In the seventeenth and eighteenth centuries, numbers of books were written involving such wide-ranging factors as magnetic fields, barometric pressure, and lunar tides in the atmosphere. At least one had a ring of truth: Glisson, about 1650 A.D., blamed infantile rickets on the foggy climate of London. It was not until 1890 that sunlight was considered important in the preventionof rickets.

In the eighteenth century, it was popular to attribute fevers and epidemics to climatic factors. We now know that mosquitoes and fleas were the unsuspected carriers of some of these diseases. With the nineteenth century came the concept of microorganisms and less emphasis was placed on climatic factors. Physicians found other means of treatment than changes of climate.

The caveman with his first fire started something more than an adaptation to a harsh climate. The residue of his little flame quickly dissipated in the "sewer of the air." But the waste products of the fires of his descendants are causing the present generation to take another look at the effects of the environment on health. □

CLIMATE & HEALTH

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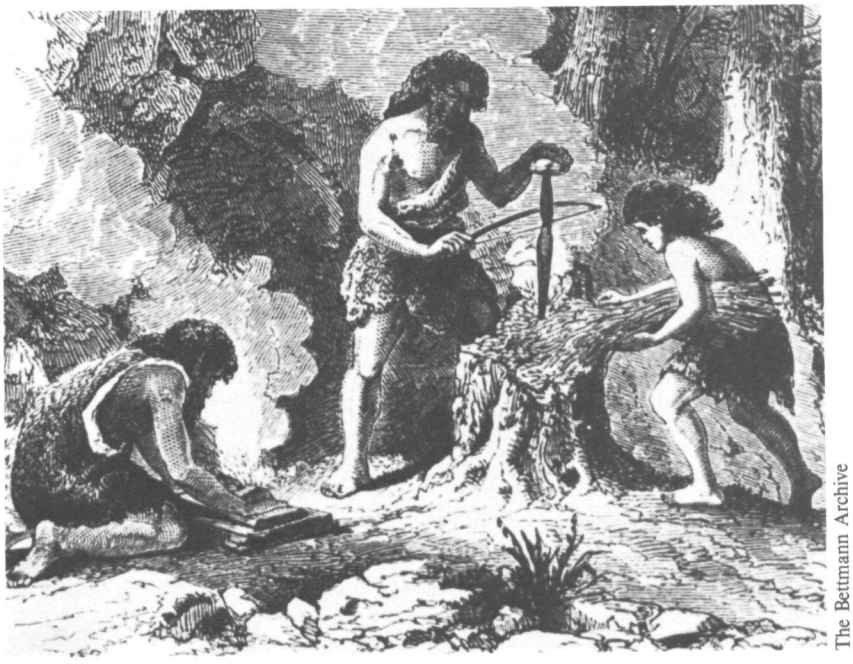
Magic, superstition, even politics, have been linked to man's maladies down through the ages.



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NOAA Profile

Climate and Bill Hodge

BY CHARLES G. THOMAS

William T. Hodge, Senior Scientist at the Environmental Data Service's National Climatic Center in Asheville, N.C., is a leading proponent of expanded climate and health studies within the Federal scientific and medical communities. Hodge, assistant to the NCC's Science Advisor, was a leading NOAA spokesperson at the Climate and Health Workshop at Research Triangle Park, N.C., June 8-9. His interest in health and the environment is not confined to his work at NCC. During his off duty hours, he is an ardent environmentalist and outdoorsman. *NOAA Magazine* visited with Bill Hodge this summer and found that a senior scientist's life is far from sedentary.

Photos : Bob Williams, NOAA

At the National Climatic Center (above) and out in the Blue Ridge Mountains of western North Carolina (right) Bill Hodge's thoughts return again and again to the vagaries of the intricate relationships between climate and human health.

Stenciled with military precision across the khaki flap of the small knapsack is LT. W.T. HODGE USAF. The high-top boots too have a military cut, though they seem somehow to lack the uncomfortable look of the spitshine GI combat boot. A quick check of his businesslike Konica 35 millimeter camera, and he's ready to go.

This is Bill Hodge starting out to do what he likes best—getting out into the mountains of western North Carolina, out into the environment, into the climate which, for five indoor days a week at NOAA's National Climatic Center, he studies by means of useful but coldly abstract statistics.

But now he is *in situ*, as the scientists like to say, heading out for the mountains. Hiking, camping, backpacking, pup-tenting, sometimes overnight, but usually just to get out and walk for a few hours, off he goes once a week or more if he has the time. On to the Blue Ridge Parkway or Route 40 out of Asheville to Black Mountain or Mount Pisgah or any of a score of favorite hiking trails. Out into the Blue Ridge Mountains, a mile high, where the air is clean and the view of the old wrinkled, rolling, tree-covered hills stretches for miles through the ever-present blue-tinged haze which gives the mountain chain its name. It's an environment in which one finds it easy to think clearly, without the workaday din of city or office noise.

It's all here: waterfalls, wildflowers, snow in the winter. Bill Hodge especially likes the winter season, a peculiarity of many born and raised in the South as he was. A native of Fayette, Mississippi, he spent his youth along the warm Gulf Coast, mostly in Biloxi, and graduated with distinction from Mississippi College in 1943. He majored in math with minors in physics and chemistry, excellent background for a meteorologist/climatologist. But this was just a beginning of the educational process for Bill Hodge. He's curious about everything and if he doesn't know, he'll find out. He hasn't stopped learning yet.

In 1944, he completed the Army Air Force Weather Officers' Course at New York University and was quickly sent to Hickam Field in Hawaii as a Flight Operations Officer as the tide of war in both the Pacific and European Theaters quickened in favor of the Allies. Before he left, however, he "twisted the arm" of his to-be wife, June, who was in the midst of a seven-year medical training program and convinced her to marry him. (June's pre-med experience was not wasted as the scientific training has stood her in good stead in her current job as a biology teacher at Montreat Anderson College at Montreat, 20 miles from Asheville.)

At th war's end, Hodge returned to New York University where, in 1947 he received his master of science degree in meteorology.

He joined the Weather Bureau, as it was then called, in 1947 and served as a meteorologist in Des Moines, Iowa. These were days of growing curiosity about the environmental sciences—not only about the weather itself, but of the effects it has on living things. In Des Moines, he worked in a special agricultural unit, adapting climatological data for practical use by farmers and cattle raisers with special problems such as the probabilities of good hay drying days during certain periods of the year. They also made weather forecasts geared especially to farm operations. For example, when fields were too muddy to plow, they let the farmers know the

chances of a change in the coming days. In those days, he recalls, they mailed out hundreds of tin cans to cooperating farmers who would send in corn samples. Hodge and his colleagues would distill the water from the samples to obtain data relating to moisture/crop relationships. At Des Moines, he continued his formal education, taking physics courses at Drake University.

In 1951, with the intensification of the Korean conflict, he was called back into the service—to Chanute Air Force Base in Illinois, where he completed the High Altitude Forecasting Course before shipping to Tokyo Weather Central as Chief of the Long Range Forecasting Section. Here Bill Hodge became interested in the climatology ofthe Pacific hurricanes known as typhoons. This interest later was to lead him to what he considers one of his most significant accomplishments weatherwise—his development of the TYFOON system of climatological prediction of these storms' tracks which is used operationally by the Navy today. But TYFOON was to come later—in 1968 and 1969 while he was working on an assignment for the Air Force/Navy Joint Typhoon Warning Center, Guam.

In 1953, he mustered out of the service and returned to work for the Weather Bureau, this time as Principal Assistant at the Weather Bureau Airport Station in Rapid City, South Dakota.

Photos : Bob Williams, NOAA

Bill Hodge's work day revolves around records. Projects take him to a library (above), to data from IFYGL with his secretary, Nancy Pope (above right), and to biometeorological material (right) with Larry Nicodemus of the NCC Science Advisory Staff.

Here there was more snow than even he cared for and he still shivers unconsciously as he describes driving to night shift work on snowy nights in freezing temperatures and the capricious plains' winds which would pile up 15-foot drifts in one place and leave the ground bare in another. From 1955 to 1959 he was South Dakota's State Climatologist. (This was before the formation of the Environmental Data Service and the Weather Bureau maintained climatological services.) He continued to study: there were an Agricultural Meteorological Institute Course from the University of Maryland, a correspondence course in Modern Methods of Meteorological Analysis and Prediction from the Department of Agriculture Graduate School.

It was during these South Dakota days, perhaps—talking to hundreds of people who came throgh his office seeking information on climate, discussing cases with his medically oriented wife, personally experiencing a sometimes cold, inhospitable climat—in the late 1950s, Bill Hodge's interest in climate and health relationships began to take form.

And—bringing up two daughters and trying to make ends meet on the far-from-generous salary paid government meteorologists at the time—he became addicted to library science as he looked for books to help him repair household wiring or keep his old car running. He now drives new cars, but his interest in libraries and their contents is undiminished. He currently is an active member of the Western North Carolina Library Association and spends a great deal of time visiting libraries and archives to study local history and early weather records.

In 1959, after a career on the move, never spending more than five years at any one place, Bill Hodge came to Asheville. That year he was named Assistant Chief of the Climatic Analysis Section at what was then known as the National Weather Records Center. The following year he was put in charge of the Climatic Information Section (now the User Services Branch).

Through this section all requests for climatological data were funneled and during Bill Hodge's tenure he began to notice the increasing frequency of a certain type of request.

Typically: "Please can you help to tell me a more healthy place to live in? I have a heart disease and rheumatism," and "I have a severe bronchial problem—and I'm in search of an area with clean air and mild climate," and "I am 68 years old and I cannot take cold weather."

It was the climate and health problem he had first become involved in back in South Dakota, but it was multiplied a hundredfold. Some were seeking a more comfortable climate to ease some physical stress; others had diseases in which the climate played an all-important part. In many cases the person's concept of what might be the best climate for a particular ailment was simply wrong. Some disregarded possible side effect of moving to a new climate. Others asked for impossible conditions—a dry, warm climate near New York City. But the requestors were earnest and the intense concern reflected in letters and phone calls indicated that the topic was an important one.

The Center did its best, sending along what was available. But Hodge and his fellow climatologists suspected that the maps and statistics they mailed out were of limited value.

In June of 1974, Hodge consolidated the thinking he had been doing over the years into *A Proposal For A Program of Climatic Research in Health Problems*, saying:

"The common climatic descriptors are of little help in analyzing the needs of people who find their present climate intolerable. We do not understand how or why the changing weather systems affect the comfort and health of people. The agencies which deal in health research have not investigated the human's response to his environment in terms of ordinary weather and climate. The medical reports on the relationship between weather and disease are few. These have not been searched out, consolidated and made

Hodge's early experience includes work as a military weatherman and a climatologist (with a cooperative observer in South Dakota at left). Today, he and his wife, June, (above) share an active life interspersed with moments of relaxation at home.

readily available to the physicians and patients who need guidance."

He continued with recommendations for a program which included a review and analysis of the literature already available on climate and health, pilot investigations in the various fields of climate and health relationships, the correlation of weather and climate with diseases, the development of a climatic data bank for human biometeorology, and, finally, a service program to assist physicians and patients.

The recent Climate and Health Workshop in Research Triangle Park confirmed the need for many of Bill Hodge's recommendations.

He says there is no simple answer. "Maybe the solution is for people to learn to live with their climate rather than seeking out new ones at great expense and with no guarantee that they'll be able to live with what they get. Perhaps the use of climate controls such as heating and air conditioning for temperature and filters for pollutants may prove the only change in environment some people need. And these 'artificial environments' may not be needed at all times. Their use only at certain times of day or during certain seasons of the year might be an effective way to ease a medical discomfort, saving the cost and inconvenience of moving to another area. What I'm saying is—and I must risk oversimplification here—if people know their problem and what causes it, they may be more able to deal with it artificially through controls other than relocation. This is one part of the climate and health thing that needs a great deal of study."

In 1974, Bill Hodge was named to the National Climatic Center's Science Advisory Staff where he works today. His interest in climate and health is only peripheral to several major, full-time assignments at NCC. For example, he is Project Meteorologist for World Data Center A for Meteorology and Nuclear Radiation, the repository for data of this nature gathered during both the International Geophysical Year (1957-1958) and the subsequent International Geophysical Cooperation 1959. World Center A maintains and dispenses data from other countries which is not available through normal channels. Hodge is also U.S. Data Manager for IFYGL (the International Field Year for the Great Lakes), a joint U.S.-Canadian research effort to develop a sound scientific basis for water resource management of the Lakes.

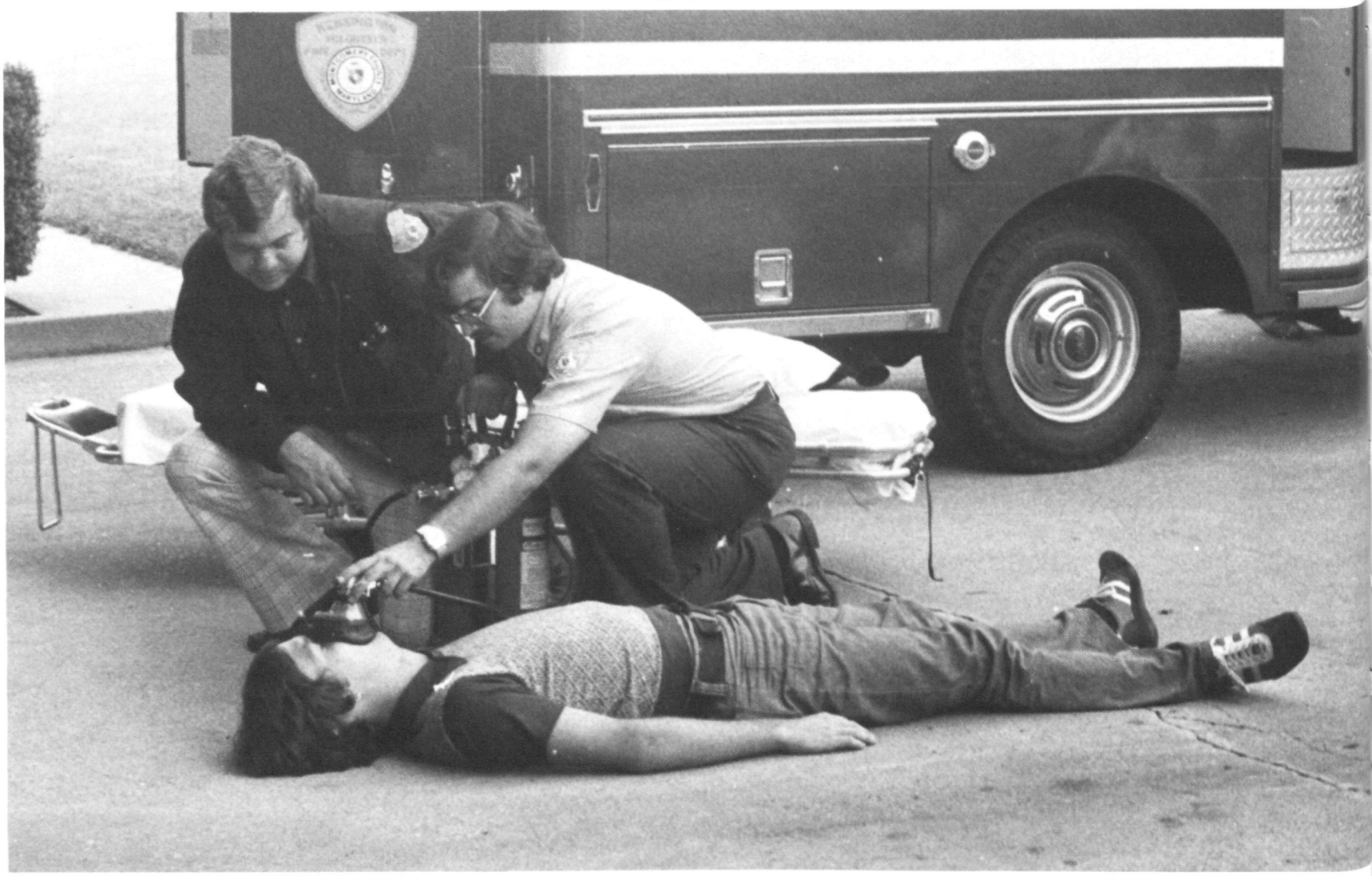
At home, in a two-story brick house on spruce-lined Farrwood Avenue in northern suburban Asheville, he likes to pursue his hobbies, which include photography, especially of nature subjects, electronics, collecting antique photographs and books.

The Hodge family (not including himself, he claims modestly) is musical. Against one wall is a Gulbransen Registering Piano manufactured in Chicago in the late '20s which his daughters used to practice on. (The daughters are grown now and live in Mississippi.) He keeps it in tune—another skill he learned through a correspondence course. "When we were moving from place to place," he recalls, "it was always Number One on the list of things we wanted to leave behind in order to save weight. But there it is!" In the corner is a huge bull fiddle. There's a uke perched atop the piano.

It's all very settled and comfortable, and Hodge, who wrestles with the problems of other people looking for congenial climates from his desk at the NCC each day, says Asheville is just fine for him. He has an allergy (ragweed) and the area's climate suits him, with its clean air and good balance of four seasons.

But as he sits at home showing off his collection of old photographs of people dressed for a different century in little folding frames, and talks knowingly of daguerreotypes, ambrotypes, calotypes, and the like, one can't help but think that Bill Hodge would just as soon be heading out for the Blue Ridge with his camera, his high-topped boots, and his stenciled knapsack.

The clean, clear air out there is conducive to thinking and Bill Hodge has a lot on his mind. □



Are our emergency medical services ready?

Ambulance Weather

BY HERBERT M. AUSTIN*

Man is less influenced by his physical environment than are other animals; he can modify it by providing various artificial support systems such as clothing, heating, and air conditioning. Through technology he is able to extend and live outside his natural biological range. Canned goods and refrigeration, clothes, air conditioning, heaters, cars, planes, ships, and medicine (vaccinations) all permit *Homo sapiens* to live in climates where his ancestors could not survive. Through medicine he is able to arrest many potentially fatal medical trends such as high blood pressure or cholesterol levels, provide assistance to th weak, infirm, and aged, and through diet and dietary supplements extend his life span.

Nevertheless, man, just as any other mammal, is still at the mercy of many of the forces of nature. In addition, some of the products of his technology—not only tobacco and rich diets—have posed an additional burden on his health. The fact is that many of us live on the thin edge of our technologically-expanded environment; and any organism, near its critical maximum or minimum, is in danger when the system fluctuates or is upset. This can create a severe health hazard, either from natural or man-made events.

Natural fluctuations include heat waves, cold snaps, and sudden changes in barometric pressure, all of which can trigger cardio/respiratory distress, a disruption of the body's thermo-regulatory functions, or cause changes in behavior.

Manmade perturbations include air and water pollution; their additive effects are noticed when a person living near his personal maximum or minimum is perturbed by a natural event and his life support system is out. An example: a person with emphysema is in trouble when the air conditioner breaks down during a heat wave or air stagnation alert.

Where the annual temperature cycles are within the natural range tolerated by humans and the seasonal variability is reduced, such as

**Dr. Austin, a National Marine Fisheries Service oceanographer, is a sergeant in the Kensington Volunteer Fire Department of the Montgomery County Fire and Rescue Services in Maryland.*

in the tropics, there are fewer periods of sudden death due to the weather. Additionally, many of these areas do not support extensive industry and are not overrun with automobiles; hence the manmade impacts on weather are less. A normal weeding-out process of the less hardy is continuous. In North America, on the other hand, where seasonal variations are beyond the normal range tolerated by humans, and the variations are flattened out by clothing, home heating, and air conditioners, the normal weeding-out process is retarded; then, during periods of extreme fluctuation, as during summer heat wave/air stagnations or the first periods of strong, fall cooling, large numbers of those living near or approaching the limitations of their bodies are susceptible to—indeed, often succumb to—the effects of the change in the weather.

Changes in weather patterns and the rapidity with which they occur often have a greater impact on behavior and health than do the absolute values reached; the rate of change of temperature may have a greater impact than the actual maximums or minimums. Sudden atmospheric cooling can initiate attacks of asthma, bronchitis, and stroke. Rapidly falling barometric pressure can also aggravate asthma. Heart attacks and the associated symptoms are more frequent following these periods of rapid cooling. Changes of this nature affect the body's thermoregulatory balance and are often associated with the common cold.

The conditions described here are generally associated with the change of air masses in the fall, particularly with the passage of a cold frontal system which is preceded by a rapidly falling barometer, rising wind speed, and followed by windy conditions and rapidly falling temperatures. It has also been noted that increased heart attack and stroke are more significantly related to pairs of days or more of rapid temperature change, and that the episode in both heart attack and stroke may lag the temperature event by two days or so. While heart disease emergencies also increase as much as 20 percent during heat waves (temperatures greater than 90°F) it is becoming apparent that most of the people living near their personal thermal maximums succumb to the heat during the first few days of the heat wave when the critical point is first reached.

It appears also that the maximum nighttime temperatures are a more important cause of heat stress than the maximum daytime temperatures; during the night the body recuperates, and high night temperatures prevent the body from reestablishing its thermal equilibrium. Factors that may promote this causal relationship between temperature change and cardio-vascular difficulty include changes in blood chemistry and volume, body metabolism, and nervous activity. If these temperature change patterns could be identified and forecast it may be possible to prevent the emergency by proper preventive medical care. The problems associated with air pollution, particularly when combined with summer heat waves, have a significant relation to human mortality. Along the urban eastern United States seaboard, these conditions are generally found on the "back-side" of a slowly moving or stationary high pressure system.

In the urban environment where ambulances are overtaxed, only the more affluent can afford private emergency life support services by paying for them directly on a pay-by-need basis. The city dweller who cannot afford these luxuries must rely upon public services such as municipal fire department or police ambulance services which are generally undermanned and underequipped. The suburban areas are coming increasingly under the same conditions, as people emigrate from the city.

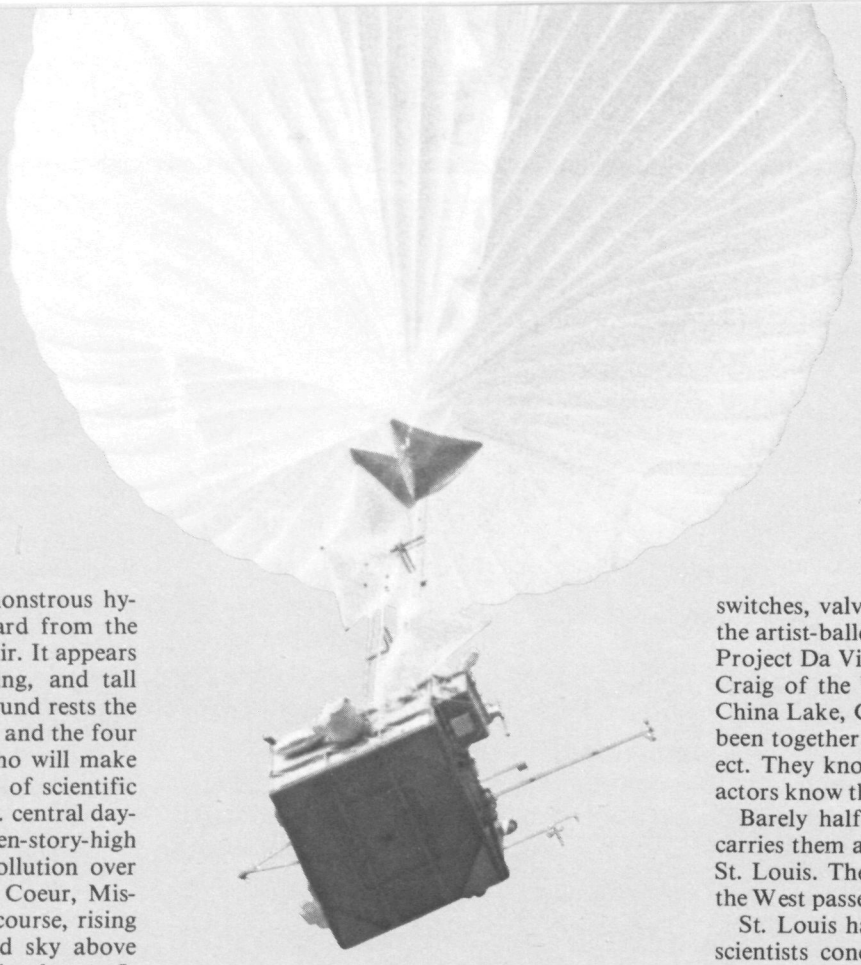
Seasonal and daily fluctuations in demand upon the emergency medical services of ambulances and hospital facilities made it difficult to plan for peak periods. Public utilities such as water and electric power are generally prepared for peak loads, both seasonally and diurnally, although they too are caught unprepared from time to time when critical demands are placed upon them by unpredicted extremes in weather. When hurricanes or tornados strike, of course, the trauma associated with them mobilizes the emergency services in short order.

The numbers of people hospitalized from cardiac or respiratory distress with the passage of the first major cold front in the fall or first major air stagnation during the late spring can exceed those affected by tornadoes or hurricanes; the area involved is generally greater and people are less prepared. Yet few if any emergency services are mobilized for the expected increase in patients. The Council of Governments' Air Quality Index (AQI) provides some indication of air quality, and high values, when associated with an urban air stagnation alert, have prompted some government agencies to issue a directive concerning the use of mass transportation systems and the taking of "preventive" sick leave for those potentially affected.

Developing an understanding of how the weather can affect our health will help us to prepare for extreme climatic situations. The approach should focus on two areas: (1) how the changing weather affects each individual, and how he may wish to alter his day-to-day activity as a result, and (2) the tactical decisions of the emergency medical services themselves. As the relationship between weather patterns and human health becomes increasingly clear, it may be possible for the weather stations to provide forecasts for "heart attack weather" similar to the AQI provided today by the Council of Governments.

The ability to forecast "heart attack" or "trouble breathing" weather several days in advance would permit fire and rescue ambulance services to have all apparatus on line and stations manned. Hospitals could also prepare for the deluge of patients by adjusting leave schedules. Most susceptible to these fluctuating pressures are the volunteer emergency groups, such as fire and rescue services in rural and suburban areas, and in small but seasonally large resort towns. Volunteer personnel, knowing that a busy weekend is at hand, could plan to be available.

Of greatest importance, however, should be the ability of each of us to determine our own critical and favorable weather patterns and to plan our lives to avoid stressful situations on potentially critical days. □



PROJECT DA VINCI: CHASING THE POLLUTION PLUME

BY CARL A. POSEY

The great balloon rises like a monstrous hydrozoan straining to float upward from the bottom of a pale, hazy ocean of air. It appears alive—transparent, fragile-seeming, and tall as an office building. On the ground rests the open two-ton cube it must carry, and the four people in the orange gondola who will make this unusual system do the kind of scientific work it does so well. At 7:25 a.m. central daylight time, July 23, 1976, the ten-story-high assembly lifts off into heavy pollution over Arrowhead Airport, near Creve Coeur, Missouri. Soon it is on an eastward course, rising slowly into the cloudless, humid sky above suburban St. Louis. The mission has begun. It is called Da Vinci III.

Da Vinci. The name evokes both science and art, in impressive combination. And, in fact, the project owes its conception jointly to the creative minds of a scientist interested in measuring the intricate chemistries of the urban atmosphere and a balloon pilot-artist who saw how these measurements could be made from a manned balloon. The balloon platform permits scientists to put their instruments into a pollution plume without disturbing it, and keep them there as time and sunlight and chemical interactions work their changes on pollutant particles and gases.

The first Da Vinci flight was conducted in November 1974, from Las Cruces, New Mexico. That twelve-hour mission in the New Mexico moonlight took the Da Vinci balloon three hundred miles from the launch point, and crew and payload to a safe landing. It also took the technique of using large balloons developed to probe the inaccessible upper fringes of the earth's atmosphere into the first few thousand feet of air, where we and the environment have our greatest mutual effects.

Dr. Rudolf J. Engelmann, new director of NOAA's Outer Continental Shelf Environmental Assessment Program, initiated Project Da Vinci when he worked for the Energy Research and Development Administration, chief sponsor of the experiment, which is a cooperative undertaking with the National Geographic Society, NOAA, and other organizations. Dr. Bernard Zak of Sandia Laboratories now directs Project Da Vinci.

Engelmann called it "a laboratory without walls." Now, as Da Vinci III moves steadily eastward, Engelmann is busy in the wall-less laboratory of the gondola. The list of measurements to be made aboard the gondola is as long as a list of Welsh Christmas candies: cloud and ice nuclei counts, light-scatter, atmospheric diffusion, infrared radiation, for NOAA; aerosol concentrations for Washington University; particle-size distribution for Los Alamos Scientific Laboratory; incident ultraviolet flux, ozone and sulfur dioxide levels, and condensation nuclei for Sandia Laboratories; temperature, pressure, water vapor, ozone, and carbon dioxide for the Atmospheric Sciences Laboratory, White Sands; eddy diffusivity and wind field for AeroVironment; filters and air samples for subsequent analysis by NOAA, Lawrence-Berkeley, Lawrence-Livermore, Sandia, and Washington State.

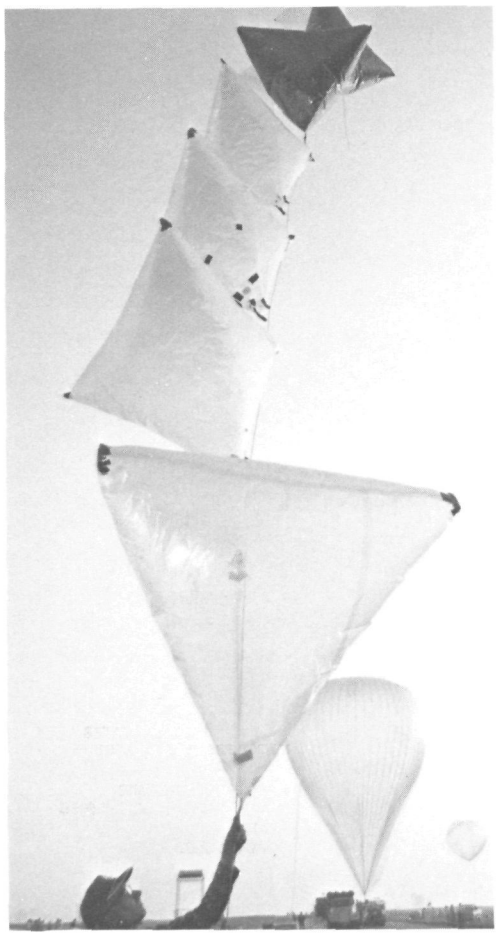
Engelmann, helped by Preston B. Herrington, a systems engineer from Sandia Laboratories, moves through the sequence of switches, valves, and recorders. Vera Simons, the artist-balloonist who conceived the idea of Project Da Vinci, sees to her cameras. Jimmie Craig of the U.S. Naval Weapons Center in China Lake, California, is pilot. The crew has been together since the beginning of the project. They know the program of their work as actors know their script.

Barely half an hour after liftoff the wind carries them across the center of metropolitan St. Louis. The flashing arc of the Gateway to the West passes just south of them.

St. Louis has become almost a test bed for scientists concerned with comprehending urban air pollution, and its long-term—and long-distance—consequences. St. Louis is a good choice, not because its atmosphere is the most polluted in America, but because it sits on the north-south boundary between air pollution in the east and relatively clean air to the west. In a sense, the city has come to represent as much a jumping off point for air-pollution specialists as it once did for another kind of pioneer a century earlier. Except that now these pioneers move east, drifting from this western gateway with today's atmospheric burden of pollutants.

In June, Da Vinci II drifted in a large, slow eddy of stagnant air over S. Louis for the first ten hours of its day-long flight. The crew breathed more than its share of ozone and sulfur dioxide. But a mission in stagnant air was the kind of mission they needed in Da Vinci. The other kind of flight was the kind it has today—a flight on a relatively unpolluted day. Now Da Vinci III picks up the plume of a powerplant on the east side of the city. They can measure how its chemistries unravel over a distance of several hundred miles—and what form the pollutants from one community have when they descend on communities downwind.

The broad, brown band of the Mississippi River moves past them in the persistent haze. They are now in the east. Over the city one still heard some traffic noise. Now it is quiet in the gondola. And still, for the balloon drifts on the wind—there is no cooling slipstream. The morning sun is still too low for the cloth sunshade to do much good, and the gondola is uncomfortably hot. It is the price they pay for working in this floating laboratory, which moves as part of an air mass, and adds no turbulence or extraneous chemistry to the St. Louis plume.



In early hours before dawn, string of "tetroons"—tetrahedral balloons—are attached to gondola (left). During DaVinci flight they will be released, and their paths and dispersion rates will provide data on atmospheric diffusion processes. Above, DaVinci II crew poses prior to flight—from left, Dr. Rudolf Engelmann, ERL; Jimmie Craig, pilot; Vera Simons, co-pilot and one of project's initiators; and (kneeling) Otis Imboden, National Geographic Society.

Long plastic tubes carry helium into balloon as project staff awaits launch time.

Craig notes that the balloon is heating steadily, causing its helium gas to expand, and the balloon to rise. He valves helium to maintain their path about a thousand feet above the low-lying, flat farmlands of this corner of Illinois.

A month earlier, Da Vinci II spent nearly half its 24-hour flight over St. Louis, then moved east across the Mississippi River toward Alton, Illinois, and landed in a wheat field near Griffin, Indiana, in the southwest corner of the state.

Da Vinci III is drifting more to the east. Behind it, two mobile-home chase vehicles track the craft and do their best to follow on the ground an object moving about 18 knots along a straight line through the air. Crows get there before cars.

Nearly seven hours into the flight they have come some 125 miles from their starting point, drifting just south of Orchardville, Illinois. And here, floating at a little more than two thousand feet, they must begin to decide between themselves and the St. Louis plume. North and east of Da Vinci III, between Columbus, Indiana, and Cincinnati, Ohio, a line of thunderstorms is forming along an advancing front. The front dominates atmospheric circulation as far away as the balloon, and draws low-level air, the pollutant plume, and Da Vinci inexorably to the northeast on a collision course with the developing storms. The afternoon haze deepens below them. Dusk finds them over Bloomfield, Illinois. They are at a critical decision point.

At Vincennes, a pilot balloon is launched to probe currents aloft, to see whether there are any winds accessible to the balloon that will carry it away from the thunderstorms. The Pibal information flashes back to the project meteorologists at Arrowhead Airport, and he passes a possibility to Craig: there is a northwest wind between six and seven thousand feet. Steel-shot ballast is dumped. The balloon rises into the approaching night, and turns back toward an east-southeast course, borne on a saving wind. But the plume is lost, taken by the thunderstorms.

The lights of Indianapolis go by to the north. Then Louisville to the south. The Da Vinci crew take their turns at sleeping. Lexington comes up to the southeast, and Cincinnati is a glow on the northeastern horizon. The balloon is at more than six thousand feet.

The earth below the balloon is also changing. They spent the night climbing the eastern slope of the Mississippi Valley, and the flat bottom lands have begun to give way to low, rounded eastern mountains and forests. At dawn these hills cup pockets of fog.

They begin the descent on a 10-knot wind, which carries them past Sprout, Sherburne, Grange City, Sharkey. Just north of the Licking River they shave a ridge and, at 9 a.m. eastern daylight time, July 24, land in a valley meadow in the Daniel Boone National Forest, in eastern Kentucky. It is the project's third perfect standup landing in as many tries.

Da Vinci has landed. The mission is over. But, for the scientists and technicians who brought this new technique to the task of studying the problems of urban air quality, this forest landing is just the beginning. □

An historic first in coastal zone management

Washington: State With A Plan

BY GLEN A. CRANDAL*

The certificate with the gold seal summed it up nicely: "The State of Washington has developed a program for the effective management, beneficial use, protection and development of its coastal lands and waters . . . Therefore it is with great honor that I award this Certificate of Approval for the Washington State Coastal Zone Management Program and commend the state for having the first such program in the Nation."

It was signed by Elliot L. Richardson, Secretary of Commerce. NOAA Deputy Administrator Howard Pollock presented the certificate and a $2 million grant to Washington Governor Daniel J. Evans at a ceremony in Seattle's Olympic Hotel on June 14.

In their remarks to a crowd of 200, Gov. Evans and Mr. Pollock stressed the importance of the local, state, and federal cooperation which had enabled Washington State's CZM program to become first among the 34 participating states and territories. In fact the slate of speakers for the Seattle ceremony testified to the importance of the tri-level cooperation. Washington's senior U.S. Senator Warren G. Magnuson; Seattle Mayor Wesley Uhlman; King County (Seattle) Executive John Spellman; Washington Department of Ecology Director John Biggs; and NOAA's Assistant Administrator for Coastal Zone Management Robert Knecht were equally emphatic about the importance of contributions by the various levels of involvement.

Sen. Magnuson, the keynote speaker also called attention to the relatively short history of concern about our coasts.

"It was not really that long ago when we in this country hardly thought about that area we now call the coastal zone," he said. "In fact, we took it for granted. We were concerned about the land where we lived and worked, and about the sea where we fished and sailed. But all too often very little regard was given to that area between dry land and the water—to the estuaries and wetlands, to the shorelands and tidal areas."

Magnuson took an early interest by being a sponsor of P.L. 92-583, the Coastal Zone Management Act of 1972. The Act was given impetus by the "New Federalism" of the early 1970's—a policy to transfer as much responsibility as possible from the federal government to the state and local levels.

"It was our intent in that Act," Magnuson said, "to provide the framework for state and local government to assert their full authority over the lands and waters in the coastal zone by providing financial assistance to develop their own programs for management of the activities in the zone."

Approval of Washington State's CZM program will provide funds to 38 cities and 15 counties for administration and enhancement of their respective shoreline management master programs. The state will also use funds from the grant for its scientific program enhancement and a coastal resource atlas.

The shorelines of Washington have been called the State's "greatest resource" by Governor Daniel J. Evans.

The fifteen counties which contain Washington's 2,337 miles of marine shoreline constitute one of the richest resource pools in the nation. The coastal zone contains only 29 percent of the state's land but fully two thirds of its 3,400,000 residents. Nutrient-rich estuaries and streams not only support a local sport and commercial fishery, but also serve as propagation waters for salmon of central importance to national and international fisheries. Deep, sheltered harbors located on the Pacific Rim contribute significantly to international trade. The zone's strategic location for national defense purposes has made it the site of several large military installations and its position in the northwestern corner of the contiguous states makes it the key access route to meet Alaska's transportation needs and to respond to the emerging Alaskan role in providing for national energy needs.

More than one hundred separate institutional organizations are faced with the task of maximizing the use potential of what amounts to an incredibly rich coastal resource. The primary competing uses to be balanced include timber harvest, industry, commercial fishing, recreation, tourism, second-home development, and agriculture. About 77 miles of shoreline have non-recreational development such as commercial and industrial areas.

The State of Washington has been actively involved in managing shorelines since the passage of the Shoreline Management Act of 1971 (later approved by the voters).

The major thrust of this predecessor of the Federal Act is toward land use planning along shorelines. This legislation was prompted by a 1969 decision of the State Supreme Court. Essentially, it stated, "The public has the right to go where navigable waters go, and no individual has the right to place obstructions to this right, except where the state determines that limited reductions of rights of the public in the navigable waters will promote and enhance the public interest."

The court also concluded that judicial decision making on a case-by-case basis was not the appropriate method of handling development on a statewide basis and thus urged the executive and legislative branches to develop a comprehensive shoreline planning and use regulation for the state. The decision effectively halted all development in navigable waters.

The SMA covers all lakes, including reservoirs, over twenty surface acres; all streams where the mean annual flow is greater than twenty cubic feet per second; all marine waters plus an area landward for two hundred feet in all directions measured on a horizontal plane from the ordinary high water mark; floodways and contiguous floodplain areas landward two hundred feet from such floodways; and all marshes, bogs, swamps, and river deltas associated with the streams, lakes, and tidal waters.

* *Mr. Crandal is a community affairs consultant with the State of Washington Department of Ecology*

The shorelines of Washington (opposite page), in both their natural and developed states, have been called the State's "greatest resource".

The framework for shoreline planning was established by the policies in the Act. Based on these general policies, the Department of Ecology developed guidelines which provide a more detailed set of policies aimed at specific shoreline related issues, mainly natural systems and various human activities which are commonly found on the shorelines.

The State's guidelines in turn were to help local governments develop their own shoreline management master programs, which are the backbone of shoreline management in the State. The Department of Ecology was only to provide initial guidance and technical help, and later to function in a review capacity to assure that the local programs are consistent with the Act.

There are 224 jurisdictions including 39 counties that needed their own shoreline programs. In some cases, the smaller towns adopted their county's program, but the major cities and also many small communities chose to develop their own.

An important facet of shoreline management mandated by the Act was a strong citizen involvement. Based on procedures outlined in the State's guidelines, local citizens were selected to help planning staffs develop the programs. These citizen advisory committees ranged in size from 3 to 60 members and were chosen to represent all types of interests. Statewide, about 2,000 private individuals were actively involved in the development of the programs.

The master programs reflect the unique shoreline conditions and the development requirements which exist or are projected to exist in the area. They are general in nature, since policies and regulations are not directed to specific sites; and they are comprehensive in that they are directed towards all land and water uses.

Shoreline management is planned and administered locally by each county and city with eligible shorelines within its boundaries. To avoid conflicts with local managers, the State has acted as coordinator between the various jurisdictions, and the State also has to review and approve the programs.

The most important implementation tool for the Shoreline Management Act is the permit system. Since the first day of the Act, all substantial developments along Washington's shorelines have been required to obtain a Shoreline Substantial Development Permit. "Substantial development" is defined as all development that exceeds $1,000 in value. There are some additional criteria and, also, several exemptions from the permit requirements.

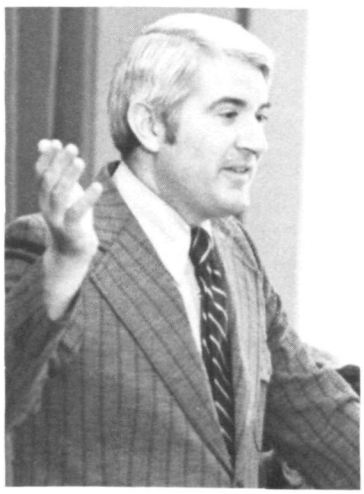
At first, development proposals were evaluated against the policies contained in the Act itself. After the State guidelines were developed, they provided additional criteria for review, but as soon as a local master program was developed, and even before its final approval by Department of Ecology, that master program provided the main direction for development.

The permits are also administered locally. A developer applies for a permit to the government in whose jurisdiction his site is located. After the local government reviews and approves the permit, it is forwarded to Department of Ecology for another review. If the Department finds the project inconsistent with the Act, the permit may be appealed to the Shorelines Hearings Board, but the Department cannot simply deny the permit.

Responsibility for administering the Shoreline Management Act rests with the Washington State Department of Ecology (DOE). DOE was established through legislative action in 1970. The responsibilities of four different agencies were consolidated in it. It houses the state's basic regulatory authorities for air and water resource and qaulity protection and solid waste management.

The Coastal Zone Management Act of 1972 provided the state with new opportunities to expand its existing program for the management of marine shorelines.

The National Oceanic and Atmospheric Administration was charged with the implementation of the Act. NOAA created the new Office of Coastal Zone Management (OCZM) and, after an organizational period, OCZM issued CFR 920, which was the guidelines needed to administer and award program development grants. These grants became available in early 1974 and Washington State, with its shoreline

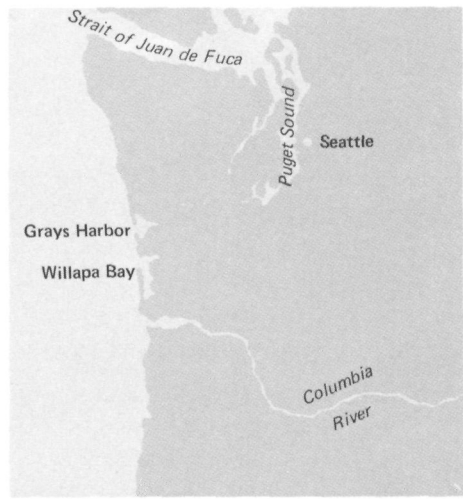


Speakers at the presentation ceremony included: (top left) Senator Warren G. Magnuson; (top right) John A. Biggs, Director of the Washington Department of Ecology; (middle left) Mayor Wesley Uhlman of Seattle; (middle right) John Spellman, King County (Seattle) Executive; and (above) Governor Daniel J. Evans, Howard Pollock, Deputy Administrator of NOAA, and Robert W. Knecht, Assistant Administrator for Coastal Zone Management.

Profile of Washington's Shorelines

Washington's 2,337 miles of marine shoreline are made up of 157 miles along the Pacific Ocean, 144 miles along the Strait of Juan de Fuca, 89 miles in Grays Harbor, 129 miles in Willapa Bay, 34 miles on the Columbia River, and 1,784 miles bordering Puget Sound and the Strait of Georgia. (These figures include the shorelines of 172 significant islands of the San Juan Archipelago.) 1,847 miles of the shoreline have beaches and the remaining 490 miles consist of rocky headlands, marsh areas, bulkheads, and revetments.

2,075 miles or about 75% of Washington's shoreline landward of the extreme high waterline is in private ownership, as is about 60% of the state's tidelands. Of the publicly owned coastline, the federal government owns about 155 miles, including the Olympic National Park and various wildlife refuge areas. Nonfederal public ownership totals 107 miles, consisting primarily of state, county, and city parks. When tidelands (between extreme low tide and ordinary high tide) which are owned by the state and managed by various public agencies are included, the public access shoreline mileage increases to 735 miles. Some of the nonfederal public land is owned by port districts and utilized for waterborne commerce facilities. In addition, about 40 miles of privately owned shoreline is used for recreational purposes, such as resort areas and privately owned marinas.



The Washington State legislature has identified the problem of competing uses on the Pacific coastline this way:

"The beaches bounding the Pacific Ocean from the Strait of Juan de Fuca to Cape Disappointment at the mouth of the Columbia River constitute some of the last unspoiled seashores remaining in the United States. They provide the public with almost unlimited opportunities for recreational activities, like swimming, surfing and hiking; for outdoor sports, like hunting, fishing, clamming and boating; for the observation of nature as it existed for hundreds of years before the arrival of white man and for relaxation and to provide certain recreational and sanitary facilities. Nonrecreational use of the beach must be strictly limited. Even recreational uses must be regulated in order that Washington's unrivaled seashore may be saved for our children in much the same form as we know it today."

program well along, qualified easily for a 305 grant in the spring of 1974.

Under Sec. 305 of the CZMA, Washington received two planning grants for development of its CZM program.

Most of the State's authorities and programs were already in existence. The State used the grant monies to develop a coastal area information base and further develop local shoreline master programs. The biggest new requirement was to develop coordination with a variety of federal agencies.

Washington State made every attempt to follow the spirit embodied in the Coastal Zone Management Act in developing federal coordination. It found, as did Congress, that there is a direct national interst in the effective management of the coastal zone and that its carefully planned development, protection, and public use is of concern to all the citizens of the United States.

Other states should profit from Washington's experience with federal coordination especially as it relates to the consistency provisions of Sections 307 (c) and (d) of CZMA. These sections specifically mention that federal activities and development within the CZM jurisdiction shall comply with the state's program.

While the thrust of the consistency clause is directed toward federal agencies, the state is charged with giving adequate consideration to the "national interest" in the siting of facilities. It was no small undertaking for the state to discover what federal agencies have an interest in the state's coastal zone. A modest list of some 20 agencies mushroomed to over 40 by the time the program was completed.

For a time, it appeared as though a difference of interpretation over excluded lands would bar federal approval of the state's program. Not unnaturally, many federal agencies viewed the consistency provision with apprehension, particularly after the state narrowly defined excluded lands. At this time, the issue remains unresolved. Legal briefs have been filed with the U.S. Attorney General, who is expected to render an opinion soon. In the meantime, the state has conceded to use the definition of excluded lands favored by the federal establishment.

Approval of the Washington program was not only a test of the validity of the state's claim of approvability, but of OCZM's capability to see such an approval through, and of the many federal agencies whose programs would be affected. OCZM learned much from the effort, as did many other states, and so the rules of the road for future state approvals are clear to all concerned.

In its grant application to NOAA, Washington included 56 separate tasks that it wishes to undertake during its 13 month grant period.

The expenditure of $2,000,000 will be utilized to support administration of local shoreline master programs, regional enhancement projects, scientific research by consultants, grants to state agencies who have a primary role in the CZM area, federal coordination and a CZM atlas.

Since local governments play a critical role in the administration of the CZM program, considerable funding is being provided to them through a Federal matching share formula. Besides administering all activities within the CZM area, they will coordinate state and federally related activities and refine and update their respective master programs.

The success and impact of approval by NOAA of Washington's program were summed up by Senator Magnuson at the award ceremony in Seattle:

"Today's award marks an important milestone for the eventual completion of a national coastal zone management program. For the fine people at the Office of Coastal Zone Management, it means rounding a corner and seeing the possibility of success. And it comes at an important time.

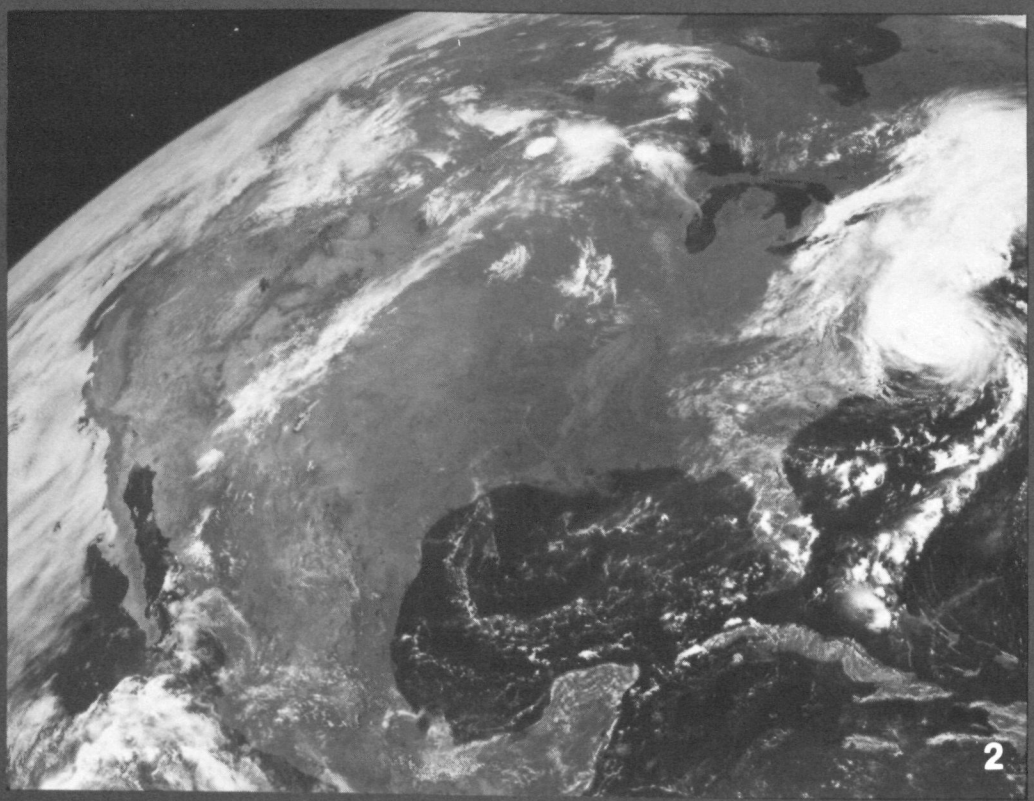
"Let me finish by congratulating the concerned citizens of the State of Washington who helped create the Shoreline Management program. I should also congratulate the officials of the State of Washington, particularly Mr. (John A.) Biggs of the Department of Ecology, who have pitched in and made this program work.

"I would also like to thank and congratulate officials at the National Oceanic and Atmospheric Administration, particularly in the Office of Coastal Zone Management, for seeing to it that the Washington State Management program received the proper support at this point in its development.

"We will hope soon to see the results of these efforts bear fruit and to bring noticeable changes by making the shoreline a better place to see, and in which to live and work." □

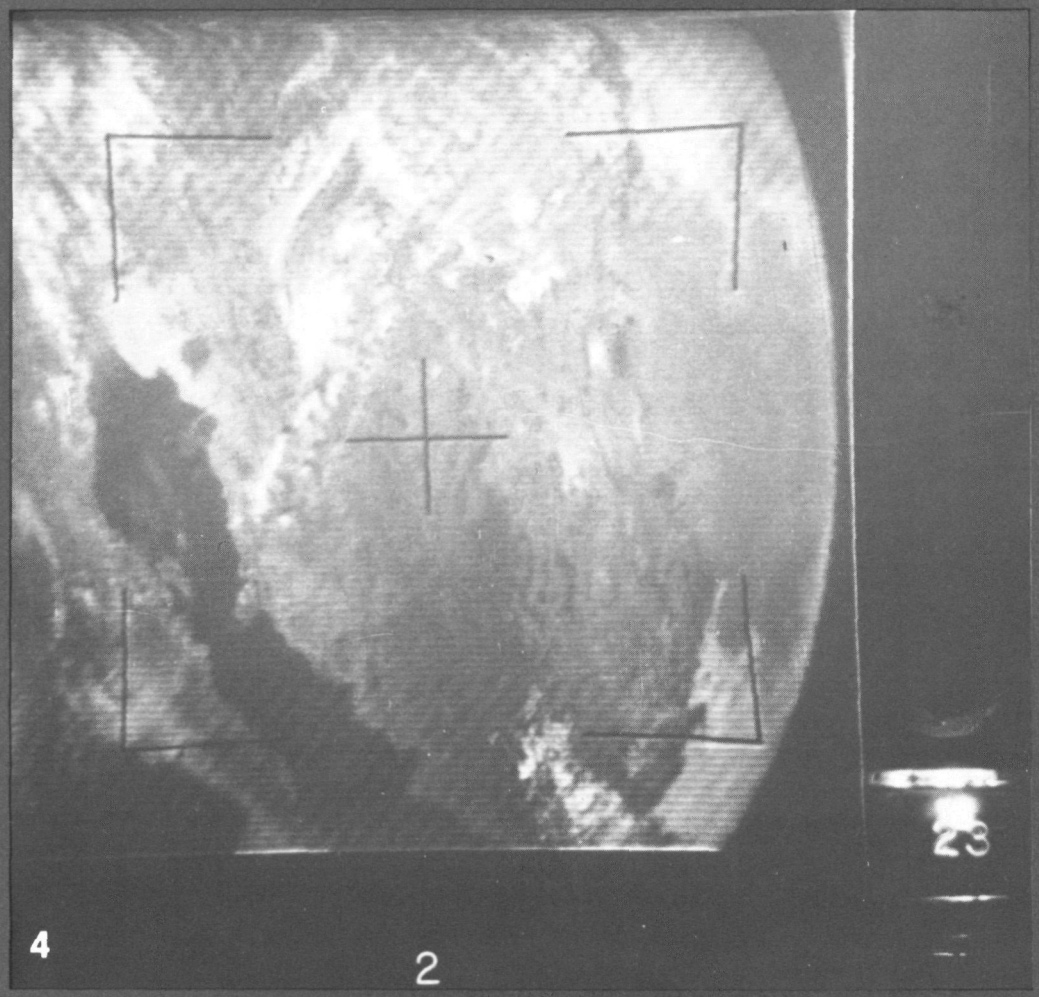
1

THE VIEW FROM SPACE



2

A new NOAA environmental monitoring satellite, NOAA-5, was successfully launched the end of July, continuing meteorological and oceanographic satellite observations begun 10 years ago when the world's first operational weather satellite system was launched, on February 3, 1966. Since ESSA 1, a polar-obiter, NOAA and its predecessor agency have seen the state of the art steadily improve, dramatically so with the availability of full-disk images as provided by GOES-1, of the geostationary type. Images from all three satellites are reproduced on these pages, a history in brief of NOAA's eyes in the sky.



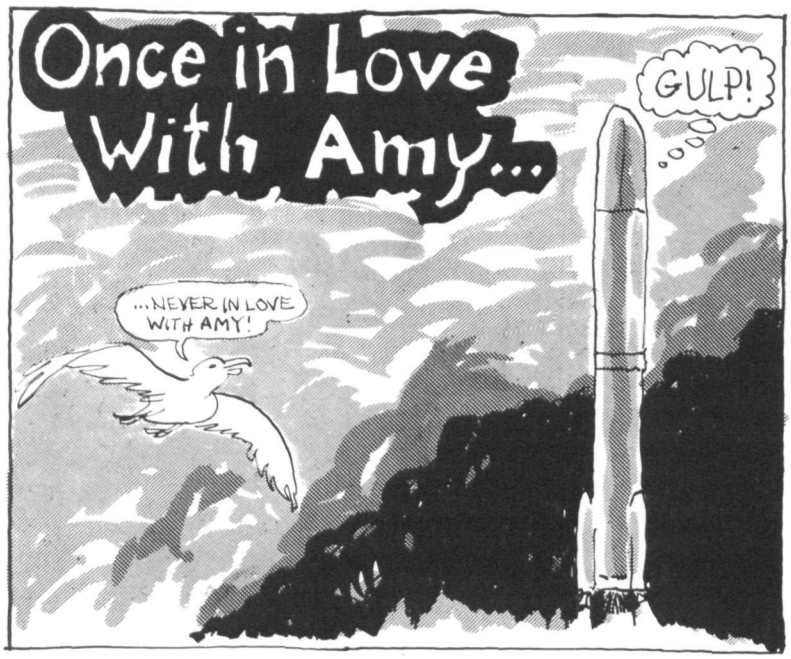
1 *Almost the full extent of Europe and the Mediterranean Sea is visible in this infrared imagery of May 8 from the NOAA-4 polar-orbiting satellite. Snow in the Alps is clearly seen, and the Danube River (center right) can be identified flowing towards the Black Sea at far right.*

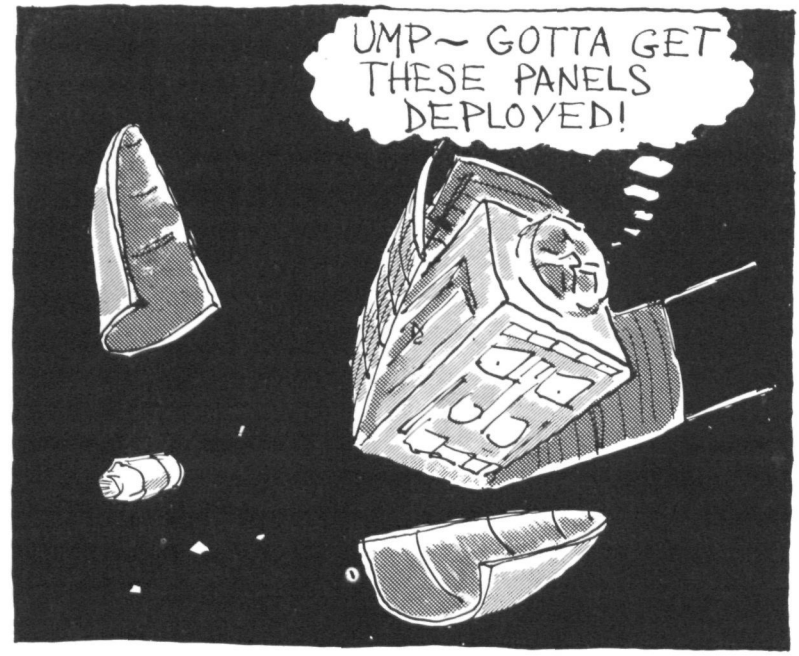
2 *Two hurricanes—Belle in the Atlantic and an unnamed storm in the Pacific—are visible in this GOES-1 picture taken August 9.*

3 *First VHRR (Very High Resolution Radiometer) image from NOAA-5, in infrared, was transmitted August 11 and shows a tropical storm just south of Baja California (upper right corner).*

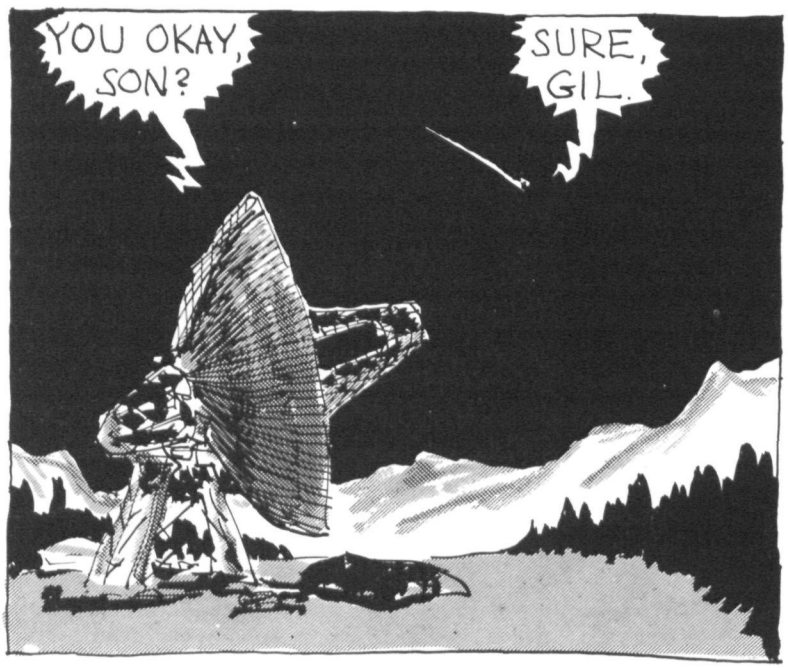
4 *One of the first pictures from ESSA-1 on February 4, 1966—the day after the history-making satellite was launched. It transmitted television-type pictures, whereas more recent satellites—including NOAA-5—convert data recorded by their various sensors into electronic impulses which are transmitted to computers on earth and converted into pictures.*

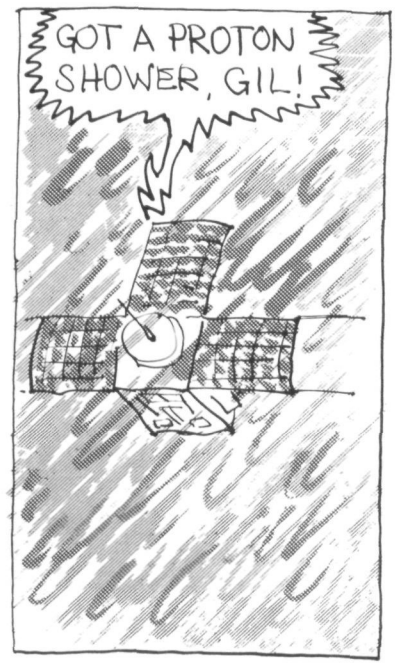
5 *A two-stage Delta launch vehicle—with the NOAA-5 satellite encased in its tip—lifts off from a Vandenberg Air Force Base launch pad on July 29, bearing the nation's newest environmental monitoring satellite into polar orbit some 900 miles (1448 kilometers) above the earth's surface.*

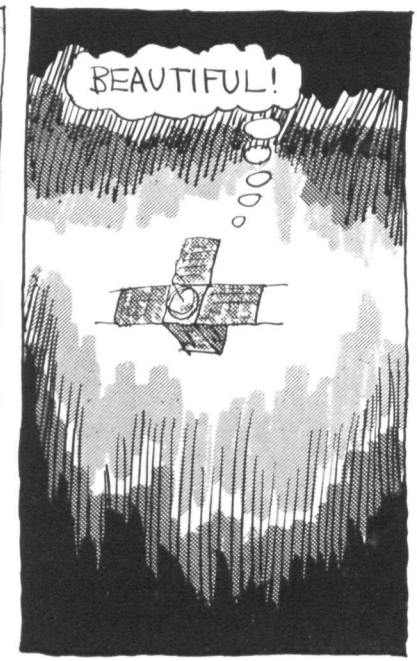

Once in Love With Amy...
GULP!
...NEVER IN LOVE WITH AMY!


UMP~ GOTTA GET THESE PANELS DEPLOYED!

OH.... WOW!


YOU OKAY, SON?
SURE, GIL.


GOT A PROTON SHOWER, GIL!

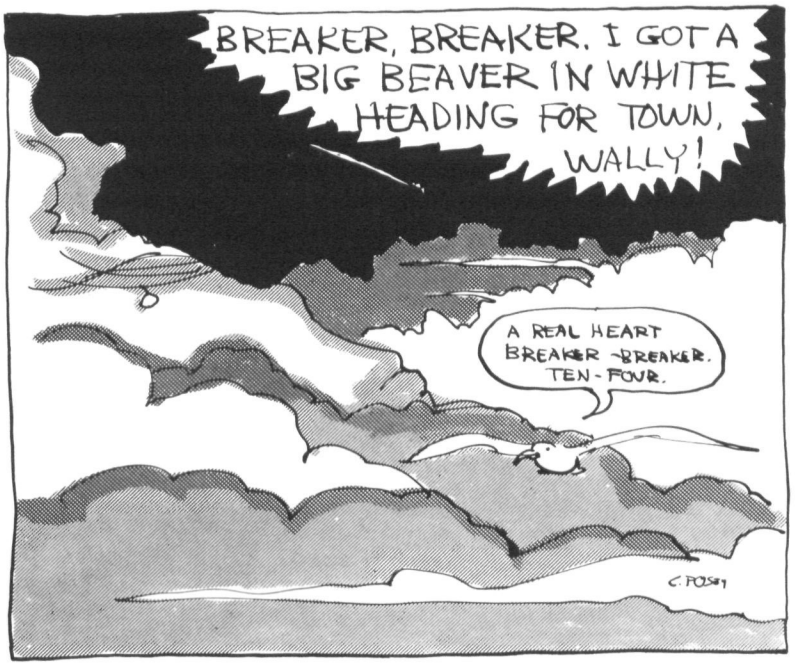

BEAUTIFUL!

HI. I'M NOAA-FIVE.
I'M AMY.

I'VE NEVER MET ANYONE LIKE YOU, AMY~BUT~YOU'RE.... CHANGING!
MATURING.

WHY.... YOU'RE.... YOU'RE A HURRICANE!
SO WHAT ELSE IS NEW?

SORRY, BABY~I'VE GOTTA TURN YOU IN.
YOU'RE AS BAD AS YOUR DAD!


BREAKER, BREAKER. I GOT A BIG BEAVER IN WHITE HEADING FOR TOWN, WALLY!
A REAL HEART BREAKER ~BREAKER. TEN-FOUR.
C. POSEY

Alive and well, and working in America, is

The Sea Grant Concept — Ten Years After

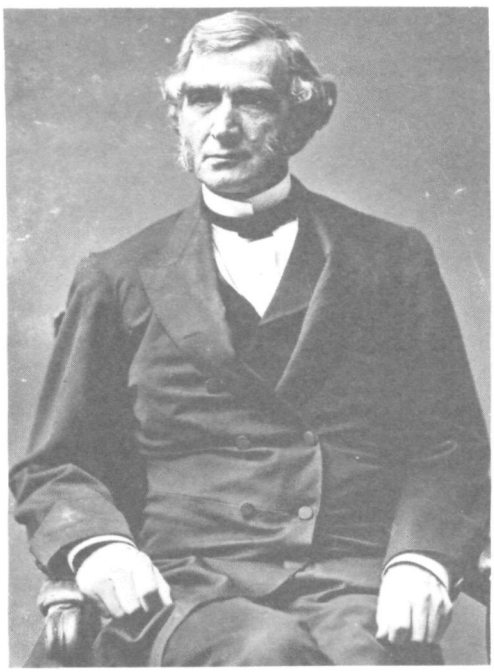
BY BRIAN GORMAN

Athelstan Spilhaus, whom everybody else considers the father of Sea Grant but who considers himself its mother ("Senator Pell was the father," he adds), claims it was the name that did it: Sea Grant. Even ten years ago it had a ring to it that was at once familiar—the Land Grant connection, of course—and new—the sea with all its romance and challenge and excitement.

Ideas that reach their fruition in the Congress, unlike the legislation they may lead to, usually don't have any convenient historical dates attached to their births. Looking back, we can say: At this point nobody even thought of such a thing and a few years later at *this* point everyone seemed to look on it as perfectly natural. But the period between those two dots of time may be the most interesting and most instructive in looking at the development and implementation of a concept.

The events—the meetings, conferences, letters—and the personalities that led to the creation of the Sea Grant College and Program Act just ten years ago are no exception to this at-times frustrating rule of history. Who were the persons involved in those early years before the Act was signed into law by President Johnson on October 15, 1966? There were many, of course, and as the idea behind the Act grew, so did the numbers of men and women who were willing to support and guide it. But there were four men, two scientists and two lawmakers, who were most instrumental in bringing the concept of a Sea Grant program into actuality. The scientists: Dr. Athelstan Spilhaus, who at the time was Dean of the Institute of Technology at the University of Minnesota, and Dr. John Knauss, then, as now, Dean of the Graduate School of Oceanography at the University of Rhode Island; the lawmakers: Senator Claiborne Pell also from Rhode Island and Representative Paul Rogers from the State of Florida.

Oddly enough, the germ for the Sea Grant idea was planted long before any of these men were born. More than a century before, in the mid-1850's, a visionary U.S. Congressman from Vermont, Justin Smith Morrill, led a long and sometimes frustrating fight to create what became known as the Land Grant College Act. The bill was finally signed into law by President Lincoln in 1862.



Justin Smith Morrill photo reproduced from Brady-Handy Collection, Library of Congress.

Morrill's notion, flying in the face of traditional educational philosophy of the time—concentrating as it did on philosophy, theology, the classical languages, and mathematics—was to broaden America's educational vision by taking advantage of its rapid industrial expansion and technological growth. Morrill felt by exploiting this material resource and by placing its development in the hands of educators and scientists in universities and colleges throughout the country, the Land Grant Act would produce an America that would become the most agriculturally sophisticated nation in the world.

The dramatic expansion of Morrill's dream was very much in the mind of Athelstan Spilhaus when, in September 1963, he addressed the American Fisheries Society's Annual Meeting in Minneapolis as the keynote speaker. It was here for the first time that mention was made of "Sea-Grant Colleges" and how they could relate to Federal and State agencies not only in fisheries but in all the broad aspects of ocean engineering.

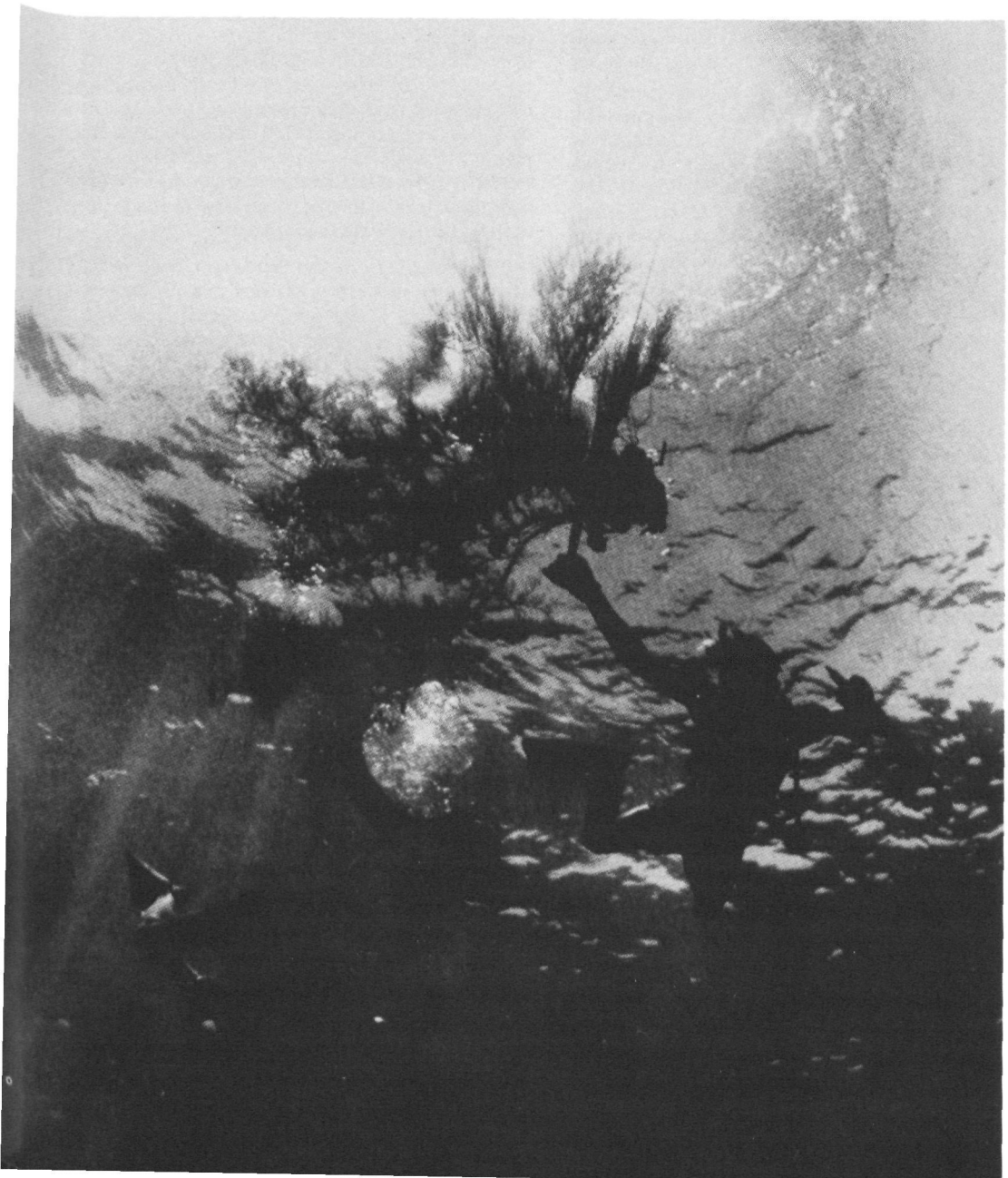
Exactly a year later, Spilhaus expanded on those first, tentative views in a guest editorial in *Science* magazine. In it he suggested that a sea grant program would "focus attention on marine science and . . . would develop strengths in the applications of marine science in colleges of aquaculture and ocean engineering." Spilhaus went on to say that these new disciplines would be "modern parallels of the great developments in the agricultural and mechanical arts which were occasioned by the Land Grant Act of about a hundred years ago."

While the idea of a sea grant program may have been novel in 1964, the growth of science that was to make it possible had been going on for some time. All the scientific and technological fields had been given a tremendous boost a few years earlier by the Soviet Union's launching of Sputnik in 1957. "There was a palpable excitement among scientists after Sputnik," recalls Dr. Knauss. "Throughout the late '50s and early '60s we began to see growth curves of 15 and 20 percent per year, not just in the area of space, but in oceanography and marine engineering as well."

It was an era of dramatic change and while the impetus behind that change—the competition fostered by the cold war with Russia—may seem somewhat dated and artificial by present-day standards, the perceived "technological gap" between the United States and the Soviet Union was soon to be closed.

The space sciences were in the vanguard of that growth. John Kennedy's promise in 1961 to put an American on the moon "by the end of the decade" provided the intellectual foundation for an entire generation of Americans—scientists and ordinary citizens alike—to meet that challenge. But the glamorous space programs, as dramatic as they were, were not what Spilhaus had in mind when he drew on the lessons and the progress of the land grant program.

"What we wanted in those early years," he recalls, "was nothing quite so romantic as a man on the moon. But it was something infinitely more practical: drawing the research out of academic institutions and pragmatically putting it to work, in the case of Land Grant, on the farms, in the case of Sea Grant, through a corps of county agents in hip boots."



But a sea grant concept, no matter how intriguing, was only a necessary and not a sufficient cause to bring about a National Sea Grant Program. Not only would the aid and support of men like Spilhaus and Knauss in the academic world have to be enlisted, but the Congress would have to be convinced that Sea Grant was indeed a worthwhile program.

"A tremendous amount of spadework had to be done," according to Knauss, "to raise the consciousness in the House and Senate with respect to problems in the oceans."

Two of the persons who set about convincing their colleagues in the Congress about the value of a Sea Grant program were Senator Pell and Representative Rogers. "It seemed so clear to me at the time," remembers Pell, recalling his feelings in the late summer of 1965, just before he introduced the Sea Grant legislation, "that this was an idea whose time had come." Amid all the flurry of scientific activity going on in the Nation at the time, Pell reasoned there was a compelling need for some kind of immediate, practical application for this knowledge. What better field than the oceans? And what better forum than our colleges and universities?

In August of 1965, just two months before the University of Rhode Island was to hold a conference in Newport, R.I., on the "Concept of a Sea Grant University," Pell introduced S.2439, a bill that, among other things, promised to establish "sea grant colleges and programs of education, training, and research in the marine sciences and a program of advisory services relating to activities in the marine sciences."

By the time hearings were held in the Senate, the House too was about to be presented with a similar bill, H.R. 16559. Paul Rogers, an articulate enthusiast for oceanology, and a member of the House Merchant Marine Committee, was its sponsor. He recalls sensing an equal interest at the time in putting the ocean's resources to work. "There was a great anticipation—a great feel-ing—that we could really move ahead on this. I guess you could sum it up by saying that there was a sense of national purpose in the Sea Grant concept."

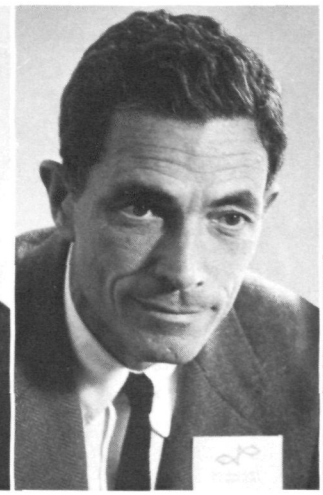
The speed with which the Sea Grant Act went through the Congress—from May 1, 1966, when the first hearings were held, to October 15, when President Johnson signed the Act--was truly remarkable (Justin Morrill was 46 when he introduced his Land Grant idea to the country. Three Congresses and a veto from President Buchanan later, the bill became law during the Lincoln administration, when Morrill was 52).

According to Spilhaus, one of the reasons for the Sea Grant Act's rapid passage had to do with its intrinsic appeal to the public and its representatives. It was non-partisan. It included in its philosophy not just the coastal and Great Lakes' states, but the entire country. And, it contained within it what Spilhaus likes to call synergism, the joint action of individual plans and ideas that when combined

Top: Sea Grant oceanographers sample plankton. Left: divers ascend with black coral to the dazzling surface, sun-reflected in this spectacular underwater photograph.

Dr. Athelstan Spilhaus

Dr. John Knauss


Senator Claiborne Pell

Representative Paul Rogers

Dr. Robert B. Abel

increase each other's effectiveness.

Not surprisingly, the idea of synergism is still what makes Sea Grant one of the most innovative and imaginative of all marine-oriented programs. The effect can be seen clearly in any number of local Sea Grant programs. The University of Delaware, for example, has a large and productive aquaculture project whose aim is to rear shellfish in a closed-cycle system which is self-contained and unaffected by outside environmental factors—clearly a project for researchers in the life sciences. But in addition to half a dozen biologists, Delaware's program is supported by persons in the fields of chemistry, nutrition, law, economics, and engineering. It also involves private industry through manufacturers of feedstuffs, prospective entrepreneurs interested in investing someday in a shellfish system of their own, the Delaware legislature through its support of the program in matching dollars, graduate students learning state-of-the-art shellfish science and who may someday become the Nation's leaders in the field, public school children whose educational tours of the mariculture system run two or three a week at times, and other scientists throughout the world whose own knowledge is increasing in direct proportion to what is taking place in Delaware. Synergism, for Sea Grant, is more than simple cooperation among faculty members at a college.

But just as the full development of the Sea Grant concept didn't reach fruition overnight, the development of programs like Delaware's took some time to mature. In January 1967, Dr. Robert B. Abel was appointed Director of the Sea Grant Program, which at that time was part of the National Science Foundation. It was not until more than year later that NSF made its initial awards. And, it was not until three years after that, in 1971, that Sea Grant, now in the newly-created National Oceanic and Atmospheric Administration, designated the first of what have become eleven Sea Grant Colleges. Those first schools, Texas A&M University, the University of Rhode Island, Oregon State University, and the University of Washington, are themselves still growing.

There have been other kinds of growth as well. Sea Grant's budget has grown, from $5 million in 1968 to almost $28 million today. The number of projects has grown, from a handful in those early years to more than 700 at present. The number of states participating in Sea Grant programs has grwn, grown to 28 including two—Arizona and Oklahoma—whose involvement confirms Spilhaus' insistence that the ocean's influence does not stop at the shore.

But these statistics, however optimistic, don't get to the heart of what the Sea Grant concept is all about: a cooperative Federal-State-industry program, working primarily through academic institutions, designed to benefit all those whose lives and livelihoods are touched by the oceans and the Great Lakes. Who are these people and what are the benefits? They are as disparate as the country that holds them. They include the obvious—marina operators, sport and commercial fishermen, seafood processors, shipbuilders, and coastal zone managers. And they include the not so obvious—pharmacologists trying to find a cure for high blood pressure, brewers looking for a way to eliminate cloudy beer, highway departments seeking ways to extend the life of bridges, and utility companies attempting to put their thermal effluent to good economic use.

Item: At the University of Oklahoma, a team of Sea Grant-supported biochemists and pharmacognosists is hard at work looking for natural chemicals that could be useful in treating cancer and leukemia, hypertension, and heart disease. The source of these chemicals? Marine plants and animals collected from the coral reefs of the Bahamas, Bermuda, Jamaica, Florida, and Eniwetok.

Item: At Cornell University, an enzyme chemist has discovered that a chemical, laminarinase, in the gut of the ordinary clam is capable of breaking down carbohydrates that cause dental plaque on our teeth, that clog filters in the breweries that make our beer, and that lead to life-threatening mold in the blood vessels of burn victims.

Item: At Florida Atlantic University, a group of engineers is designing steel reinforced concrete structures that are highly resistant to seawater corrosion. Many of Florida's 4000 reinforced concrete bridges are in hostile coastal zone areas or even the open sea. The State Department of Transportation, which estimates that the anticipated replacement of the Florida Key bridges alone over the next ten years could cost as much as $250 million, is especially interested in the results of this Sea Grant project.

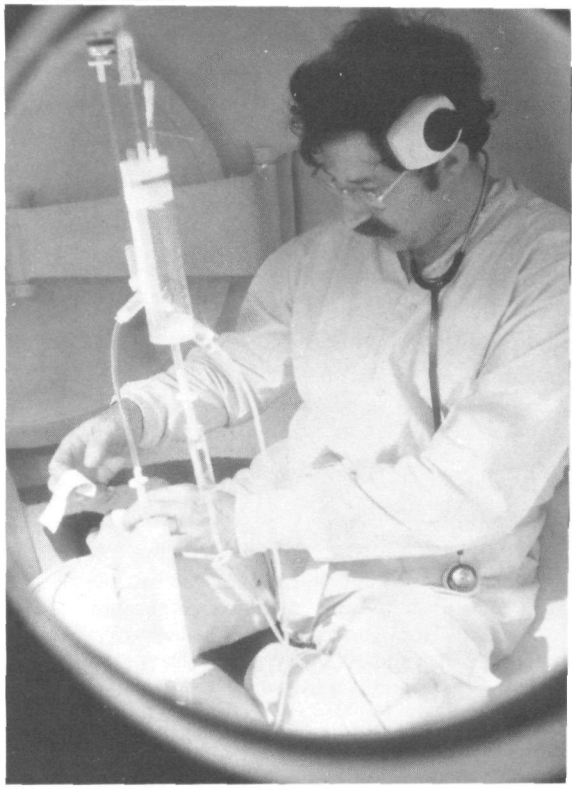
Item: At the University of Maine, environmental scientists, who were among the first to develop a mathematical model from field data to predict changes in concentrations of radionuclides in shellfish, are now learning about the benefits that can accrue to those same molluscs living in the heated effleunt of power plants. Already one commercial and two pilot shellfish grow-out operations are underway to determine how effective this heated water is in making the shellfish grow faster.

The excitement of the Sea Grant concept is not so much in meeting the obvious challenges of the marine world—improving aquaculture techniques, designing better trawl nets, dealing with shoreline erosion—but in realizing there are countless unrecognized, unevaluated, and unanticipated intellectual, scientific, and practical benefits to be discerned, resolved, and applied to the problems of an amazingly complex society living on an incredibly complex planet.

These intellectual challenges, so integral a part of the Sea Grant concept, are mentioned nowhere in the Sea Grant Act. Pragmatism, applicability, usefulness are the watchwords of Sea Grant, for these represent the thrust of the National Sea Grant Program and are the touchstones by which the relative merits of an undertaking ought to be measured. But in a larger sense they are only the palpable reflections of what Sea Grant's whole philosophy—its concept—is all about: undogmatic and comprehensive and adventurous.

The important question to ask on this tenth aniversary of the Sea Grant Act therefore is not how has the Sea Grant *Program* grown? but how has the Sea Grant *concept* grown?

Perhaps the best persons to answer that question are those men who were involved with the concept while it was still in its infancy. Paul Rogers sees the Sea Grant idea reaching out toward new applications in the management of the coastal zone and in the development of our offshore mineral re-



Clockwise from above: University of Michigan tests sand-filled plastic cylinder as partial breakwater; Dr. Lee Somers checks equipment in hyperbaric chamber; rearing tanks used in the University of Delaware's closed-cycle aquaculture system; salmon being removed for study at the University of Rhode Island.

sources. "We're beginning to see another build-up of interest not just within Sea Grant but with the country as a whole," he says. The *idea* that we can apply our technology to an increasing number of oceanic challenges, something that has been implicit in the Sea Grant concept all along, is what heartens the Florida Congressman.

Claiborne Pell too is optimistic. The increasing number of courses offered in the marine sciences, particularly at the elementary and high school level, is only one indication of a new awareness of the importance of the seas, according to Pell. "The life guards on the beaches of my home island of Aquidneck," Pell says with some pride, "are no longer calling the marine vegetation that grows along the shore 'seaweed,' they're calling the material 'seaplants.' " He adds that it's a small change, of course, but it is an important indication of a change in people's characterization of the oceans as something that can be productive, like farmland, rather than simply an area of recreation that contains an occasional biological curiosity.

Like Pell, John Knauss sees the enormous growth in marine studies in the lower grades as a promising index of the day-to-day impact the marine world has on all of us, students, teachers, and parents. "The programs in marine education that have been developed through Sea Grant support as well as those that have been initiated in areas without any Sea Grant influence are both a cause and an effect," he says. "They're a cause because they are teaching young people about the oceans. And they're an effect because they are an undeniable indication of how local governments feel about the importance of marine sciences."

Spilhaus, now special assistant to NOAA Administrator Dr. Robert M. White, feels that indeed the Sea Grant concept had grown. Always a visionary, however, Spilhaus sees the greatest conceptual challenge for Sea Grant lies ahead. And it lies not in the sciences but in the humanities. "The oceans are a wonderful place on which to focus any discipline," he claims. "It's not just a place for scientists. It's a place for everybody. It's a place for artists; it's a place for writers; it's a place for musicians." What Sea Grant has done so admirably, according to Spilhaus, is to take peoples' enthusiasm and use it to project into science. Expanding upon this natural enthusiasm Spilhaus sees as the great challenge for Sea Grant in the years ahead.

Land is just an island, Spilhaus is fond of telling us. And, echoing John Donne's reminder that each of us is a "part of the main," he is hopeful that the Sea Grant concept will go a long way toward showing all of us the truth of that statement. □

Bonnie Stubblefield, oceanographer, seeks

Secrets of the Seafloor

BY JOAN VANDIVER FRISCH

While most of her colleagues are sound asleep, Dr. Bonnie McGregor Stubblefield is awakened by the shrill ring of her bedside clock. It's 3 a.m. as she turns off the alarm, dons a sweater, slacks, and sneakers and heads for the deck of the NOAA ship Researcher. Her mission: to haul in seismic equipment used to map the eastern seaboard's ocean floor.

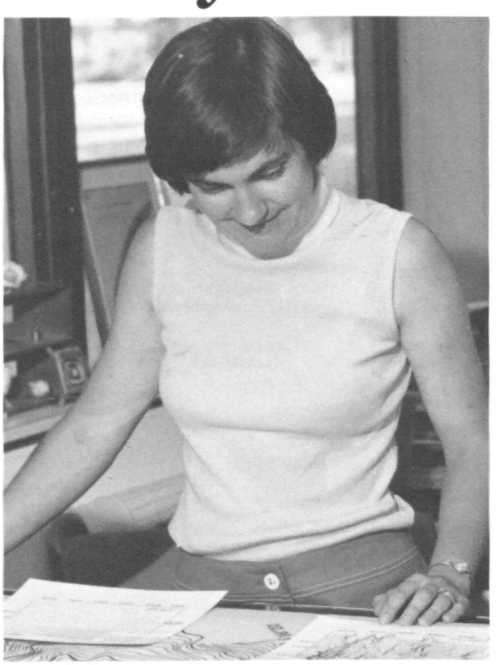
She joined NOAA's Environmental Research Laboratories four years ago at its Atlantic Oceanographic and Meteorological Laboratories in Miami, Florida. Since becoming a member of the Laboratories' Marine Geology and Geophysics Laboratory, Stubblefield has been put in charge of one of the lab's three principal programs—RUSEF (Rational Use of the Sea Floor)—a study which is concentrating on the region between the eastern coastline's continental shelf and the deep sea.

RUSEF complements the lab's other two areas of focus: the Marine Ecosystems Analysis project in the New York-New Jersey harbor area, a near-shore program; and the Trans-Atlantic Geo-Traverse project. The latter is a deep-ocean study which is concentrating on the evolution of the seafloor, and the possibility of marketable metals being present where the sea floor is forming along the mid-Atlantic Ridge.

"My principal interest is looking at the ocean floor and near-floor processes along the continental slope—the RUSEF study area," Stubblefield says. "To accomplish this objective, I spend about 40 days and nights a year on board the Researcher, recording bottom currents, sea floor slumping, and creep of sediments as they move from the continental shelf down the slope to the ocean depths."

During the past summer, Stubblefield and fellow scientists have been analyzing the sedimentary framework of the continental margin—the zone which separates a continent from the deep sea floor—using seismic reflection profiles gathered by sonar-type equipment on board the Researcher.

"From the profiles, which run parallel to the margin, we can determine variations in the sedimentation history from the Tertiary Period—10 to 70 million years ago—to the present," she explains. "Before the Tertiary Period, during the Mesozoic, the Atlantic ocean basin started opening, and with it began the evolution of the continental margin."



However, the width of continental shelves, the intensity and direction of current systems, and supply rate of sediments vary widely. While marine geologists have gathered much information about the structure of continental shelves, much less is known about either the sediments or the underwater profiles of the continental slope, his particular area of research.

In the past the geologic oceanographer and her colleagues collected data between the Georges Bank off Cape Cod, Massachusetts, and Cape Hatteras, North Carolina. This summer the NOAA research team gathered information between Cape Hatteras and Cape Canaveral, Florida.

"During the cruises, we follow a strict schedule," she explains. "Between 7 a.m. and 3 p.m. we sample sediments along the outer continental shelf, slope and rise at 60-mile intervals with a piston core device."

The core equipment consists of a 20-foot-long metal hollow barrel, about three-inches in diameter, with a one-ton weight and strong steel cable attached to its top end. When the piston and barrel are dropped over the side of the ship, the device sinks at a rate of 70 meters per minute toward its destination on the ocean floor.

At a water depth of 7,900 feet (2,400 meters) the journey to the bottom takes the drop corer 35 minutes and the entire round trip takes over an hour. Approximately four core samples are collected on an eight-hour shift.

"Along the laboratory s study area, the continental slope varies from 100 meters below sea level at the upper edge of the rise to 4000 meters at the bottom edge," Stubblefield explains.

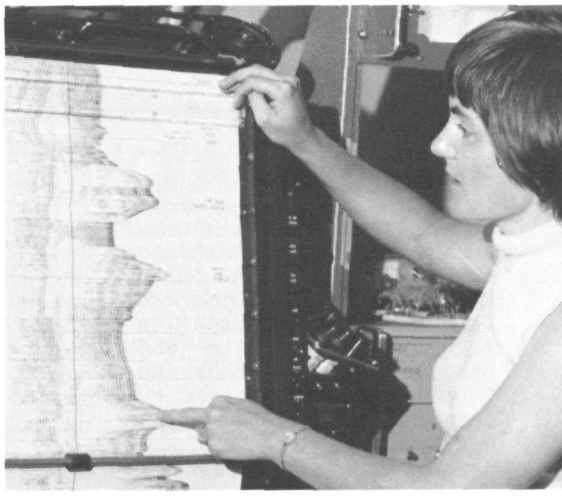
Once the corer has reached its destination on the ocean floor, the barrel is pulled clear, its cargo of sediment already encased in plastic which is capped and sealed on board the Researcher for analysis at NOAA's Marine Geology and Geophysics Laboratory.

With two 20-foot sections of pipe, this method is effective for collecting samples of the top 40 feet of sediment.

Piston cores for the present research are being collected in a cooperative program with Dr. Larry Doyle at the University of Southern Florida's Marine Science Department in St. Petersburg. Dr. Orrin Pilkeyat Duke University in Durham, North Carolina, is also taking part in the program.

When a day's work of sampling the ocean floor ends at 4 p.m. Stubblefield takes a dinner break before changing techniques to gather seismic reflection profiles of the ocean floor at night.

To gather the profiles between 6 p.m. and 3 a.m, two air guns—a 40-and a 120-cubic inch model—are towed simultaneously behind the Researcher via steel cables. The air guns, which consist of metal piping with a series of ports—use compressed air as their energy source. When positioned for action, guns are fired at eight-second intervals. A 200-foot hydrophone, resembling green rubber garden



Dr. Bonnie Stubblefield uses many tools of the oceanographer's trade as head of RUSEF (Rational Use of the Sea Floor)—magnetometer (upper left) and seismic reflection profile of the seafloor (upper right), as well as shipboard sediment coring (center) with later laboratory work (lower right) in Miami where William Sawyer carefully sections the cores for analysis. At home, the oceanographer turns gardner (lower left).

hoses equipped with 100 evenly spaced elements, is towed behind the ship.

"As the air guns begin firing, the return echo signals are received by the hydrophones and recorded on board the vessel," she explains. "The first return echo comes back from the sea floor itself. Successive returns are reflections of sediment horizons within the sea floor down to a depth of about 800 meters.

"Our ultimate goal is to analyze these sediment core samples and seismic profiles to determine recent sedimentation patterns along this portion of the eastern coast.

"The objective of the RUSEF program is to look at the continental margin and locate sea floor areas where ocean floor processes have affected sediment stability."

Using the seismic profiles for reference in identifying such affected areas, Stubblefield and her colleagues then return to the research area and perform more detailed studies on these specific areas. The intensified research includes photography of the ocean floor, current meter measurements, 40-foot sediment core samples, and detailed bathymetric surveys.

For example, the NOAA research team has located an area off the coast of Wilmington, Delaware, measuring 35 square miles, where a large "slump block" has been identified on the continental slope. With 40-foot sediment piston cores to assess the region's stability and with seismic profile, the scientists have been able to outline the underwater slump block's shape and volume. Located approximately 75 miles offshore, the area is of particular interest because of marine dumping operations and construction of offshore structures.

The end product of such research—detailed hand-contoured bathymetric maps—are especially useful to environmentalists and petroleum companies interested in assessing sea floor stability.

Before the oceanographer began conducting such research for NOAA in Miami, she was more familiar with the coastlines of Rhode Island and Massachusetts. Born 34 years ago in Fitchburg, about 50 miles west of Boston, she first became interested in oceanography as a junior high school student.

"I thought it was a good field for anyone who liked sailing, science, and the sea," she says. After receiving a B.S. degree in geology from Tufts University in Medford, Massachusetts, she completed an M.S. degree in oceanography from the University of Rhode Island. In 1975 she received her Ph.D. in marine science from the University of Miami.

When she is not on board ship or behind her desk, she is engrossed in off-hour activities around her home as the wife of Lt. Cdr. William L. Stubblefield of the NOAA Corps.

"I'm a frustrated gardener at heart," she says. Both she and her husband care for a backyard garden in south Coconut Grove, Florida, which includes orchids, crotons, gardenias, grapefruit, avocado, and mango trees. They also like to refinish and build furniture and when time allows, take a weekend of camping.

"I like being a scientist, and enjoy the time I can spend outdoors appreciating nature." □

COASTAL MANAGEMENT ACT AMENDED

President Ford has signed into law a bill amending the Coastal Zone Management Act of 1972, administered by NOAA's Office of Coastal Zone Management. The Act authorizes a total of $1.6 billion to assist coastal states and territories in developing and implementing coastal management programs, and for coping with impacts of offshore oil and gas production.

Final Congressional action on the report capped nearly four months of conference committee deliberations, and two years of work.

The new legislation has two distinctive parts. It amends the basic authority of the Coastal Zone Management Act to $464 million, and establishes a $1.2 billion, 10-year Coastal Energy Impact Fund to help coastal states cope with the impacts of coastal energy activity, including offshore oil and gas development.

The fund authorizes $800 million in loans and $400 million in grants to help states and communities provide public facilities (schools, highways, hospitals, for instance) needed to accommodate inflated coastal populations brought about by offshore drilling operations and certain other coastal energy activities.

The fund may also be used to plan for the socio-economic and environmental consequences of increased energy activities at the state and local level; to prevent or reduce environmental damages resulting from such activities; and to guarantee state and local bonds issued for dealing with energy impacts.

The $800 million will be alloted to states in the form of loans, requiring repayment, while the $400 million will be awarded in grants based on a formula including the number of offshore acres leased, the volume of oil and gas produced and landed, and the number of new residents employed in Outer Continental Shelf-related activities. The purposes for which the grant money may be used are carefully restricted.

Amendments to the basic act extend funding authority through September 1980, permit states to receive a fourth year grant to develop their programs, increase the federal share of program development grants from two-thirds to 80 percent with states contributing the balance, and provide an interim period before final approval during which states may receive an 80 percent grant to complete the development program.

Among the distinguished guests present at the signing of the new bill were (from left) Rep. Ralph H. Metcalfe (Ill.), Rep. Mathew J. Rinaldo (N.J.) Rep. Edwin B. Forsythe (N.Y.), Secretary of Commerce Elliot L. Richardson, Sen. Ernest F. Hollings (S.C.) Rep. Leo C. Zeferetti (N.Y.), Rep. Norman F. Lent (N.Y.) Sen. Warren G. Magnuson (Wash.) Unidentified, Rep. Robert E. Bauman (Md.), Sen. Ted Stevens (Alaska), Rep. Charles A. Mosher (Ohio), Rep. Mario Biaggi (N.Y.), Rep. David C. Treen (La.), Rep. Pierre S. du Pont IV (Del.), Rep. David F. Emery (Me.), and Rep. Fred B. Rooney (Pa.).

International Gulf of Alaska Chart Issued

The National Ocean Survey has published an international nautical chart, INT. 500, covering the Gulf of Alaska from Dixon Entrance on the east to Unimak Pass in the Aleutian Islands. It is the fourth of five international nautical charts to be issued by the NOS as part of a multination program sponsored by the Monaco-based International Hydrographic Organization (IHO).

The IHO program will provide a standard series of nautical charts of the world's oceans that can be used by all nations. Each IHO member nation is authorized to reprint charts in its own language, but employing the same form of navigational information, such as depth curves, sounding spacing, aids to navigation, and nautical symbols.

Published by the NOS Office of Marine Surveys and Maps, INT 500 (NOS Chart 500) is 1:3,500,000 scale, and is the fourth metric chart issued by the NOS showing elevations as well as depths in metric units.

Computer Model Mimics Hydrologic Cycle of World

Two Environmental Research Laboratories scientists have developed a mathematical model of atmospheric circulation that simulates the seasonal changes in the movement of water through the global environment. With such a model, scientists can manipulate conditions such as sea surface temperature to single out the factors that affect precipitation.

Working toward the ultimate goal of predicting weather and climate, scientists at ERL's Geophysical Fluid Dynamics Laboratory in Princeton, N.J., are developing and refining computer models of the atmosphere and its components. The hydrologic cycle—moisture's round-trip excursion through rainfall, streams, oceans, evaporation, clouds, and back to rain—is one of the main ingredients of weather and climate, and one of the most difficult to predict. With an artificial earth that exists only as computer instructions based on physical laws, GFDL researchers will be able to conduct experiments to determine the effects on climate of mountains or changes in sea temperature and carbon dioxide concentrations.

Drs. Syukuro Manabe and J. Leith Holloway, Jr., have succeeded in developing a simplified model that does a satisfactory job of simulating the hydrologic cycle and climate. It already has been used to study the effects of sea surface temperature anomalies over the Arabian Sea on the Indian monsoons.

The model takes into account such factors as solar radiation, water vapor, and sea surface temperature, and the variations of these factors in time and space. To test their model, they allowed it to run through three artificial "years," and compared the results with observations in the real world.

NOAA, Exxon Study Mediterranean Sea Oil

NOAA scientists and the Exxon Research and Engineering Company of Linde, N.J., have begun a joint examination of how much oil is in the Mediterranean marine environment, and whether this contamination is increasing.

The project is supported by a contract from NOAA's Marine Ecosystems Analysis program which studies the relationships between human activity and the marine environment.

Personnel aboard Exxon ships will collect samples of Mediterranean Sea water which NOAA scientists subsequently will analyze for hydrocarbon levels and comparison with data obtained three years ago in cooperation with the U.S. Maritime Administration.

Data taken in the present study also will be compared by NOAA researchers with hydrocarbon levels in the New York Bight and Puget Sound; both sites of ecosystem analysis studies.

Information from the study should help scientists refine appraisals of how much oil is in the global sea. It is estimated, for example, that oil from natural seeps enters the marine environment at a rate of more than 550,000 tons (about half a million metric tons) a year, and that offshore petroleum production raises that total to nearly 1,650,000 tons (1.5 million metric tons), or about 9.5 million barrels a year.

NOAA-5 Satellite Operational

A new polar-orbiting satellite launched for NOAA is providing weather forecasters and others with a wide variety of environmental data.

NOAA-5 spacecraft, built for NOAA by RCA, was put into orbit by the National Aeronautics and Space Administration some 935 miles (1505 kilometers) above the earth's surface.

The new spacecraft replaces an earlier version, NOAA-4, as the primary operational polar-orbiting satellite. NOAA-4 has become the back-up spacecraft.

The National Environmental Satellite Service operates two satellite systems; one is polar orbiting, while the other consists of two geostationary satellites which remain in the same relative position to the earth's surface at all times.

The polar-orbiting spacecraft scans any given spot on earth twice every 24 hours, returning visual and infrared imagery of cloud cover, sea surface temperature, and other environmental indicators.

Among other uses, polar orbiting imagery is being utilized to help supply vessels pick their way through the summer ice off Alaska's North Slope en route to Prudhoe Bay, a major supply depot for Alaskan pipeline activities.

Gulfstream Model Simulates Currents

NOAA scientists have described the precursors of the Gulfstream in a mathematical model that simulates currents in the Gulf of Mexico, and that may eventually be used to predict where those currents would carry oil spilled in the Gulf.

The model has been applied to Gulf currents by scientists at the Atlantic Oceanographic and Meteorological Laboratories (part of the Environmental Research Laboratories) in Miami, Fla., for the Interior Department's Bureau of Land Management.

It is the first in an evolving family of such models that could be used in predicting oil spill trajectories in the Gulf of Mexico.

The mathematical equations which compose the model use density data—salinity and temperature measurements taken at different ocean depths—to calculate currents.

Scientists Probe Florida Waterspouts

Three scientists from Colorado have been probing Florida waterspouts with laser beams aboard a small, single-engine plane.

The laser is part of a novel wind sensor that Dr. Ronald Schwiesow and Richard Cupp of NOAA and Dr. Peter Sinclair of Colorado State University are using to measure wind velocities in the seagoing funnels off the Florida Keys. Their study, sponsored by the Nuclear Regulatory Commission's Office of Nuclear Regulatory Research, hopes to use the results to understand severe weather phenomena.

The wind-sensing system, designed by Schwiesow, Cupp, and others at NOAA's Wave Propagation Laboratory (one of the Environmental Research Laboratories) in Boulder, Colo., uses laser-generated beams of infrared radiation to gauge wind speeds. It has been used previously to study dust devils, thermal plumes, and other weather phenomena on land.

The infrared doppler device uses a lidar (the laser equivalent of radar) to measure the velocity with which particles—such as water droplets in a waterspout—are moving toward or away from it, by bouncing light waves of known frequency off the target and measuring the frequency (doppler) shift of the return signal.

When they spot a waterspout, the researchers probe it from a safe distance of about half a mile. Simultaneously, a specially instrumented aerobatic T-28 flies into the spout, obtaining on-the-spot velocities to compare with those obtained by the remote sensor.

The researchers hope to answer questions raised by previous investigations concerning vertical motions in waterspouts. Measurements from aircraft flying through waterspouts suggest central updrafts, contrary to theoretical understanding of the thermodynamic processes involved. In fact, it is thought that a downdraft is more likely, according to Dr. Joseph Golden of the ERL Office of Programs.

'It's pretty hard, going through a spout, to get a good wind profile. We can take our time and scan the whole thing," Schwiesow said. While the doppler lidar can measure only the wind velocities parallel to the line of sight of the laser beam, making updrafts and downdrafts difficult to measure, Schwiesow believes that by flying close to the top of the spout and looking downward any vertical winds can be detected.

Memorandum Signed; Provides New Calibration

Under a memorandum of understanding between NOAA and the U.S. Naval Oceanographic Office (NAVOCEANO), NAVOCEANO now provides oceanographic instrument calibration services at the National Space Technology Laboratories at Bay St. Louis, Miss.

The Gulf Regional Calibration Center (GRCC) of the National Ocean Survey's National Oceanographic Instrumentation Center has provided calibration services to the community, in addition to supporting the marine and atmospheric calibration requirements of the NOAA Data Buoy Office, which is also located at Bay St. Louis.

GRCC has been utilizing a multi-million dollar calibration and test facility designed for marine and atmospheric instrumentation calibration that was established at NSTL in 1971 by the National Aeronautics and Space Administration. Economic and other factors dictate that this modern, state-of-the-art equipment be utilized by NAVOCEANO, whose personnel are being relocated at Bay St. Louis. NAVOCEANO's calibration services will also be available to the marine community.

NOAA will provide engineering assistance to train Navy personnel in the calibration of the instruments not normally utilized by Navy, and will assist in the establishment of a Naval Oceanographic Office liaison with the Center's present customers.

The Navy will assure the quality of its instrument calibrations. Measurements will be traceable to the National Bureau of Standards through the Navy Metrology Calibration program, and to recognized international standards.

Hawaiian Monk Seal Becoming Endangered

The Hawaiian monk seal may be in danger of becoming extinct and may be placed on the endangered species list.

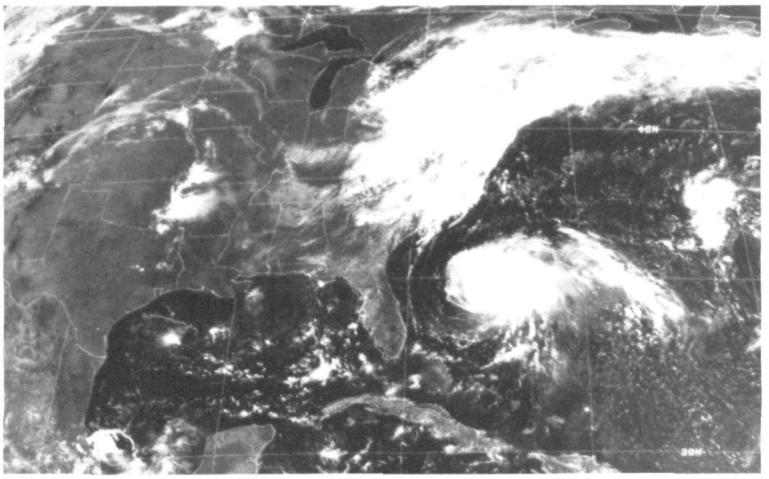
Robert W. Schoning, Director of the National Marine Fisheries Service, and Lynn A. Greenwalt, Director of the U.S. Fish and Wildlife Service, proposed a ruling that would list and protect the Hawaiian monk seal (*Monachus schauinslandi*) as an endangered species throughout its range. It is issued under the authority of the Endangered Species Act of 1973.

Found throughout the Hawaiian Archipelago, the Hawaiian monk seal breeds only on the islands of the Leeward Chain, including French Frigate Shoals, Laysan Island, Lisianski Island, Pearl and Hermes Reef, Midway Atoll, and Kure Atoll.

A status review undertaken by the NMFS reflects the rarity of the species, the high mortality in pups, the relatively low reproductive rate, and indications of population decline and harassment.

Satellite Photos Help

NOAA Estimates Rainfall



Satellite photo showing Hurricane off the Florida Coast

NOAA hurricane forecasters this year are testing a new method for predicting the difference between destructively wet hurricanes like Agnes (1972), Fifi (1974), and Eloise (1975), and relatively dry ones.

The experimental technique estimates hurricane rainfall potential from cloud images transmitted by one of NOAA's geostationary satellites, operated by the National Environmental Satellite Service. The spacecraft is in an earth-synchronous orbit that keeps it aways 22,250 miles (35,800 kilometers) over the same point on the equator.

Rainfall estimates derived from satellite pictures of approaching storms are flashed from the National Hurricane Center in Miami, Fla., to the National Weather Service river forecast offices. There, computer models of river basins in the path of hurricanes will use the information to predict probable flooding and flash-flooding.

NHC Director Dr. Neil Frank explained, 'we've known for years that some hurricanes are wetter than others, but this will be the first time we've had a tool for getting that difference into our warnings.

"We're excited about the new technique because, if we can give our River Forecast Centers realistic rainfall forecasts, they can make excellent predictions of river flooding. The importance of timely flood warnings ahead of hurricanes was dramatically illustrated by Agnes in 1972 and Eloise last year."

According to NHEML Physicist Cecilia Griffith, the satellite method of estimating rainfall was formulated jointly by scientists in Miami and their colleagues at the University of Wisconsin's Space Science and Engineering Center. The method is a by-product of the Florida Area Cumulus Experiment, or "FACE."

"The technique was developed for use in FACE to give us an approximation of rainfall in large areas outside the target area," she said, referring to the area south of Florida's Lake Okeechobee where cloud-seeding experiments took place. "We needed to know this to help determine whether increased rainfall in the target area was robbing rain from somewhere else."

The researchers used radar and raingage data taken inside the target area to "calibrate" rainfall estimates based on cloud brightness in photos from earth-synchronous satellites. With that calibration, they then were able to make estimates for areas outside the target area based on satellite images alone.

"For hurricanes," Ms. Griffith explained, "We take a satellite picture, measure the cloud area at two specified brightnesses, and relate that to the volume of rainfall produced by that hurricane.

Ozone Enemies Destroyed By Chemical Scavenger

A restless chemical scavenger in the atmosphere may devour certain potential ozone-destroyers before they ever reach the protective shield in the stratosphere.

Dr. Carleton J. Howard, a researcher at NOAA's Environmental Research Laboratories in Boulder, Colo., is conducting chemical experiments to help determine the odds that a given compound released at earth's surface will be rendered harmless.

"The ubiquitous hydroxyl molecule, consisting of one oxygen and one hydrogen atom, is a chemical scavenger, capable of removing various polluting gases in the lower atmosphere," explains Howard.

"For example, lethal carbon monoxide, released in automobile exhaust, is oxidized by the hydroxyl and converted to carbon dioxide, a harmless gas. And hydrogen sulfide, produced in great quantities by decomposed organic material, is probably also precipitated out of the atmosphere in the same way."

But until recently, little was known about how hydroxyl reacts with another class of compounds, the halocarbon compounds, containing chlorine, bromine, and fluorine.

These three elements, if they reach the stratosphere, can destroy ozone.

Because of the quantities released, chlorine—and to a lesser extent bromine—are the two elements presenting the greatest hazard.

"If significant amounts of chlorine contained in industrial compounds reacted with the hydroxyl molecule, that would reduce their atmospheric lifetimes in the troposphere (the lowest layer of the atmosphere) and effectiveness in destoying ozone in the stratosphere," he said. "Identifying those compounds which react with the hydroxyl molecule is the reason for carrying out the laboratory experiments."

Howard and his colleagues at NOAA's Aeronomy Laboratory in Boulder, Colo., tested the hydroxyl, ever-present in the atmosphere from natural sources, with a variety of compounds in which one or more of the hydrogen atoms in industrial methane, ethane, or ethylene had been replaced with a halogen atom.

Evacuation Maps Issued By NOS for Gulf of Mexico

The National Ocean Survey has issued nine storm evacuation maps for the area along the Gulf of Mexico from New Iberia, La., to Beaumont, Tex.

The maps show emergency evacuation routes, areas subject to flooding from hurricanes and other storms, and elevations that might afford "safe islands" for storm evacuees.

The New Iberia to Beaumont maps have been distributed to state and local officials and community emergency preparedness committees.

The nine maps include parts of the Louisiana parishes of Iberia, Vermilion, St. Martin, Cameron, Calcasieu, Jefferson Davis, and Acadia, as well as Newton, Jasper, Orange, Liberty, Hardin, and Jefferson Counties in Texas. In addition, numerous communities are covered by the maps, including Beaumont, Port Arthur and Orange, Tex., and Vinton, Sulphur, Lake Charles, Welsh, Jennings, and Abbeville, La. Many beaches and other points of public interest along the Gulf Coast also are covered.

U.S. and Japan Continue Albacore Research

Research by the United States and Japan on the North Pacific albacore stock—thought to be approaching its biological limits—will be continued under an informal agreement.

In recent years the total annual harvest of North Pacific albacore has increased from 70,000 to 100,000 metric tons, primarily because of the expansion of the Japanese pole-and-line fishery, which accounted for 64 percent of the 1974 catch. Other major fisheries are the Japanese longline, 15 percent; and the United States troll and live-bait fisheries, 21 percent.

The agreement between the two nations emerged from a population dynamics albacore workshop held at NOAA's National Marine Fisheries Service laboratory in Honolulu, Hawaii, and involved the NMFS' Southwest Fisheries Center, La Jolla, Calif., and the Far Seas Fisheries Laboratory, Shimizu, Japan.

United States albacore fishermen actively support and finance government-industry research programs with the objectives of increasing the efficiency of albacore fishing and developing scientific information for albacore conservation.

Recreational Fishing To Be Evaluated

The effects of marine recreational fishing upon this country's economy will be studied under a $70,329 contract awarded by the National Marine Fisheries Service.

The contractor, Centaur Management Consultants, Inc., of Washington, D.C., will gather information on the value of goods and services generated from sport-fishing equipment, boat rentals, motors, camping equipment, food and lodging. The survey will identify and evaluate the commerce created by the sale of these items, and divide the economic impact into four regional areas: northeast, southeast, northwest and southwest.

Sources of information will include sampling surveys of supplies of goods and services from origin to point of sale.

The end product of the study will be a comprehensive document of the socio-economic scope and value of marine recreational fishing in the United States. The study, to be completed in the spring of 1977, will assist the NMFS, state agencies, and regional management councils in evaluating the relative merits of recreational and commercial fishing in the management of marine resources and in administering the Fishery Conservation and Management Act of 1976.

Sonar System To Be Developed By Mass. Firm

NOAA has awarded a $395,000 contract for the development of a Bathymetric Swath Sonar System to supplement the basic hydrographic charting program.

The device, a modified sonar system, will permit the hydrographer to evaluate a wider swath of echo soundings beneath the survey vessel than those obtained by conventional echo sounding techniques. The system will provide a contoured display of shoaler depths and navigation hazards to the left and right of the survey ship's track in addition to the traditional digital record of the bottom profile directly beneath the ship.

The contractor is the General Instrument Corporation, Westwood Mass. The contract calls for the new system to be installed on the NOAA Ship Davidson late next year in Seattle.

OCEAN CURRENTS TRANSPORT HEAT

Ocean currents carry more than water. They are in effect a mass transit system for heat.

Two scientists have recently completed the most thorough investigation ever done on how heat energy from the sun is distributed around the earth, and found that the oceans transport much more of this heat than anyone had thought.

Drs. Abraham H. Oort of the Environmental Research Laboratories and Thomas H. Vonder Haar of Colorado State University analyzed the heat balance of the northern hemisphere, making quantitative estimates of how much heat is gained, lost, and stored by the atmosphere and ocean each month of the year in 10-degree latitude belts.

Dr. Oort, a researcher at the Geophysical Fluid Dynamics Laboratory at Princeton, and Dr. Vonder Haar based their conclusions on thousands of temperature measurements in the atmosphere and oceans collected by other researchers from satellites, ground stations, and oceanographic vessels.

The data included satellite measurements of reflected sunlight and infrared (heat) radiation from earth from 1964 to 1971; five years of daily atmospheric temperature measurements taken by balloon at about 600 stations throughout the northern hemisphere; and all the ocean temperature observations on record at the Environmental Data Service's National Oceanographic Data Center.

From this data the two scientists formulated representation of the earth's heat balance that includes how much heat enters the top of the atmosphere, is stored in the atmosphere and oceans, transported by oceanic and atmospheric circulation, and interchanged between atmosphere and earth—the ocean, land, ice, and snow.

The atmosphere and oceans serve as reservoirs, storing heat during summer and releasing it during winter, thereby evening out seasonal differences. Winds and currents transport huge amounts of heat from warm to cold regions, smoothing out the climate in a geographical sense. Thus the oceans and atmosphere exert a moderating influence. Without them, the climate everywhere on earth would be harsher than it is; winters would be colder and summers hotter.

The heat budget analysis showed that from September through February the northern hemisphere loses heat; the rest of the year it is warming. It also revealed that heat storage in land, snow, and ice is relatively small when compared with that in the atmosphere and oceans.

The researchers also found a large variation in heat storage and movement with seasons.

"The oceans undoubtedly form the most important medium to store heat, at least on a seasonal time-scale," the researchers report.

In general, both the atmosphere and oceans seem to transport heat from whichever hemisphere is in summer to the winter hemisphere. Oceanic transports are of major importance south of 40 degrees latitude, and are strongest between 10 and 20 degrees. There, in spring and fall, the oceans transfer some 5,000 trillion watts of heat northward. In winter, the transports are weaker and occur farther north. One major feature that the researchers noted is a strong convergence of heat between 45 degrees and 60 degrees north latitude in winter.

MIT Researchers Study Destructive Red Tides

Research underway at the Massachusetts Institute of Technology on red tides is looking for the causes of these destructive blooms of marine algae that have plagued the New England coastline during the past several years.

Civil engineers in M.I.T.'s Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics are seeking a better understanding of the chemical and physiological mechanisms causing red tides in the complex environments of offshore waters. Their study, supported by the M.I.T. Sea Grant Program and the International Copper Research Association, may indicate that one key to the onset of red tides could be trace metals such as copper that are found dissolved in seawater.

Dr. Francois M.M. Morel, associate professor of civil engineering and leader of the M.I.T. project, and his colleagues are studying how the concentration and chemistry of copper will promote or inhibit the growth of phytoplankton, the seas' one-celled, floating algae; Gonyaulax (one alga that causes red tide) appears to be much more sensitive to copper's toxicity than other species.

The researchers are now testing their hypothesis that an influx of organic substances into the seawater can bind up, or chelate, the dissolved copper, thus preventing its toxic effect on Gonyaulax and allowing the red tide organisms to increase rapidly in number.

Small fish and horseshoe crabs left on the beach by destructive red tides.

Scientists Measure Martian Ozone

As Viking scrutinizes Mars from the planet's surface, earthbound scientists have found a way to measure at least one Martian characteristic from millions of miles away—ozone in the atmosphere. They believe their discovery will permit long-distance studies of Martian weather.

The researchers, Drs. John F. Noxon of the Environmental Research Laboratories' Aeronomy Laboratory, Wesley A. Traub and Nathaniel P. Carleton of the Smithsonian Astrophysical Observatory and Pierre Connes of France's National Center of Scientific Research, were able to detect ozone's presence by its effects on other, more observable, constituents of the atmosphere.

Using powerful telescopes at Mt. Hopkins, Ariz., and Mt. Palomar in California, they detected the faint radiance emitted by excited oxygen molecules on Mars, betraying the presence of ozone. Since the amount of ozone in an atmosphere is related to temperature and water vapor, ozone measurements are a key to weather observations.

The presence on Mars of gaseous ozone, a triatomic form of oxygen, had eluded much closer scrutiny. Mariner 9, which orbited the planet in 1971 and 1972, had detected ozone at the winter pole of Mars, but could not tell directly whether it was gaseous ozone in the atmosphere or frozen into the ice cap (though other experiments suggested that it was in the atmosphere). Because of severe space limitations, neither of the two Viking spacecraft carries an ozone sensor.

The technique Drs. Noxon, Traub, Carleton and Connes used is indirect, but unequivocal. "What we actually saw in the Martian atmosphere," said Dr. Noxon, "was the infrared radiance caused by excited oxygen molecules." These are produced when sunlight breaks up an ozone molecule. B measuring the brightness of these emissions, the researchers could calculate the amounts of excited oxygen and, therefore, the amount of ozone.

The group's measurements indicate that, as on earth, ozone in the Martian atmosphere is thin near the surface and densest at high altitudes.

"What we've done is show that it's feasible to monitor ozone, and these other properties, from earth," concludes Dr. Noxon. "Not just anyone can do it—you need a big telescope and a good spectrometer." The researchers had used a 60-inch (1.5-meter) reflector at Mt. Hopkins and the giant 200-inch (5-meter) telescope at Mt. Palomar.

Wash., Firm Awarded ERL Contract

NOAA has awarded a contract to Battelle Northwest of Richland, Wash., to study small marine organisms most likely to accumulate petroleum hydrocarbons and trace metals attached to sediment on the ocean floor.

The contract is part of a major environmental study conducted by NOAA's Environmental Research Laboratories for the Interior Department's Bureau of Land Management as a portion of the department'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.

The research will be carried out at Battelle's Marine Research Laboratory, located at the northeast corner of the Olympic Peninsula at the mouth of Sequim Bay, Wash. At present the laboratory operates flow-through exposure systems capable of simulating low-level, chronic oil pollution. The systems can expose organisms to varied mixtures of seawater and crude or fuel oil for periods of up to six months, with total petroleum hydrocarbon levels of less than one part per million.

According to scientists at Battelle Northwest, fine sediments found in back bays and turbid regions of the coastal zone represent the type of materials most likely to adhere and retain petroleum hydrocarbons. Marine sediments with no detectable hydrocarbon contamination from a lagoon in nearby Sequim Bay will be used in the research project.

Admirals Taylor, Lippold Assume New Positions

R. Adm. Taylor

R. Adm. Lippold

R.Adm. Eugene A. Taylor has been appointed Director of the National Ocean Survey's Pacific Marine Center in Seattle, Wash. For the past four years he has been Associate Director of the Office of Fleet Operations at NOS Headquarters in Rockville, Md. R. Adm. Herbert R. Lippold, presently Director of the Center, will take over as Associate Director of Fleet Operations.

PMC has jurisdiction over NOAA's Pacific fleet of 13 oceanographic, hydrographic and fishery research vessels based in Seattle, San Diego, Calif., Auke Bay, Alaska, and Honolulu, Hawaii. Nine are based in Seattle, and approximately 275 civil service and commissioned personnel are employed at PMC.

The Office of Fleet Operations is responsible for management of the NOAA fleet, which currently comprises 25 ships. Adm. Lippold will direct fleet activities from NOS headquarters in Rockville, Md., through the Atlantic Marine Center in Norfolk, Va., and the PMC.

Both Adm. Taylor and Lippold joined NOS' predecessor, the U.S. Coast and Geodetic Survey, in 1950.

Dr. Hebard Named MESA Director

Dr. J. Frank Hebard has been appointed Director of the Marine Ecosystems Analysis (MESA) program.

Managed by NOAA's Environmental Research Laboratories, MESA is concerned with the impact of human activities on selected marine ecosystems. Present studies focus on the marine life and environment of the New York Bight and Puget Sound, and on the environmental consequences of deep-ocean mining.

Before assuming his present position, Hebard was chief of NOAA's Marine Environmental Protection Office in Rockville, Md., and also held several posts within the National Marine Fisheries Service.

Satellite Information Helping Calif. Tuna, Salmon Fisherman

An innovative method of using satellite-provided information to help tuna and salmon fishermen find more productive fishing grounds off California's coast is being expanded this season.

The method, proven of worth in a pilot project last year, involves advising commercial fishermen where "upwelling" occurs in coastal Pacific waters. A NOAA polar-orbiting satellite, equipped with infrared sensors, can identify the cold, nutrient-rich waters associated with upwelling, and provides a picture showing their locations. Salmon and tuna favor these upwelled waters.

Satellite coverage has now been expanded to include the area from the Straits of Juan de Fuca (between Canada and Washington) to Point Concepcion, Calif., and information from the satellite is now more readily available to fishermen through use of an automatic telecopier that transmits thermal front data to the dockside more quickly.

The service to fishermen is provided jointly by NOAA's National Environmental Satellite Service and the NOAA-sponsored Sea Grant program at Humboldt State University, Arcata, Calif.

Rhode Island Sea Grant

Scrap Used in Breakwaters

Scrap produced from trimming conveyor belts may be the long lasting material sought for tying used tires together in the floating breakwater being refined by the University of Rhode Island Sea Grant Program.

Finding a material which would not deteriorate and allow tires to break loose has been the focus of research to improve this inexpensive protection device.

The belt trimmings have provided the most desirable and long lasting results of 15 materials tested by URI ocean engineering research associate Albert P. Davis. The other materials tested, including various sizes of chain, fiber rope and stainless and steel wire, showed drawbacks such as severe abrasion, accelerated corrosion and unraveling.

"By using nylon nuts and bolts for joining the belting, this total system of tires and typing materials is organic, which eliminates a corrosion problem. The system is also not as susceptible to deterioration caused by boring organisms such as gribbles," Davis explained. (A gribble is a small marine crustacean that burrows into and rapidly destroys submerged timber.)

The researcher added that the conveyor belt trimmings recycles a scrap product which is now burned.

The conveyor belt edging picked for use in the breakwater is made of layers of rubber and a nylon-polyester fabric. The edging is a remnant produced when conveyor belts are trimmed to size.

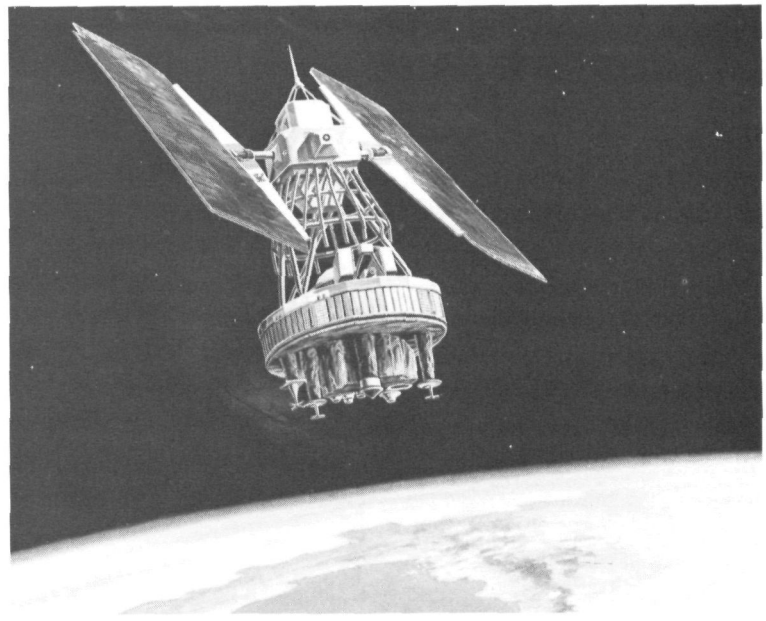
Cannon Named New Coordinator

Kessler R. Cannon has been named to the post of Conservation Coordinator of the National Marine Fisheries Service. He will have primary responsibility for conservation relations for the NMFS at the national level, working closely with the environmental community on matters of mutual concern.

For seven years he was Assistant to Governor Tom McCall of Oregon for natural resource and environmental affairs, and during the past year served as an Oregon State University professor, teaching natural resource and environmental management.

In announcing his appointment, NMFS Director Robert W. Schoning stated that Mr. Cannon's job is to "ensure that the NMFS is aware of the concerns of environmentalists and conservation organizations, and that they in turn know about our efforts in the entire range of conservation of our marine resources."

SCIENTISTS "FIND" FISH BY USING SATELLITE DATA



A team of fishermen, engineers, physicists, oceanographers, biologists, and computer specialists have "found" fish off the Louisiana coast by using a satellite. The project represents the culminatio of a larger effort—the LANDSAT Menhaden and Thread Herring Investigation—which NOAA initiated last year.

Investigating the feasibility of using satellite data for assessing fisheries resources in the northern Gulf of Mexico, and thereby enhancing management of them, has been a cooperative industry-Federal Government project. Personnel from the Earth Resources Laboratory of the National Aeronautics and Space Administration and the Southeast Fisheries Center of NOAA's National Marine Fisheries Service have been working together with boats, planes, and crews from member companies of the National Fish Meal and Oil Association.

Their work has shown that there are relationships between the distribution of menhaden and water turbidity—which the LANDSAT sensor measures as water color. From the water colorations sensed by LANDSAT, scientists can infer the probable presence or absence of menhaden. The satellite cannot sense, or "see" fish directly.

Menhaden vessels, fishing under the direction of their spotter aircraft pilots, confirmed the presence of menhaden in most, though not all, of the high probability concentration areas predicted by analysis of LANDSAT data, while special navigation systems plotted the locations of the fish precisely and scientific observers on board several vessels collected water samples.

Thus, they validated a technique for locating fish concentrations from space which may lead to a greatly improved understanding of coastal fishery ecology and to better methods for resource assessment and management.

NOAA and USCGAUX make Chart Updating Flight

(From left) William Shakespeare, Captain of Division 13, USCGAUX; Capt. Richard Alderman, Commanding Officer, NOAA Ship Fairweather; Fred Button, Commander of Flotilla 6, Division 13, USCGAUX, Pilot; Ens. Neal Millett, NOAA Ship Fairweather, flight participant; and Lt. Col. Lester Brown, Assistant District Staff Officer, Operations, District 11, USC-GAUX.

A flight to update nautical charts—the first of its kind—was conducted in the Los Angeles, Calif., area in a joint effort by members of the NOAA Ship Fairweather and the United States Coast Guard Auxiliary.

The USCGAUX is a volunteer organization of interested private boaters who provide valuable charting information to the National Ocean Survey to help maintain up to date nautical charts.

The joint inspection by plane of a stretch of California coastline between Newport Beach and Santa Barbara examined an area in a matter of hours that would have required several weeks by boat, the usual procedure.

This inspection was the first such joint effort conducted by NOS hydrographers and USCGAUX personnel and proved highly valuable to both organizations.

At the time of the flight the Fairweather was in the area to conduct a routine hydrographic survey project along the same coastal waters.

noaa/people

Charles A. Blake recently was selected for the position of Chief, Labor Management Relations Branch, NOAA Personnel Division. He succeeds **Perry E. Walper**, who recently retired.

George F. Berner, Publication Distribution Officer in the Distribution Division of the National Ocean Survey's Office of Aeronautical Charting and Cartography, recently received a Department of Commerce Bronze Medal in recognition of his innovative management ability and expertise in formulating distribution systems.

William Chapman, Meteorologist in Charge of the Salt Lake City National Weather Service Forecast Office, and **Glade Gerber**, Assistant Chief of the Facilities Engineering Branch for the NWS Western Region, recently received Department of Commerce Bronze Medals.

Melvin W. Usimaki, Electronics Technician at the National Weather Service Office in Sault Ste. Marie, Mich., recently received a Department of Commerce Bronze Medal.

Dr. Harris B. Stewart, Director of the Environmental Research Laboratories' Atlantic Oceanographic and Meteorological Laboratories in Miami, Fla., has been elected Councilor-at-large by the Florida Academy of Sciences.

Bernard H. Chovitz, Director of the National Ocean Survey Geodetic Research and Development Laboratory, has assumed the office of President-Elect of the Section on Geodesy of the American Geophysical Union.

Dr. Edward T. Pierce, an atmospheric scientist specializing in lightning and thunderstorm research, has joined the Environmental Research Laboratories' National Severe Storms Laboratory in Norman, Okla.

John W. Eason, Leading Forecaster at the National Weather Service Forecast Office in Birmingham, Ala., has been selected to head the NWS program at the FAA Academy at Oklahoma City, Okla. He replaces **John W. Zimmerman**, who is retiring.

Claire Jensen, Meteorologist in Charge of the National Weather Service Office in San Diego, Calif., since 1972, is the new Principal Assistant at the Weather Service Forecast Office in Phoenix, Ariz. He succeeded **Nick Ropar**, who has joined the Public Weather Branch at NWS Headquarters in Silver Spring, Md.

Dr. Francis J. Merceret, Research Meteorologist with the Environmental Research Laboratories National Hurricane and Experimental Meteorology Laboratory in Coral Gables, Fla., has graduated cum laude from the University of Miami Law School and was admitted to the Florida Bar.

G. Stanley Doore, H. Michael Mogil, Arthur R. Thomas, and **Billy R. Rice** were among the officers elected recently for 1976-1977 by the District of Columbia Chapter of the American Meteorological Society.

Walter Wojcik, Office of Management and Computer Systems, was awarded a Certificate in processing (CDP) from the Institute for Certification of Computer Professionals (ICCP) for successfully completing the 1976 examination.

Holmes S. Moore, Electronic Engineer in the Office of Environmental Monitoring and Prediction, recently was elected a Vice President of the American Oceanic Organization.

Robert V. Ochinero, Director of the Environmental Data Service's National Oceanographic Data Center, was elected interim Chairman of the UNESCO Intergovernmental Oceanographic Commission's newly established Group of Experts on the Development of a Pilot Program for Responsible National Oceanographic Data Centers (RNODCs).

Hubert B. Webb, Weather Service Specialist at Orlando, Fla., has been selected to fill the Official in Charge position at Del Rio, Tex., vacated by **James Little** who has transferred to Athens, Ga.

Harvey L. Moore, former Assistant to the Director of the National Marine Fisheries Service Northwest Region in Seattle, Wash., has been appointed to the Oregon State University Extension Service and will serve as Executive Secretary of the Pacific Sea Grant Advisory Program (PASGAP).

William B. Hannum, Jr., former President and Chairman of the Board of Sea Farms, Inc., Key West, Fla., has been named Staff Assistant in the Living Resources Office of NOAA's Associate Administrator for Marine Resources.

Dr. W. Charles Braun, Dr. Bernard Fridovich, and **Harold W. Yates**, of NOAA's National Environmental Satellite Service, and **Dr. Daniel L. Albritton** of NOAA's Environmental Research Laboratories' Aeronomy Laboratory, participated in the 31st Symposium on Molecular Spetroscopy, sponsored by the Department of Physics of the Graduate School of Ohio State University and the National Science Foundation.

Marian Woods, an Equal Employment Opportunity specialist, has been appointed Federal Women's Program Coordinator for the Environmental Research Laboratories in Boulder, Colo.

Dr. Harold L. Crutcher, Science Advisor at the National Climatic Center in Asheville, N.C., was elected a fellow of the American Society for Quality Control at the organization's international meeting in Toronto.

The first NOAA Corps Diver's Pin was presented to NOAA's Deputy Administrator, Howard W. Pollock (left), by R. Adm. Harley D. Nygren, Director of the NOAA Corps (center). Although regulations specify that the pin is to be worn only by those NOAA Corps officers who are Certified NOAA Divers, the honorary pin was presented to Mr. Pollock because he is a Certified NOAA Diver. Lt. (j.g.) David H. Peterson (right) received the first Diver's Pin presented to a NOAA Corps officer.

Barbara J. McKain, a Lead Forecaster at the Cheyenne, Wyo., National Weather Service Forecast Office, has been named to head the Amarillo Weather Service Office. She succeeds **William Frank**, who has transferred to Lake Charles, La.

James Dew is the new Official in Charge at the National Weather Service Office in Dayton, Ohio.

Phillip W. Swain, Supervisory Meteorological Technician at the National Weather Service Forecast Office in Indianapolis since 1973, has been selected for the position of Official in Charge of the San Francisco Weather Service Office. He succeeds **Clyde Holmes**, who has retired.

John W. Kofoed, who has been Deputy Director of the Environmental Research Laboratories' Atlantic Oceanographic and Meteorological Laboratories in Miami, Fla., for approximately ten years, has been appointed Director of the Marine Geology and Geophysics Laboratory at AOML.

Alton K. Hansen, the National Ocean Survey geodetic advisor for the State of Louisiana, has been selected to become chairman of the Louisiana Section of the American Congress on Surveying and Mapping (ACSM).

Capt. Charles A. Burroughs is now assigned to the Deepwater Ports Project Office in the Environmental Data Service.

Dr. Donald K. Atwood, a research chemist and oceanographer, has been appointed Director of a newly formed Ocean Chemistry Laboratory in Miami, Fla.

Dr. Kenneth H. Roberts, Assistant Professor of agricultural economics at Clemson University in Clemson, S.C., has joined the Sea Grant staff under the Intergovernmental Personnel Act.

Vincent S. Murino has been named Chief of the Executive Affairs Staff in the Office of the Director of the National Weather Service. He previously served as Executive Officer to the Director of the Systems Development Office.

George H. Cooper has been named Chief, Administrative and Technical Services Division at the Environmental Data Service's National Climatic Center in Asheville, N.C.; and **Hugo V. Lehrer** has been named Chief, Cooperative Data Branch, Data Operations Division, at the Center.

Marvin Miller has been appointed Meteorologist in Charge of the Weather Service Office at Cleveland, Ohio. For the past two years he has been the MIC at Charleston, W.Va.

U. of N.C. Designated SG College

Secretary of Commerce Elliot L. Richardson has designated the University of North Carolina as a Sea Grant College.

"In the North Carolina Sea Grant Program's six years of existence," the Secretary said, "its constituent projects have made considerable strides in the fields of aquaculture, coastal zone studies, education, and advisory services." Most important to the program's success, he added, have been its strong ties with State agencies and private industry.

In recognition of the excellence of a university's marine program, the Secretary of Commerce may confer on it Sea Grant College status.

Scientists at the University of North Carolina and North Carolina State University are studying one of the State's most prominent marine resources—the two and one-half million acres of estuaries, sounds and marshes behind its barrier islands.

These valuable salt water areas are the foundation for a large commercial and recreational fishing industry as well as growing tourist activity. In one project, which examines the build up and erosion of the shoreline from eastern Albermarle Sound to southern Pamlico Sound, researchers are trying to discover what makes some areas more vulnerable than others to scouring, and will devise methods for dealing with coastal erosion problems. Special "erosion potential maps" are being drawn to help implement North Carolina's Coastal Zone Management Act.

Kofoed Named New Lab Director

John W. Kofoed, who has been Deputy Director of the Environmental Research Laboratories' Atlantic Oceanographic and Meteorological Laboratories in Miami, Fla., for approximately ten years, has been appointed Director of the Marine Geology and Geophysics Laboratory at AOML. Since November 1975 he also has served as Acting Director of this Laboratory.

A veteran of numerous marine expeditions, Mr. Kofoed has participated in many oceanographic research project activities of national and international scope since joining NOAA.

IWC Advances Whale Conservation

Conservation of the world's whales was significantly advanced by the International Whaling Commission (whose members take over 90 percent of the world's whale catch) at its 28th meeting in London. Dr. Robert M. White, NOAA Administrator, is U.S. Commissioner to the IWC.

Sharp differences between the whaling nations and those nations interested in the cessation of commercial whaling were decided in favor of further major reductions in the quotas allocated for the whaling season of 1976 and 1977. Quotas established for whales in all oceans were reduced by almost 6,000 from last year's quotas of 32,000 animals. This reduction is all the more significant because it involved reduced quotas on the largest whales such as the sperm, fin, sei and Bryde's.

The new quota levels are the lowest in the history of the Commission. For the first time, all commercially harvested whales are under IWC quotas. Fin whales in the southern hemisphere, regarded as being the most depleted of those being commercially harvested, have been placed under total protection with the inclusion of the last area of the Antarctic Ocean in which catches of such whales were allowed prior to this year. Some increases were agreed to in the quotas of Minke whales, the smallest of the great whales and hitherto relatively unexploited.

OCSEAP Study Expanded To Areas Off Alaska's Northwest Coast

NOAA's Outer Continental Shelf Environmental Assessment Program (OCSEAP) is expanding to cover prospective oil-lease areas off Alaska's northwest coast.

The $8 million, multiyear study of life forms and environment in Alaska's Norton Sound and Chukchi Sea is part of a continuing investigation conducted by the Environmental Research Laboratories for the Interior Department's Bureau of Land Management. It extends work already underway in the Bering Sea, the Gulf of Alaska, and the Beaufort Sea, which links Alaska to the Arctic Ocean.

Emphasis in the program will be on conducting reconnaissance work to identify the crucial biological and physical elements of the Alaska marine ecosystem. These findings will be used to establish scientific baselines for the regions, against which petroleum-connected impacts can be detected, assessed, and monitored.

Design of the Chukchi Sea-Norton Sound study has been guided by more than a year and a half of such investigations in other outer continental shelf areas off Alaska, according to OCSEAP Director Dr. Rudolf J. Engelmann.

"Given the time constraints of oil leasing and development schedules," he explains, "we've had to narrow our investigation. Our first year and a half up here taught us that we're not going to obtain a full statistical description and explanation of the environment in a reasonable time, at tolerable cost. The natural variability of the ecosystem is too great, the species are too mobile, and the environment is too hostile to accomplish that.

"Instead, we are doing reconnaissance to identify key species and habitats and then placing high priority on determining how they will be affected by petroleum development.

NOAA Ship Saves *Kelez Personnel Rescue NY Boaters*

Personnel of the NOAA Ship George B. Kelez rescued four individuals whose pleasure boat had hit a pier and disintegrated near Floyd Bennett Field, Brooklyn, N.Y.

Responding to hysterical screams of "They are going to drown!"Ordinary Seaman Elvin T. Gillikin and Chief Marine Engineer K.N. Windley grabbed a flashlight and the ship's life ring and followed Edmond Turturro along the darkened pier to a spot 150 yards forward of where the Kelez was moored.

The flashlight located three people hanging onto pieces of debris or pilings of the pier. Gillikin threw the life ring to Donna Rossomando, apparently the most injured of the three, and remained at the scene while Chief Windley raced to the Kelez and returned with a Jacob's ladder. Securing it to the side of the 12-foot pier, the two descended and assisted Miss Rossomando and Lisa Sheinowitz to safety, then gave the life ring to William Roemmelt, whose injuries prevented him from climbing the ladder.

In quick follow-up, Lt. (j.g.) Thomas L. Meyer phoned the U.S. Park Police and the Coast Guard. Meyer obtained first aid supplies, and Gillikin remained to administer first aid.

Then Boatswain Group Leader Franklin J. Mickle and Second Cook Melvin McCray assisted in launching a boat, and crew members helped get Roemmelt aboard the Coast Guard vessel which had arrived, and accompanied him to the Coast Guard Station at Rockway and then in the ambulance to the hospital.

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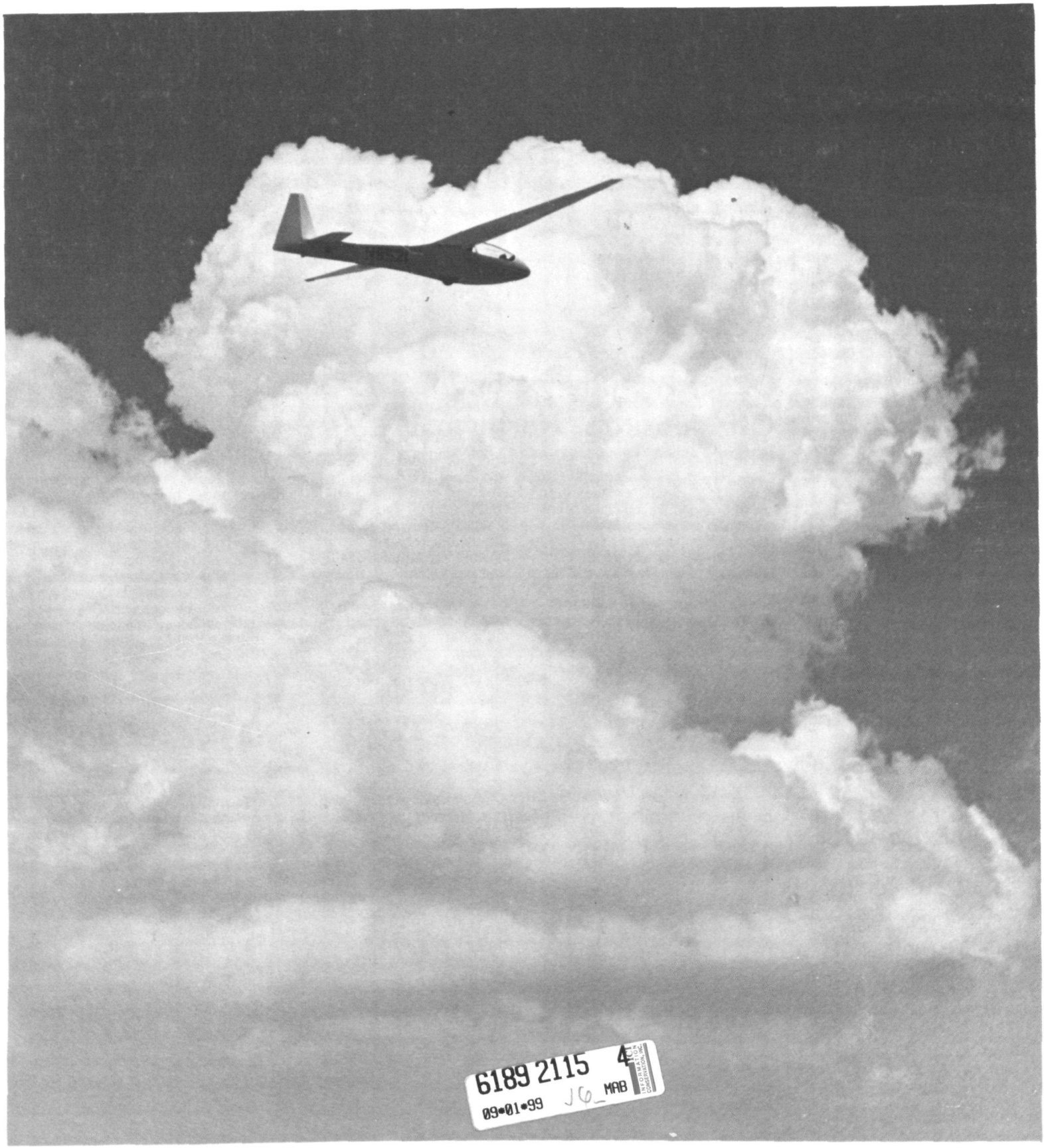

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For story see page 26.

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