VOLUME 8 NUMBER 1 JANUARY 1978

noaa

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National Oceanic and Atmospheric Administration

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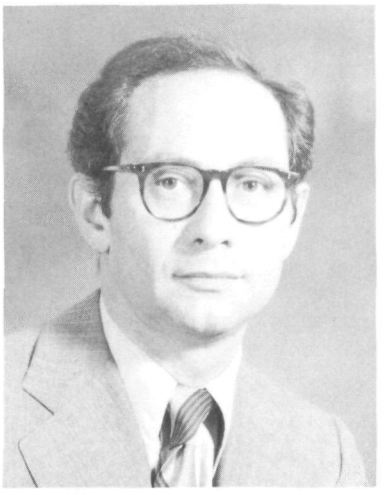
A Message From The Administrator



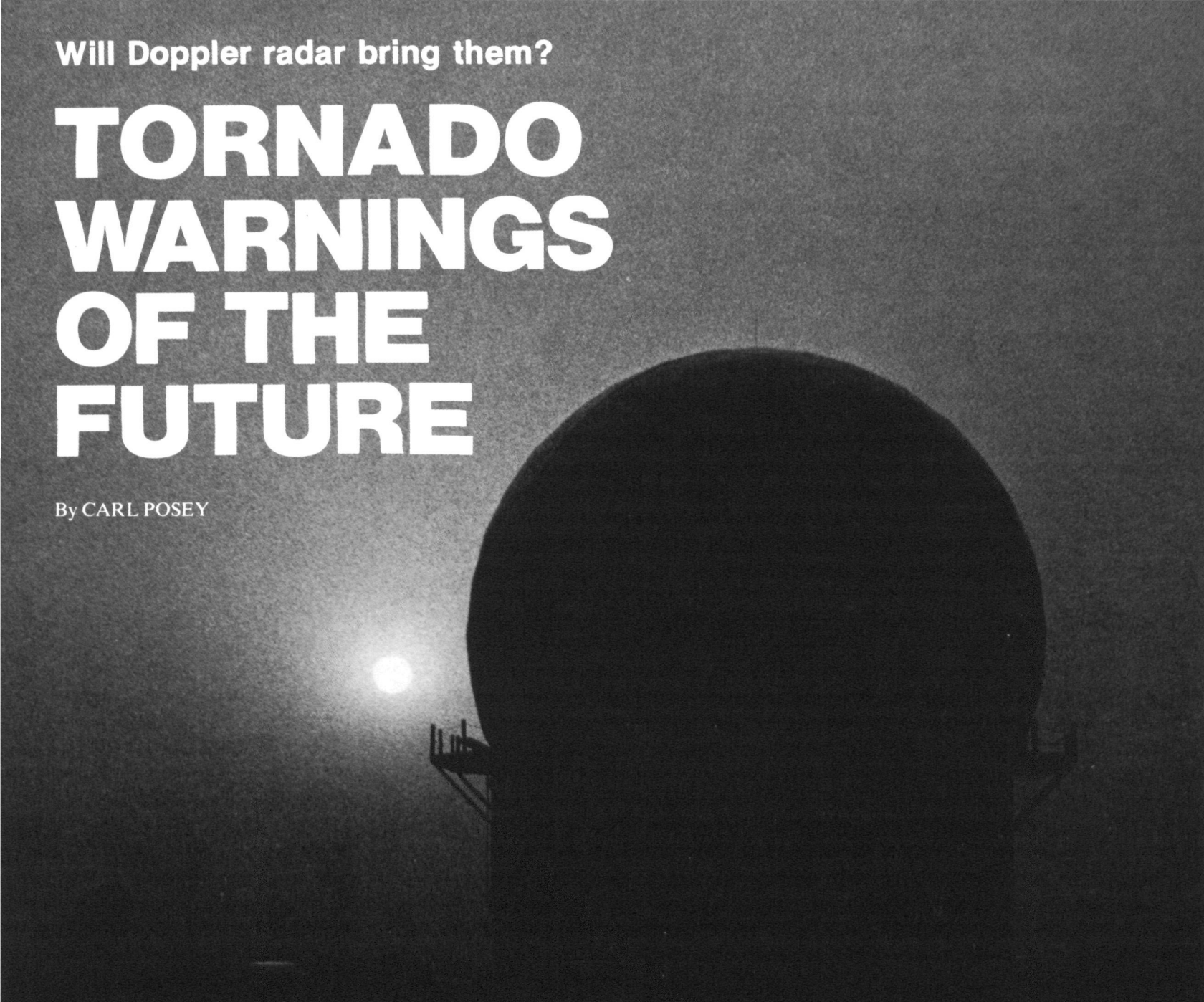
NOAA's budget for Fiscal Year 1979 has just been presented to the Congress, and we will soon begin the hearing process which precedes Congressional action. The budget is the product of long and devoted work on the part of the NOAA family, and represents a major step forward for us. We have requested increases for important programs in the oceans and weather, and we will have a key role in the forthcoming interagency climate initiative. I look forward to the coming months with great confidence in the staff and organization that has been assembled to undertake these challenging tasks.

Richard A. Frank
Administrator

Will Doppler radar bring them?

TORNADO WARNINGS OF THE FUTURE

By CARL POSEY



The radar display ticks away its updates, minute by minute, sweeping the atmosphere with bursts of radio energy, feeding a small , powerful computer the echoes that flow back through the warm midwestern night.

Since morning the forecaster has watched moisture flowing in from the south and east, filling and energizing an area more than two hundred kilometers to the west. On the radarscope, a round abstract of color shows where moisture has condensed into a cloud. Each minute the display blinks, and a new image appears. Now, as the strength of its reflection matches the levels set into the radar-controlling computer, one of the contoured areas begins to flash. Quickly, the forecaster taps out an order on a computer terminal: Give me winds. The display wipes away the multicolored abstract and returns with a new abstraction, this one made of reds and blues, like stellar spectra, showing the motion of the winds toward or away from the radar, and their velocity. A small area flashes down to the southwest. The forecaster orders the computer to give him a closeup. The display blinks back a freeform in which bright red and bright blue patches slowly circle one another. Now the situation is clearer: the red and blue areas represent high levels of windshear, a rotary circulation some ten kilometers above the ground. The forecaster taps out another series of commands and the computer replaces the color display with an extreme closeup, but instead of color freeforms the image is a field of moving arrows. The rotary circulation comes clear. It is a mesocyclone, the parent circulation of a tornado. And, there, within the larger circulation, he sees a narrow band of high wind shear, a section through a funnel. A tornado has begun to form high in the thundercloud. The forecaster prepares the computer with times and geographic coordinates, then gives a final order: warn. It is fifteen minutes before the tornado will become visible to the human eye, if anyone is watching. It is half an hour before the violent funnel can roar through another midwestern town.

Last spring, a series of tests began on the Oklahoma prairie to begin shaping that kind of future for tornado detection and warning in the United States. The tests were a cooperative effort of NOAA's Environmental Research Laboratories and National Weather Service, and the Air Weather Service of the U.S. Air Force. Their objective: to determine when, how, in what form, and whether an important new technology can be brought into operational use.

The new technology is Doppler radar. Since the beginning of the 1970's, storm season by storm season, scientists at NOAA's National Severe Storms Laboratory in Norman, Okla., have forged this extremely promising instrument for detecting and warning against tornadoes and the damaging winds of severe thunderstorms. Recent work at the Norman laboratory indicates that their Doppler radar can identify the parent circulation of tornadoes—the "mesocyclone"—well before the destructive funnel forms; and that the radar can also detect the smaller, embryonic circulation of the tornado itself, as much as half an hour before that circulation becomes visible to observers on the ground.

That kind of capability would seem to make Doppler radar a certain candiate for immediate operational use. In fact, Doppler radar represents a major jump in sophistication for both the equipment and the people who operate and interpret its data. Perhaps such high technology is too expensive, too delicate, too technical to be assimilated into the day-to-day routines of civil and military weather services.

To begin to understand the possibilities of such technology, one needs to look briefly at the implications of the term, Doppler. It is the surname of the 19th-century Austrian physicist who inferred that waves moving between objects are changed in frequency by the relative motion of the objects. The example most often used to illustrate this Doppler shift in frequency is the changing wail of a train whistle, rising (increasing in frequency) as the train approaches, falling (decreasing in frequency) as it recedes. Astronomy was the first science to put the Doppler shift to work, using the observed shift of a star's spectrum toward red or blue to determine whether the star was moving away from us a (red shift) or toward us.

Electronics made it possible to add a Doppler capability wherever you wish to measure relative motion. There are Doppler navigation systems that continually update one's position from a starting point. NOAA researchers in Colorado have developed acoustic, laser, and radar devices that employ the Doppler shift to sense motion and other parameters in the atmosphere and sea. And there is the big Doppler radar in Oklahoma.

The radar at Norman is one of a pair developed by the laboratory. The other is at Cimarron, about 25 miles northwest of the lab. Both use a large (9.2-meter) diameter surplus military (FPS-18) radar housed in a geodesic radome. The brains and vital organs of the radars are housed in the radome pedestal, along with the control room where scientists gather every spring to run a complex and fast-moving study of the storms that drift through the radar-covered area. The Norman radar has several important features to extend its range and velocity measuring capability, including a dual pulse repetition frequency processing system.

The radar doesn't sweep a broad beam of radio-frequency energy around its compass; instead, it pulses energy into the atmosphere at very short intervals of time, like a very-high-speed sewing mechine needle darting through cloth. From a given sweep through a storm, the radar receives information from some ten thousand points, the echoes reflected by water droplets and ice crystals in the storm.

These echoes of the 10-centimeter-wavelength pulses can be interpreted in terms of intensity (or reflectivity), like conventional digitized weather radar returns. But the NOAA radar also provides the Doppler frequency shift information that can be made to tell how fast the reflective particles are moving toward or away from the antenna.

The velocity display features fifteen velocity categories, using maximum color contrast (that is, red and blue) to separate velocities of opposite sign. The reflectivity display uses a color mix that emphasizes higher intensities, running from blue through bright green to red.

For this torrent of real-time data to be useful, however, it must be channeled in such a way that the radar operator has a continuous, or near-continuous, display, and the means of selecting from the dense flow of information the material of greatest interest to him. This has been accomplished through innovative computer-processing techniques and display graphics.

Evolution of the Doppler radar capability has been swift. Early in the 1970's, the single radar at Norman entered research use, gathering storm data that was studied retrospectively. A high-repetition-rate capability for studying tornadoes was phased into the system soon after. Then a second system went in at Cimarron. Then a way was found to display the Doppler return in real time, computer-transformed into a field of vector arrows. Now, if the instincts of the researchers and Weather Service staff are correct, the technology is ready to take the next big evolutionary step—the transfer of new technology into an operational system, in an operationally useable form.

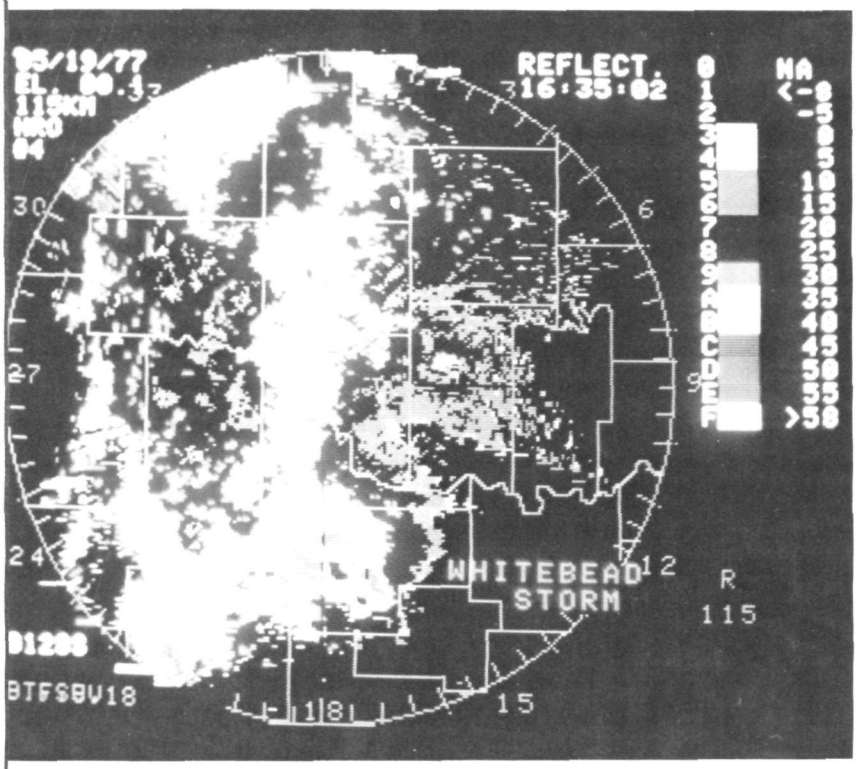
"Just having the technological capability is not enough," explains Dr. Edwin Kessler, director of the National Severe Storms Laboratory. "The systems we have today are extremely complex, involving people and machines, communications, training. The whole hierarchy of interactions among these elements has to be considered. The fact that some people may know something doesn't mean that the whole system can use it. It may be that there are other overriding considerations that cancel out the benefits of new technologies."

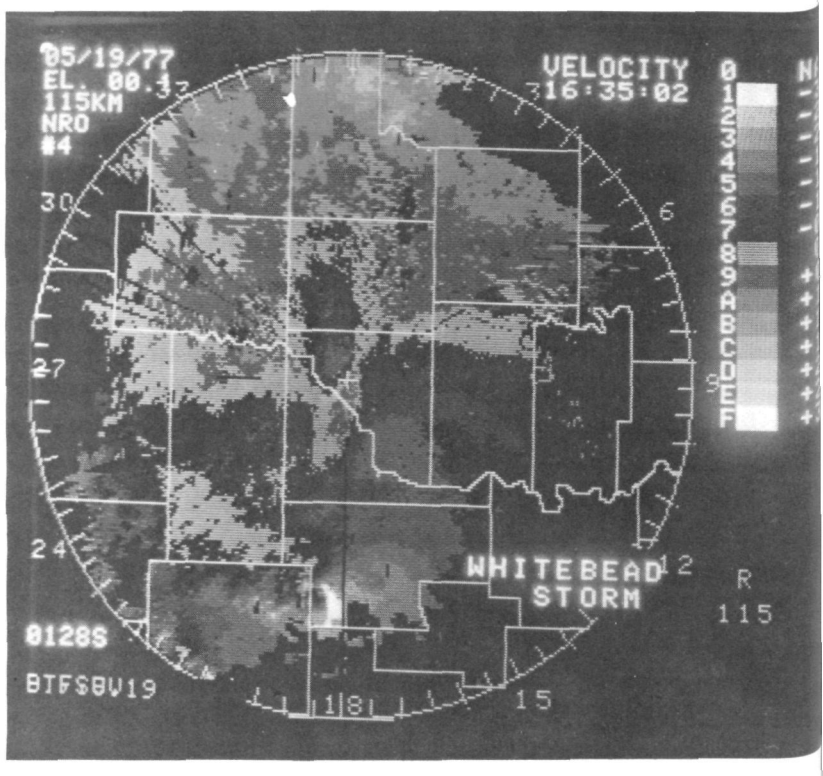
Technology transfer is nothing new to the Oklahoma laboratory, where an impressive family of techniques have already entered operational service. Radar meteorology is very much imbedded in the traditions of the facility, which grew out of the National Severe Storms project of the former Weather Bureau, begun in the late 1950's in Kansas City, Mo.

"In the early sixties," Kessler says, "it was found that the Weather Radar Laboratory would have to be moved somewhere else because the Kansas City facility wasn't really set up to make the kinds of observations that appeared to be necessary. The research couldn't continue without a good base in observations."

Since then, much of the National Severe Storms Laboratory contribution to Weather Service operations has been in the form of

The 1977 Doppler radar evaluation team: from left, Don Devore, National Weather Service, at the multimoment display; Air Force Capt. Joel D. Bonowitz of the Air Weather Service, at the reflectivity/velocity display; and Donald W. Burgess of the National Severe Storms Laboratory.



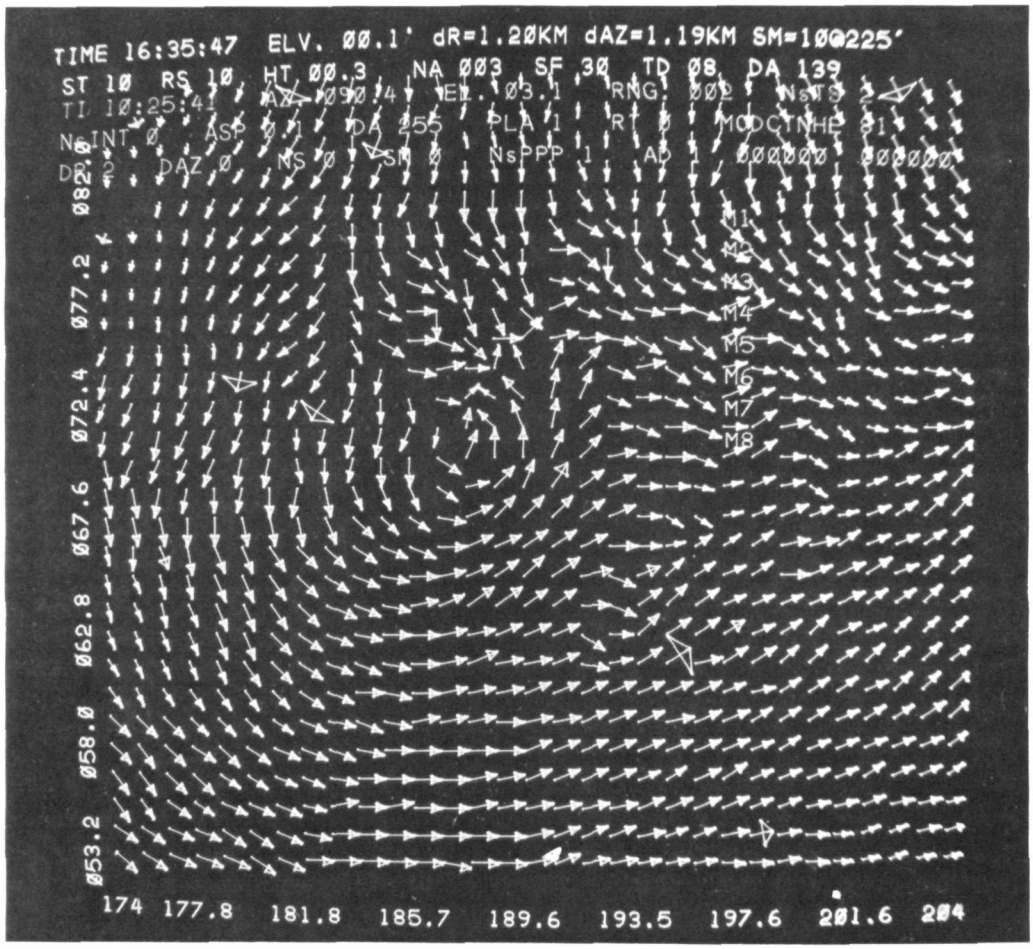


radar technology. Some of the earliest and best work on radar contour mapping— a technique for displaying many different intensity levels simultaneously, now common practice in the weather radar field—was done at Norman. Scientists there also pioneered methods of estimating rainfall from contoured radar displays, methods that are coming into operational use.

"More recently," Kessler says, "we've been working with private industry to develop ways of communicating radar data over a telephone line, and this has been very successful. We produce a bright display containing all the relevant meteorological information, updated at one-minute intervals, visible in a bright room—you don't have to darken the room to see the display as is still the practice with most conventional radar displays. I think it won't be very long before we see radar displays like that in practically all weather forecast offices and aviation facilities."

Now the researchers who developed the Doppler radar capability in Oklahoma and their colleagues in the National Weather Service and Air Weather Service are working together to determine whether the surname of Christian J. Doppler—and all that it has come to represent—will become part of the lexicon of operational meteorology during the 1980's.

The 1977 evaluation brought Weather Service and Air Force meteorologists to Norman for a short indoctrination in the use and potential of a single Doppler radar, especially in detecting the mesocyclone signature that appears to be a precursor of tornado formation, and the Doppler velocity signature of the tornado itself. On the evaluation team were Donald W. Burgess of the Norman lab, Donald R. Devore, a forecaster from the Oklahoma City Weather Service Forecast Office, and Air Force Cap-



Shown here are Doppler radar displays taken just after 4:35 p.m., CDT, May 20, 1977. At left above, reflectivity information is shown by arbitrarily-chosen colors (reduced to black-and-white in this photo) ranging from cool to hot to indicate the storm's severity. At right, a velocity display shows the speed of rain droplets toward and away from the antenna; again, colors have been reduced to black and white. Below, a multimoment display is a closeup of high-shear areas identified on the velocity/reflectivity readout, represented as a field of arrows.

tain Joel D. Bonewitz, from the Air Weather Service. The procedure for conducting the study linked these operational weathermen, aided by Burgress, with their opposites at WSFO-Oklahoma City and half a dozen military bases in the region swept by the radars.

The evaluators hope to answer certain key questions in the course of the first spring study. First, they want to determine what radar beam width would be required to resolve mesocyclone signatures out to a distance of 140 miles (230 kilometers). Then, how best to display this information, and what degree of training would be required for its operational use. And finally, what degree of improvement in tornado warnings could an operational Doppler radar system provide?

Studies that bring researchers and operating meteorologists together require a special relationship between the laboratory and the operating unit.

That kind of relationship is familiar ground to the Weather Service Forecast Office at Oklahoma City's Will Rogers International. "We've always had a special connection with the Severe Storms Lab," explains meteorologist-in-charge Ray Crooks. "The Severe Storm Project used to be housed in a hangar here at Will Rogers. We've always been sort of a test bed for new techniques developed in Norman."

Every Weather Service Forecast Office has its own special qualities. In Oklahoma City, there is the expected emphasis on severe storm work and often public service. But there is also an unusual emphasis on climatology, which reflects the climatological background of Crooks' principal assistant, Billy R. Curry. While this is only a kind of sideline, the climatologist's touch is visible in the quality of the storm-data documentation done by the Oklahoma City office, which covers a 70,000 square mile area and 77 counties. Their radar is a WSR-57 located with the office. But they find, as other facilities do, that the new local-use solid-state radars — in their case, the ones at Wichita Falls and Tulsa — greatly augment the larger, older WSR-57 systems, improving the forecaster's ability to detect and warn against severe weather.

What about Doppler radar?

"I think it's an exciting development," Crooks said last spring while the evaluation was underway. "It seems to have greater range than we expected, and it may have some potential for flash flood warnings. Of course there's still the question of what the best display is for that kind of information. We hope to have a display remoted in here from Norman during the 1978 evaluation. This would help us evaluate training requirements. The thing is, in a severe weather situation, you have to have something one man can handle. So operational requirements during severe weather will do much to shape the kind of use we can make of Doppler radar."

Don Devore, the Weather Service meteorologist on the Doppler team in Norman, represents the first attempt to quantify the manpower term in the Doppler radar equation. By mid-May of 1977, he was enthusiastic, and assimilated. "Before long," he said, "you begin to think like a Severe Storms Lab person. 'Looks good' means there's going to be a tornadic storm somewhere within Doppler radar range." Devore started with the Weather Service in Oklahoma City in 1964, worked in Mississippi and Texas, and finally returned to Oklahoma City. In the evaluation, Devore provides the link between the Doppler radar control room in Norman and the radar operator at the Weather Service Office. While Bonewitz monitors the full-area color display, Devore watches the Doppler display of vector arrows—called the multimoment display because it shows the three principal moments of the Doppler spectrum.

"In the evaluation itself," Devore explains, "when there's a possibility of severe weather we monitor the Doppler displays at Norman, and notify the Weather Service Office by phone when we identify a mesocyclone or tornado vortex signature. When we issue a mesocyclone advisory to the Weather Service, we do a survey of the area afterward to determine whether a tornado or other severe weather occurred.

"We've seen mesocyclones south of Wichita Falls and as far west as Amarillo. Beyond a hundred fifty nautical miles, we're scanning so high that the bottom of the radar beam is five kilometers high."

Did he have any preconceptions about Doppler radar when the evaluation began.

"I'd heard of it, and read a few articles about it. I was surprised by the accuracy you get with the Doppler radar, and I really like the multimoment display. You can't always identify a mesocylone with the color display.

"We don't seem to miss any tornadoes with the Doppler. At night, we receive many public reports of tornadoes — we can then look at the Doppler display and determine if it's a valid report. I think we could really cut down the false alarm rate with this, since we'd only be issuing warnings when something was there. My own personal view is if we had one going full time we could cover all of Oklahoma and never miss a tornado."

Enthusiasm is almost a problem. While Severe Storms Laboratory scientists fear their Doppler radar might be oversold before the problems of bringing it on line have been resolved, there is no controlling the obvious affection the researchers — and the visiting evaluation team members — develop for the equipment and what it can do. But, sentiments aside, the Norman radar seems to have performed well in its first "operational" storm season, according to the evaluation team's reports.*

An important comparison in the 1977 tests was the warning time available when Doppler detection of mesocyclones or tornado vortex signatures were the basis for warning, versus the warning time available using conventional techniques. The significant finding here was that the Doppler radar data improved the lead time in tornado warnings. The team reports that about 44 percent of the tornado warnings issued by the Weather Service Forecast Office were based on public reports. This means that the warnings followed visual sightings (or what the reporting people *thought* were sightings) of tornadoes, so that there was actually negative lead time beacuse the tornado had already formed when the warning went out. When Doppler radar detection was used, advisories were forwarded to the Weather Service about 23 minutes ahead of conventional sighting, and warnings could be issued by the Weather Service 10 minutes before the tornadoes could have been detected by conventional means.

The potential of Doppler radar for reducing the false alarm rate derives from the present dependence of forecasters on public reports of tornadoes. During the evaluation period, most tornado warnings issued were the result of public reports; but seven warnings were issued based on reports of tornadoes that had not occurred. The team found that the Norman system could be a valuable method of "de-verifying" such erroneous reports.

The utility of the familiar (but popularly overrated) "hook echo" also proved to be low compared to the Doppler velocity signatures. According to the evaluation team, only three of ten hooks observed on the Oklahoma City WSR-57 radar could be verified with tornadoes.

An unexpected, and tentative, result of the evaluation was that the presence of a mesocyclone was often accompanied by heavy rainfall rates, opening the possibility that Doppler radar might be a useful flash-flood warning tool. The reason for this connection is that the mesocyclone includes a very strong updraft and its attendant circulation, so that strong downdrafts must accompany and balance the updrafts. Very heavy rain and hail occur in these downdrafts, apparently within five to ten miles of the mesocyclone signature. Experience gained in 1977 suggested that the presence of a mesocyclone usually warranted a heavy rainfall statement as part of severe thunderstorm warnings. This will be the subject of additional study.

Based on the results of the 1977 studies, what will the 1978 tests be like? Probably there will be more than one team, to reduce the fatigue factor, and liaison with the Oklahoma City Weather Service Forecast Office will be strengthened, possibly with additional displays installed there. The color display's resolution will be improved, and a "zoom" capability added so that Doppler radar operators can go in for a closeup of areas of interest.

The principal difference will be a closer involvement of operational meterologists in the Doppler radar operation — a more intensive look at how Doppler radar can improve the precision and timeliness of tornado warnings. If the evaluation is positive, the National Weather Service will develop a prototype Doppler radar facility, and continue to push the evaluation of this technology toward operational use sometime in the 1980's. It may be one of the crucial steps toward reducing the toll we pay the whirlwind. □

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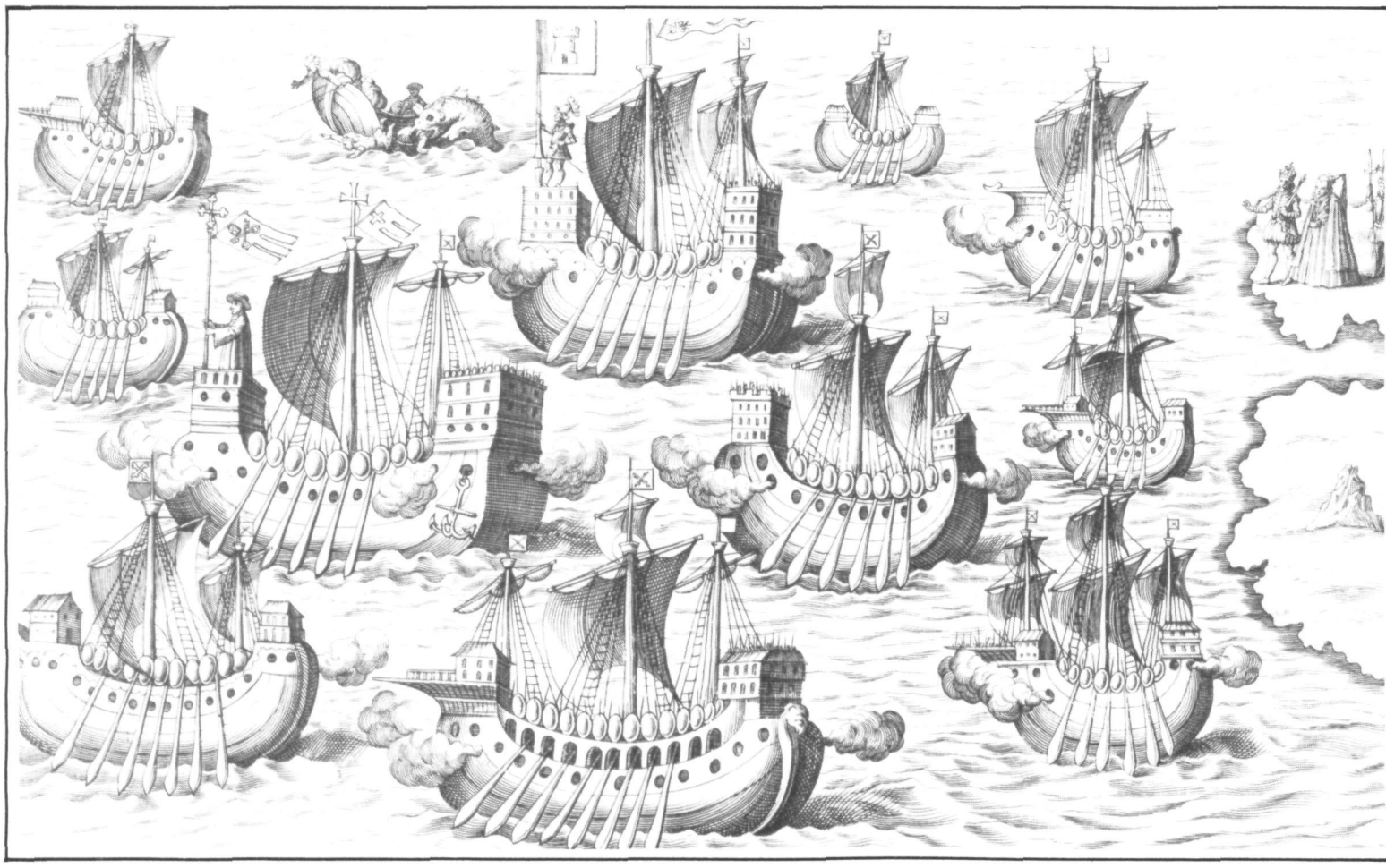
* *Operational Doppler Experiment: Results Year One, by Donald W. Burgess, Joel D. Bonewitz, and Donald R. Devore, November 1977.*



From the Library of Congress collection

Columbus departing Spain on his second voyage to the Indies.

New explorations at historic anchorage

NOAA Habitat Opens for Business

By ROLAND D. PAINE

CHRISTOPHER COLUMBUS, Admiral of the Ocean Sea, Viceroy and Governor-General in perpetuity of the Islands and Terra Firma, commander of a fleet of seventeen ships, found himself on Nov. 14, 1493 on the north side of yet another island, one of a multitude that seemed continually to bar him from finding the mainland of India. It was his second voyage to the Indies on behalf of the powerful Queen Isabella of Spain. He wished to establish some communication with the natives of the island, and also hoped to locate a source of fresh water for his fleet.

Unable to enter a large bay because of a coral reef barrier, he coasted westerly, and at length ordered his ships to anchor outside what appeared to be the mouth of a narrow, shallow river. It might provide fresh water. An armed 25-man party was sent in to investigate.

The welcome that they received from certain of the inhabitants stimulated Columbus to dub the headland "Cabo de las Flechas" — Cape of Arrows. The little stream is today known as Salt River, and at its mouth — exactly where the Spanish fleet anchored — there rests in 50 feet of water a small habitat that is part of NOAA's Underwater Laboratory System . Above it floats a Life Support Boat whose technology is as far from Columbus's caravels as theirs was from the primitive canoes of the fierce Carib Indians. The life support system was first "fired up" in a dedication ceremony Nov.17, 1977 — three days away from the 484th anniversary of the day the mighty Admiral anchored there and saw his men engage in history's first recorded fight between Spaniards and natives of what later was known as the New World.

The island still retains the name given it by Columbus, Santa Cruz, though in its French version, St. Croix. Largest of the U.S. Virgin Islands, it lies to the south of the main chain of the West Indies, and provides special interest to geologists who will use NULS-I as base for their undersea research. The surrounding waters also offer challenging research opportunities for fishery and other biologists, physical oceanographers, coral researchers, and scientists interested in assaying oceanic pollution, petroleum and mineral potential, and a host of other subjects.

NULS-I is no newcomer to undersea science support. It was constructed in 1961 by Perry Oceanographics, Inc., and operated — as Hydro-Lab — for two years off the southeast Florida coast, and for five years off Freeport, Grand Bahamas. It was the underwater base for the NOAA-sponsored Project SCORE (Scientific Co-operative Operational Research Expedition) in 1975. Hydro-Lab was purchased last year by NOAA for $50,000, completely refurbished and rehabilitated, and will begin regular operations early in 1978. It is now part of NOAA's Oceanlab program, looking toward a more

From the Library of Congress collection

Christopher Columbus, Admiral of the Ocean Sea.

flexible and deeper-capability system in the future.

As Hydro-Lab, the system had been reliable and well-planned, but in some respects distinctly uncomfortable for the four-person teams who lived in it for up to five days at a time. They would swim out to carry on their research and return to eat, sleep, and identify and mark samples. To plan for refurbishment, Elliott Finkle, operations manager of NOAA's Manned Undersea Science and Technology program, sat down with Denny Breese of Ocean Agents, Inc., and went over every complaint, criticism, and suggestion provided by the diver-scientist occupants of the little structure during its seven years of active service.

Hydro-Lab, or NULS-I, provides a relatively small space for incorporating large changes. The 60-ton habitat is only 16 feet in length and eight feet in diameter, with six small viewports along the hull and one large (four-foot diameter) viewport at one end. Attached to it is a 10-foot long tunnel originally designed to provide an entrance passageway to research submersibles.

Finkle and Breese had the old floor of the habitat removed, and installed aluminum decking nine inches lower down, so that now the inhabitants can stand up straight while inside (unless they happen to be taller than 6'4", the ceiling height in the center). They also provided other amenities — a hot and cold running water sink, a hot water heater, microwave oven, trash compactor, work shelves and storage compartments — all new, all items that were not previously provided in the spartan little cylinder. Four bunks 6'7" long are provided (instead of only two, as previously), and in the dry areas the occupants walk on indoor-outdoor carpeting instead of hard concrete.

NULS-I is equipped for seven-day missions, at the end of which the occupants — saturated to habitat depth — require 16 1/4 hours decompression. A battery-powered emergency life support system in the habitat can provide power for 72 hours, more than twice the amount required for decompression, should the power supply from the Life Support Boat (LSB) somehow fail.

The LSB that floats above the habitat is hardly as grand as Mariagalante, Columbus's flagship of nearly 500 years ago that anchored in just about the same spot. LSB, anchored fast to the habitat, has a fiberglass hull 23 feet long and nine feet wide, and is built to withstand seas greater than 10 feet. It provides fresh air, power, water, and communications to the divers below through an umbilical system.

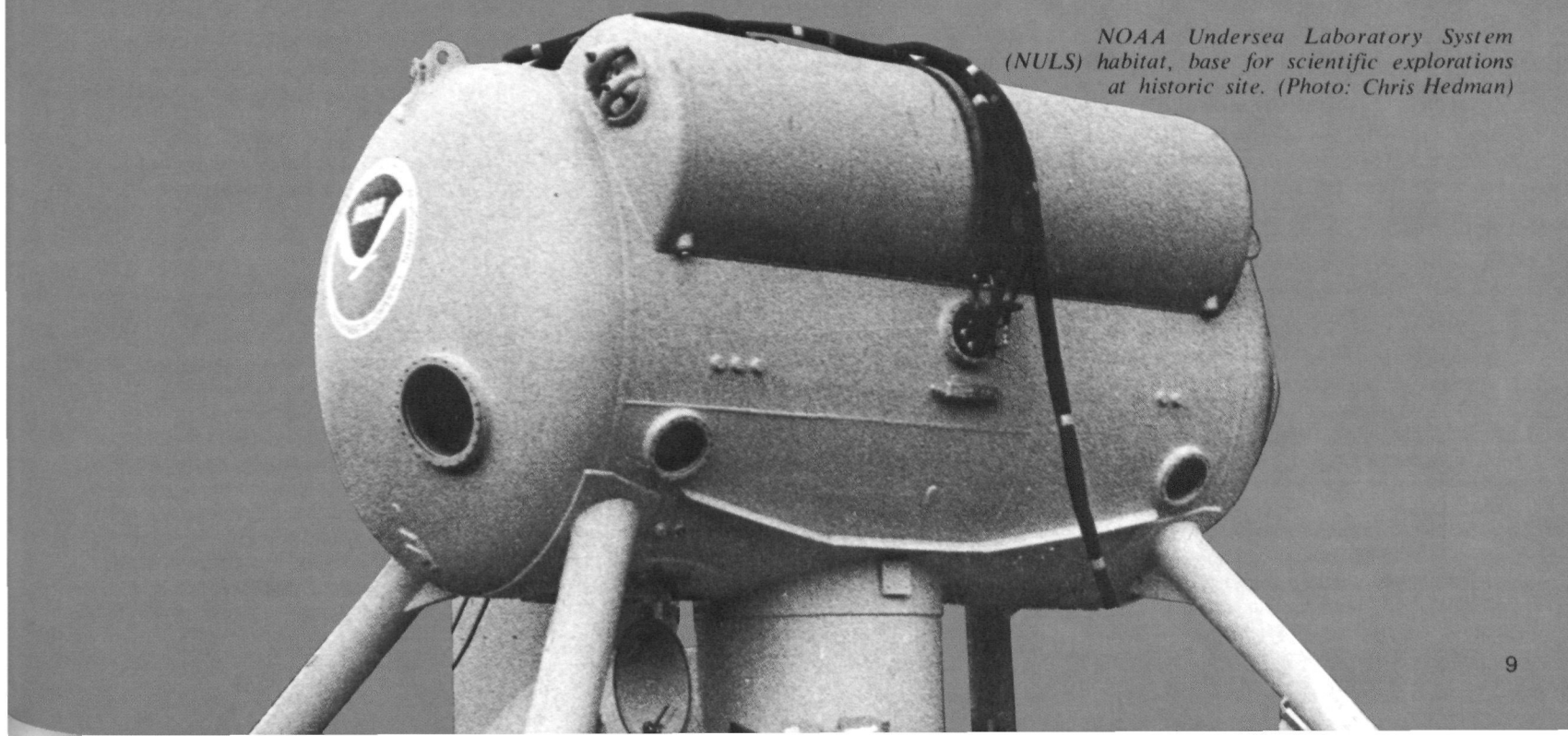
The LSB has two air systems, a low-pressure system for the occupants of the habitat, and a high-pressure system to replenish the air bottles they use while on swimming excursions. It contains a 250 gallon fuel tank, 250 gallon water tank, ventilation fan, FM/VHF radio system, diesel engine, batteries, and other equipment to keep it operating automatically day and night while the divers live and work below.

A third component of NULS is called PUTS, and PUTS stands for Portable Underwater Talking Station. PUTS looks something like an underwater telephone booth — if there were such things as underwater telephone booths — and stands outside the habitat. Scientist-divers who want to talk to each other without taking the time to enter the habitat can swim over to PUTS, duck under, and stand up. They will be about waist deep in water, with their heads and chests in air, and they can talk things over and then swim back to work.

PUTS can also be used as a safe haven for the aquanauts if for any reason they should be forced to evacuate the NULS-I habitat.

Following its rehabilitation, NULS-I — comprising the habitat, the LSB, and PUTS — was shipped to St. Croix and installed in its new environment. NULS-I is operated for NOAA under contract, by the West Indies Laboratory (WIL) of Fairleigh Dickinson University, a six-year old field station and teachng facility headed by Dr. Robert F. Dill. WIL is located near the eastern end of St. Croix, on Tague Bay, and provides housing, a dining facility and library, and other services. NULS-I is located toward the west end of the island, with its shore base on property donated to Fairleigh Dickinson by John B. Faile.

When Columbus's landing party rowed ashore on what later became the Faile property, they found a few Carib huts whose owners had hastily departed, and a few Arawaks, slaves of the Caribs. The Spaniards captured the Arawaks, finding them quite



NOAA Undersea Laboratory System (NULS) habitat, base for scientific explorations at historic site. (Photo: Chris Hedman)

ready to go along with these bearded strangers in order to escape their cruel masters. The landing party might have skirted the edge of a salt water marsh on its way back toward the fleet.

The marsh is no longer there, having been replaced many years ago by a small boat inlet and land built up by the material dredged to make the inlet. Handsome buildings constructed on the property and included in the Faile gift house a small laboratory, recompression chamber, and living areas. A boat dock and other facilities are also provided.

The property was the site of the Nov. 17 dedication of the undersea laboratory system, as more than 150 guests and students of WIL gathered. NOAA officials Finkle and Dr. Donald C. Beaumariage, Director of the Manned Undersea Science and Technology program of the Office of Ocean Engineering, represented the Federal sponsor. St. Croix Administrator Clement Sackey, Samuel Bough of Congressman Ron deLugo's office and Karl Kaufhold of the Faile estate spoke of local interests and participation in the project, and Dr. Jerome N. Pollack and Dr. Joseph Green, respectively President and Vice-President of Fairleigh Dickinson University, represented the operating institution, with Dr. Dill as master of ceremonies.

NULS is to be administered and used as a national facility, available to trained diver-scientists having sufficent experience in operating under saturated conditions. It is the nation's only operational habitat — there is just one other in the world — and it is planned to be a prototype for regional underwater habitat programs in U.S. coastal waters. The NULS program encompasses the following scientific goals:

—To acquire information about the marine environment applicable to problems existing in U.S. continental coastal regions;

—To develop new and improved underwater scientific techniques;

—To study the basic properties and processes that control tropical marine environments.

In addition, NULS has several technical and training goals, including:

—To train experienced marine scientists in underwater techniques;

—To test and evaluate underwater biomedical and diving procedures developed in onshore hyperbaric laboratories;

— To test and evaluate oceanographic instrumentation and scientific diving equipment.

To ensure that high quality research projects are selected for the limited number of missions that will be possible (about one per month), NOAA is establishing a peer review system under the leadership of Dr. James W. Miller, Deputy Director of MUS& T. Proposals for projects to be carried out in NULS-I will be reviewed and adjudged by well-qualified scientists and engineers from academic, private and Federal research institutions.

An experienced team has been put together by Dr. Dill to maintain the habitat and operate the system effectively. Dill himself is a geologist with particular interests in marine geology and sedimentary processes, and he is a long-time Scuba diver and former Navy submersible pilot. Head of on-site coordination and programming is Dr. Dennis Hubbard, whose previous experience includes active participation as a scientist-diver on Project SCORE. Operations engineering is the province of Barry Walden, formerly of the Woods Hole Oceanographic Institution and well acquainted with the sophisticated undersea system of the Alvin submersible. Henry Tonnemacher, an accredited Scuba instructor, is diving coordinator.

Dr. Robert Dill, Director of the West Indies Laboratory, Fairleigh Dickinson University, speaks at the dedication of NULS-1; other speakers included (1. to r.) Karl Kaufhold, manager of the Faile estate that donated the property for the land base; Rev. Richard Abbott; St. Croix Administrator Clement Sackey; and Samuel Bough, representing Congressman Ron deLugo.

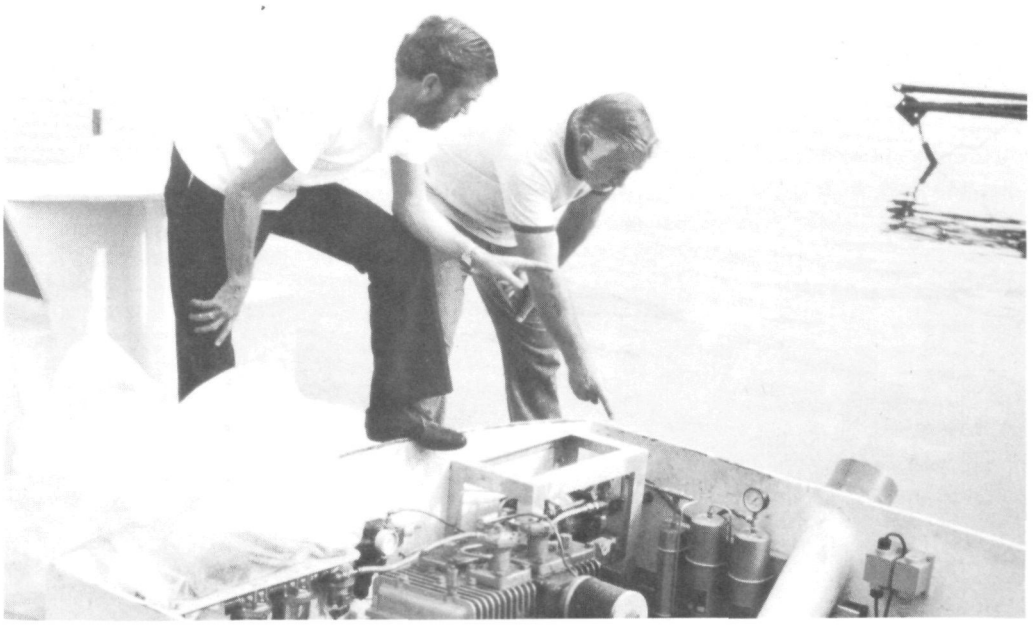
All operations will be carried out in conformity with the operations manual that has been under development by WIL under Finkle's supervision. Diving practices will follow the guidelines of the NOAA Diving Manual and recommendations of Dr. Morgan Wells, NOAA Diving Coordinator.

Moreover, the area that the scientist-divers in NULS-I will use for their research and experiments will have been thoroughly charted for them ahead of time. One problem with many underwater research projects in the past has been that the scientist-diver did not know exactly where to go, when swimming out from the habitat-base, to find the kinds of specimens that most interested him (or her — some of the most fruitful underwater science has been accomplished by women). A day of swim time might be wasted while poking around the bottom to locate exactly what was required. Unforeseen interruptions ranging from ocean swells caused by distant hurricanes to ear infections or equipment problems are always a possibility, and the underwater explorers want to accomplish their tasks as quickly as possible.

Indeed, the first explorers to visit the NULS-I site ran into an unforeseen interruption that prevented them from accomplishing their mission. Columbus's 25-man party, swelled by the addition of a few Arawak captives, had pushed off from shore when they came upon a small Carib canoe containing four men, a woman, and a small boy, who were drifting and staring in open-mouthed wonder at the huge ships of the Spanish fleet. The boarding party passed between them and shore, blocking their retreat. Whereupon the Caribs — the first aggressively unfriendly natives Columbus had ever encountered — attacked the much larger Spanish force.

Both sides soon beached on a nearby point of land and all six Indians, says the expedition chronicler, seized bows and arrows and let fly at the invaders with terrible ferocity. Despite their superior number, light armor, and shields, one Spaniard was killed and another wounded before they managed to subdue the small party of Indians and make their way back to the fleet. It was this brief encounter that led to Columbus's wry nomenclature and his decision to leave at once and look elsewhere for fresh water. Had a map of the area been available to the great explorer, he could have made a better decision about whether to stop at that point, or proceed elsewhere to satisfy his needs.

Such a "map" will be available to scientists using the NULS-I system. Under the aegis of Sea Grant, Dr. Michael Heeb of the national Sea Grant office and a group from the University of Maryland Sea Grant program in cooperation with scientists from WIL, are scheduled to make a series of dives to lay transects in the neighborhood and chart



The Life Support Boat (LSB) for NULS-1 is fired up for the first time (above); checking it out ahead of time are Dr. Donald Beaumariage (1.), Director Manned Undersea Science and Technology program, and Elliott Finkle, MUS&T's operations manager (below).

depths, superficial geology, flora, and that part of the fauna that doesn't move around. Underwater photographs will support the sketches. A preliminary series of observations have been made, and plans are afoot to complete the project early in the year. A series of charts will be produced to enable the habitat occupants to start right out for what would appear to be the best locations for their work.

St. Croix offers special possibilities for research that will not only add to mankind's knowledge of coral reef environments, but will shed light on other processes important to management of the oceans and to betterment of life. The island lies off the main chain of the Lesser Antilles, a long submerged mountain chain whose tops break the surface of the ocean and form the numerous islands of the area. St. Croix, however, is not a volcanic, but a sedimentary ridge.

St. Croix was formed in an ocean basin, into which generations and millenia of sediments fell. At some point the vast sedimentary plateau that resulted was uplifted and turned on its side by great tectonic forces from below. The part that appeared above the sea level became the island of St. Croix. The layers of sediments, originally horizontal, are now more nearly vertical. Erosion caused by winds and rains has eaten away at different sedimentary layers at different rates, helping to form the hills and valleys of the island.

Much of the geological history of these processes is revealed in the rock and soil of the island, but much of it, too, has been obliterated by the forces of the weather. Geologists working under the water will be able to ferret out further information from rock and sedimentary layers that have not been subjected to the changeable elements of the climate, but have been shielded and cradled in the warm southern ocean.

Because of its sedimentary nature and origin, possibilities exist for the discovery of petroleum and useful minerals in the underlying strata. Petroleum geologists from the major oil companies have gone to the island in increasing numbers in recent years, often making contact and exchanging ideas with staff at WIL. Some of the geological formations being drilled in Canada and Alaska, as well as other areas of the earth, were originally deposited by processes similar to those that took place at St. Croix. The NULS-I habitat will help provide basic information on these processes, which can be used to interpret processes in other areas of the world.

The topography of the Salt River harbor is interesting to marine scientists. Partly protected by a coral reef, there is a natural break in the reef system that enabled the sailors of Columbus's fleet to work landward up the river. Outside the reef, seaward of the river mouth, is an undersea canyon that extends gradually, then more steeply downward for about six and a half miles, to a depth of about 10,000 feet, where it joins another canyon that goes down to about 15,000 feet. The NULS-I habitat is located near the head of the Salt River canyon. One wall of the canyon is steep, the other much more gently sloping, and each wall has its characteristic forms of coral and other sea life. To the men and women of science who want to know why, the challenges of the site are many.

St. Croix is bordered by both carbonate sand beaches and rocky shorelines, and the shallow platform that surrounds the island — into which the Salt River canyon is cut — contains a variety of types of coral reefs. Many types of marine vertebrates and invertebrates are found over the surface and edges of the shallows, and more than 300 species of marine algae have been identified. The Salt River submarine canyon provides a natural laboratory for sediment transport studies.

The north shore of St. Croix includes many areas of natural shoreline relatively undisturbed by man's activities, including a well developed bank, barrier reefs such as the one that kept Columbus from entering the present site of the Christiansted harbor, two submarine canyons, several lagoons, and a rocky intertidal zone interspersed with stretches of sandy beach. On the southwest shore of the island is a heavily industrialized area that includes one of the world's largest oil refineries, a bauxite plant, a major sewer outfall, a rum distillation plant outfall, and a city refuse site. The island thus offers many opportunities for close study of man's impact on a relatively limited environment and its associated interconnected ecosystems.

Scientific programs using NULS-I are scheduled to start in April, once all the training and preparation has been completed and appropriate missions selected. The system is another step forward in NOAA's undersea program, and represents a measured advance over facilities and techniques previously available. With the full expectation that useful science and highly productive applied research and technological progress will result, NOAA's manned undersea efforts may then move toward small regional habitats and ultimately toward the Oceanlab system, a major advance in the nation's capability to explore and beneficially manage the oceans. The Admiral of the Ocean Sea himself could not have plotted a sounder course. □

BOULDER ASSIGNMENT:

By CDR. RICHARD E. NEWELL*

THE YOUNG OFFICER slid the last survey sheet into the wide chart table drawer, which he then slammed shut. He paused to give the area a final check. To a sailor, there's no lonelier place than a deserted ship's bridge an hour after making port. He stepped out onto the bridge wing, then down the ladder to the next deck. The heavy whine of the ship's crane rose from the stern as the Bos'n and his men helped the scientists offload their gear to the dock. The officer left the noise behind as he reentered the ship and traversed an air conditioned passageway to the Mail Room.

His mailbox, usually empty during the past month at sea, was now crowded with letters and oversized manila envelopes. One letter looked particularly official. He tore it open and quickly read the magic words: "The Officer Assignment Board has recommended and I have approved your assignment to the Environmental Research Laboratories, Boulder, Colorado . . . , signed Rear Admiral Harley D. Nygren, Director, NOAA Corps."

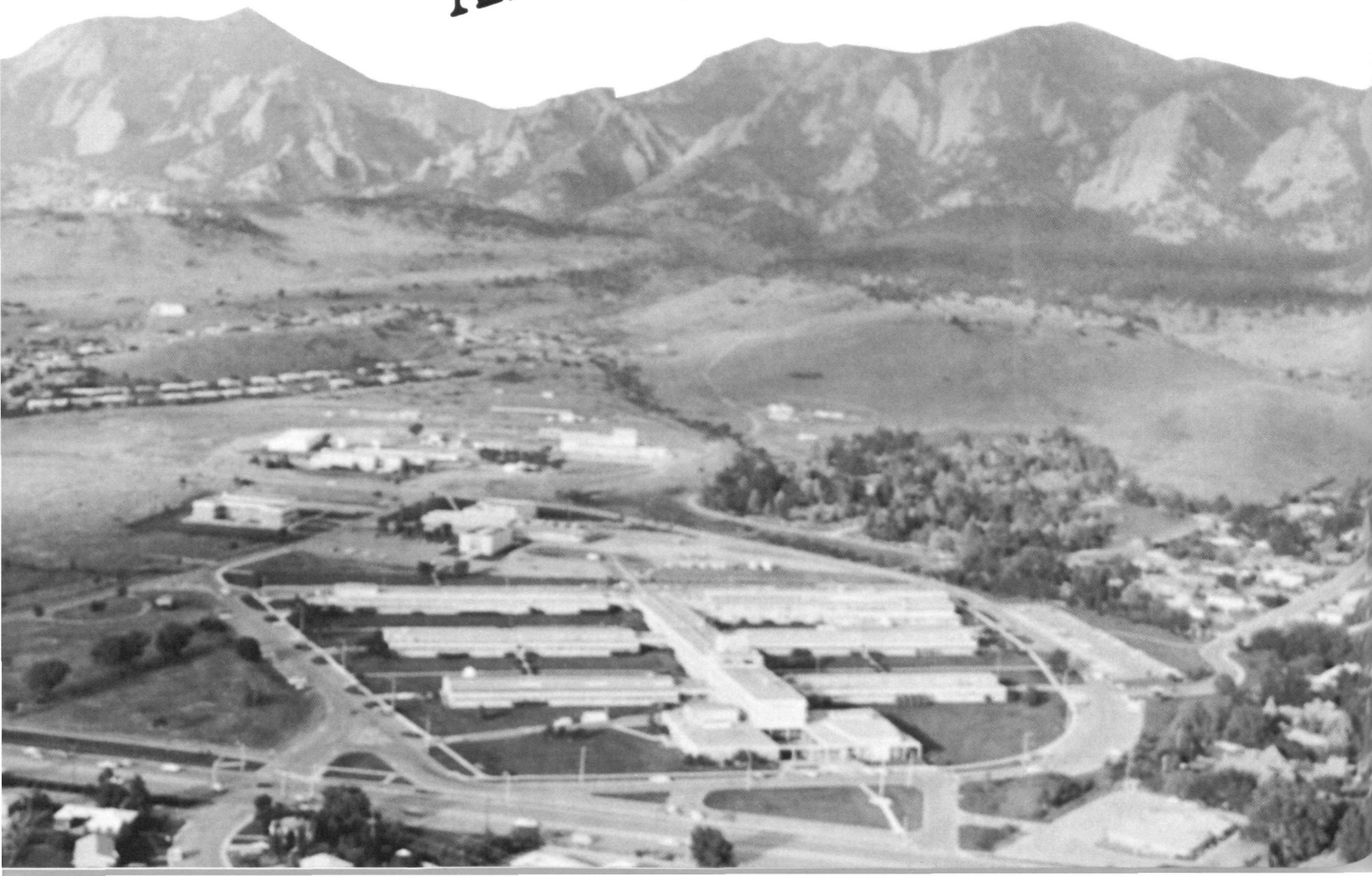
This junior officer has just savored two of the most cherished experiences of a NOAA Corps career — making port and getting firstclass shore duty. He is ready to take his leave of the sea and climb to the High Country, to Boulder, where he will lay aside his uniform and "do science."

Members of the commissioned corps have been coming to Boulder since 1967, when Lieutenant Joe Carr was assigned to the Space Environment Laboratory as a solar forecaster. The creation of the Environmental Science Services Administration (ESSA) just two years earlier had paved the way for Carr's assignment. This new agency brought the corps' parent organization, the Coast and Geodetic Survey, under the same roof with the Weather Bureau and the Central Radio Propagation Laboratory of the National Bureau of Standards, with the aim of providing a single national focus on efforts to describe, understand, and predict the environment.

The expanded scientific role of the corps in ESSA was described by Admiral Nygren in his "Origin and Development of the NOAA Corps." The new agency was empowered to direct officers with engineering and scientific backgrounds "to serve when and where needed in any component of the Adminstration, regardless of remoteness of station, . . . length of family separation, or hazard of duty." The creation of ESSA thus led to both an expansion and a diversification of the Corps.

With the formation of NOAA in 1970, "members of the NOAA Corps assumed key positions in many more technical and ocean-related operations." The commissioned corps, created in 1917, thus evolved from a group of hydrographic and geodetic engineers into a diversified pool of officer-scientists who not only command NOAA ships, but also support and supervise scientific and technical programs ashore and at sea and bring scientific and engineering expertise to NOAA staff posts. And so it is that these officers now journey to Boulder and a host of other focal points for NOAA's wide-ranging scientific interests.

** Cdr. Richard Newell, NOAA Corps, is assigned to the Magnetospheric Physics Group of ERL's Space Environment Laboratory*



Most of NOAA's scientific work in Boulder takes place in two large buildings nearly two miles apart. "RB-3", near the center of town, is modern, brick, and six stories high — fairly tall by Boulder standards. The older "Radio Building" is a low-lying cement structure appropriately cast in the form of a giant reclining antenna, its long-armed spine running down the foothills at the western edge of town.

Our young officer fresh from the sea would notice some of the more nautical features of this building. What appears to be a glass-fronted command post fortified by a bulky turret is perched atop the leading end of the long structure. He could be looking up at the bridge of a hybrid NOAA ship, complete with exhaust stack. Above and around the "bridge" a wind vane with anemometer, and a host of assorted antennas, add to the nautical flavor.

There are no ships in Boulder, and no great bodies of water. Still, an assignment here has more in common with sea duty than most officers would care to contemplate. After two years of ship-driving and data-taking, these sailor-scientists are ready to let science prevail. But even though they now sit high and dry, many features of the marine environment persist, to remind them of their ties with ships and the sea.

The name of the game aboard the ships they leave behind is "sampling" — the systematic collection of data specimens, from traces on stripcharts to mud in coring tubes, from pulses or magnetic tape to critters in nets. Officers who come to Boulder are likely to continue with the sampling game. One of these is Lt. Cdr. Joe Bush, who spends most of his working day in a windowless lab in the rear wing of the Radio Building. He ventures forth twice a month to collect air samples for ERL's Aeronomy Laboratory. He wants to keep right on collecting them after he returns to sea and is working to enlist others to his cause. In fact, his interest in atmospheric trace constituents is global. He is setting up an oceanic sampling program, in which the NOAA ships Oceanographer, Discoverer and Researcher are already participating. And as a part of his drive to extend these observations around the world, he provides small sampling containers for his scientist-friends to use on their travels.

This kind of work carries a high priority these days. It's part of the Aeronomy Lab's study of possible chemical threats to the stratospheric ozone layer. When this layer is weakened, more ultraviolet radiation gets through to the earth, and this could pose a biological threat. The trouble might show up as a change in climate or as direct damage to plant life — including plankton, at the base of the food chain — or even as a hazard to animal life, in terms of both food chain breakdown and increased rates of skin cancer.

"Right now, I'm focusing on ground level measurements of nitrous oxide," Bush explains. "When this gas reaches the stratosphere, it's converted to nitric oxide which, along with fluorocarbons, destroys ozone." Nitrous oxide has several natural sources. "It's one of nature's ways to control the amount of ozone up there," he says, "but man produces nitrous oxide too." The burning of fossil fuels and the use of nitrogen-rich fertilizers are thought to be important examples. "In the case of fertilizers, microbes in the soil convert the nitrates and nitrites into ammonia. The process is called denitrification, and nitrous oxide is a by-product." He points out that agriculture's worldwide Green Revolution could be raising the production level of nitrous oxide, and many are concerned about the environmental effects.

Investigators have been measuring nitrous oxide over the past ten years, but the basic question of whether the worldwide level has been increasing or decreasing has yet to be answered. Bush hopes that his work will help to shed some light on this problem. This is what takes him into the laboratory.

This lab is basically like those on NOAA ships — it's a place where samples are analyzed. But there are some big differences too. It doesn't come with bulkheads lined with Nansen bottles, nor is it manned around the clock by survey technicians. And there are no visiting scientists moving in to set up arrays of sophisticated equipment. That was research at sea.

Now that he is ashore, Bush has a laboratory he can call his own. Its walls are lined with bulky, tube-tied gas injectors, detectors, and cylinders that he uses to carry his work beyond the sampling stage.

He serves up his samples to a gas chromatograph, the collective name for the bulk of this rack-mounted paraphernalia. He began restoring it to active use shortly after he came here and still keeps busy improving it. His biggest problem? It's the same one the shipboard analyst often faces — to keep his equipment free of internal impurities, so that he can isolate purer samples of the trace constituents he's after.

Bush is happy where he is — it's his second tour of duty with the Aeronomy Lab — but some of the officers who come here are just as happy to mix science with travel. And NOAA accommodates them. Attached to a bulkhead just forward of the oceanographic lab of the research ship Oceanographer is a map of the world, criss-crossed by colored tracklines — a different color for each year of field work. Just as NOAA's sampling needs take the "Oceo" far from her home port of Seattle, so do they sometimes take Boulder-based officers to remote corners of the earth.

Lt. Tom de Foor has moved to the poleward edge of North America. He is the chief of the Point Barrow Geophysical Observatory in the Alaskan Arctic.

He talked about his new assignment while settling back into his third-floor RB-3 office, following a get-acquainted trip to Barrow. The observatory there is one of four stations set up to provide the data needed for accurate predictions of climate changes. The other three are in Hawaii, American Samoa, and Antarctica. These stations are operated by the Geophysical Monitoring for Climatic Change (GMCC) program, of ERL's Air Resources Laboratories, although the Antarctic observatory is housed in a National Science Foundation facility. They make baseline measurements of natural and man-made contaminants of the atmosphere (carbon dioxide, ozone, aerosols, fluorocarbons), as well as properties affected by these contaminants (atmospheric turbidity, solar radiation).

De Foor is an electronics engineer with a fondness for data acquisition systems and a yen to travel. Although his work has taken him north to Alaska, he said "south to Samoa" was his first choice. Even so, he and his wife were happy to make the move.

"We'll both be working six days a week," he said. "I'll work at the Lab and Kaye will

Lt. Cdr. Joseph Bush works with gas chromatograph in the Aeronomy Laboratory, to measure atmospheric trace constituents to within eight parts per billion.

teach in town." They live at the Naval Arctic Research Laboratory with about 200 others, made up of military and civilian personnel and their families. In spite of certain hardships, such as the lack of indoor plumbing, he expected their stay to be pleasant.

De Foor first went to sea aboard the Surveyor, out of Seattle, and later transferred across the dock to the Fairweather. Officers have the same kind of opportunity in Boulder. The needs of the local NOAA agencies frequently mesh with the changing awareness and desires of the officers who serve here. The result is that a lab-to-lab transfer in Boulder is probably as commonplace as a ship-to-ship transfer at NOAA's marine centers in Seattle and Norfolk.

Any job-hopping done here is usually the result of the officer's own initiative. De Foor became aware of GMCC's global observatories while working with the Space Environment Laboratory (SEL) in the Radio Building. His friend, Lt. Cdr. Emerson Wood, was then slated for duty at Barrow. De Foor expressed a strong interest in the geophysical observing program, and when the Barrow position again opened up, he was offered the assignment.

When a man moves on another must replace him. That is how de Foor got his job, and that's what is giving his replacement the chance to enter a new career field. Lt. Bruce Johnson's first year in Boulder was spent as a solar observer and forecaster for the Space Environment Services Center, operated jointly by SEL and the U.S. Air Force's Air Weather Service — it's the only facility in the world dedicated to real-time monitoring and prediction of the space environment.

During that year at the forecast center, as SESC is informally called, Johnson discovered that he prefers electronics to space science. His new job is to service the forecast center's electronics gear and to help build new equipment. He's also beginning to design it.

When he goes to sea again, Johnson hopes to serve in the capacity of Electronics Officer. Actually, his work in support of the forecast center is much the same as it would be on a NOAA ship. When it comes to electronics, he is maintenance man, troubleshooter, and general overseer. The main difference is that aboard ship the job of Electronics Officer is collateral work, taking second priority to bridge duty.

Whether at sea or ashore, one aspect of Lt. Johnson's new career field of electronics that is playing a growing role in NOAA's sampling programs is remote sensing of the environment — gathering data at a distance. Another is on-site computer processing of data. Put these together and you have an exciting new field of technology in which several NOAA Corps officers in Boulder are taking part.

The oldest example of remote sensing technology known to man is the optical telescope, discovered and turned toward the heavens by Galileo over 300 years ago. The modern solar telescope is an electronic marvel — Galileo wouldn't recognize it — and, of course, it comes with a built-in computer. NOAA is involved with these telescopes because it has a stake in what is happening on the sun. This is why Lt. Mark Losleben will soon journey to the Far East to help install, operate, and maintain the fourth solar telescope of a new five-station global network. This Solar Observing Optical Network (SOON) is being built and operated by the U.S. Air Force, but some of the observatories will be run with NOAA's help.

Losleben, like Johnson, began his Boulder duty as a solar observer-forecaster, but he

Two young NOAA Corps officers at the Space Environment Laboratory — Lt. Bruce Johnson (above) works with device that ties high-speed paper-tape punch into a computer, and Lt. Mark Losleben examines the surface of the sun through the laboratory's solar telescope. At right, a view of the laboratory on a chilly winter day.

knew from the start he was in the right business. "Although I concentrate on the observational end," he said, "I also enjoy working at the forecast desk, because it helps me to keep track of what the other observatories are reporting. I can get a good feeling for what's going on everywhere."

As Chief Observer in charge of seven work-study students, he makes several trips each workday from the forecast center back through the central corridor of the Radio Building to an outdoor stairway, then up to the graveled roof and across a long slatted walkway leading to the white, metal dome of the old Razdow solar telescope.

Here he brings the image of the sun into focus, to see how its lined and mottled face has changed over the hours — for the sun's countenance, like the sea's, is not a constant thing. There are times when it does no more than lie there, nearly featureless, and invisibly steam its coronal vapors into space. But at other times large areas are taken over by bright plage (from the French for "beach"), frequently dotted by underlying sunspots. It is here on these celestial "beaches" that the enormous energy of a solar flare is sometimes released, as a giant ocean wave might spill onto an earthbound beach to liberate its energy in a dazzling surge of foam.

Losleben's new "superscope" will bring him closer to the sun than ever. Instead of squinting at the solar disk through an eyepiece, he will be able to look up at four television monitors, each offering a high-powered view of a different region of the sun. Rather than getting subjective measurements of just a few solar variables, he can get highly standardized measurements of a whole raft of them. No more must he train and oversee a large team of rotating observers — he will simply order up the desired menu of observations by "talking" to his telescope through a computer terminal. The system will serve up his choice of optical observations in the desired timed sequence, and automatically record and transmit them as well.

Sometimes, he won't even have to ask. Detection of solar flares will be automatic, based on a linkup between the computer and a brightness analyzer. When he hears the flare alarm, he may merely verify the event and press a button that sends a flare report on its way. But Losleben can always have the last word. He can manually override the system any time he judges that its performance is questionable.

All remote sensing devices rely on traveling waves of one sort or other to bring information to them. While Lt. Losleben focuses on light waves emitted from the sun, Lt. Craig Blasingame tunes in on radar waves backscattered from the sea. His work for the Wave Propagation Laboratory has taken him from the sandy beaches of Florida to the rocky shores of Alaska, as a part of his laboratory's effort to perfect a remarkable new radar system for mapping surface currents in coastal waters.

This revolutionary current-mapping device is based on a phenomenon associated with all traveling waves — the Doppler effect. The solar telescope uses this effect to gauge the speed of convection cells and gas clouds on the sun. The coastal current radar uses it to observe the action of ocean waves, which subtly trace the underlying currents. The key to the process is the slight change in velocity imparted by the currents to the waves and detected by the radar receiver. Using a pair of transportable radars, at least a thousand times more data can be gathered in a twelve-hour period than with any alternative technique. An on-site computer can calculate the currents and map them over an area as far as 80 kilometers (50 miles) from shore with errors presently less than 20 centimeters/ second (0.4 mile/ hour). The principle isn't new, but the development of a mobile system with rapid data output is.

The system has many practical uses. It can help to show how currents erode our coasts or where they might carry pollutants. It can provide on-the-spot tracking during oil spills and rescue operations, when darkness or fog hampers visual detection. It might even be installed at major harbors to provide routine current observations to the general public.

There is also the opportunity that presents itself with many a new source of abundant data — to use it to develop and test a prediction model. Just as the new solar telescope could point the way to flare prediction, this new radar system could put us on course toward successful surface current forecasts. And just as with the observations themselves, good surface current forecasts carry a special dividend — knowing the surface currents, it is possible to calculate the currents and circulation below, all the way to the ocean floor.

Successful field tests of the mapping system have already been conducted. "All told," says Blasingame, "I spent five months in Miami taking care of logistics and helping to check out the system. We ground-truthed the radar data by tracking a drifting buoy — we brought a boat alongside every five minutes to make a navigational fix. The fact that the Gulf Stream was fairly steady in the test area gave us the simple current structure that we needed for those first tests. The data checked out fine.

"In Florida," Blasingame continues, "our two radar sites were at Fort Lauderale and Miami. The later Alaska testing took us to Seldovia and Anchor Point in Lower Cook Inlet. Data from the complex current environment there will allow us to try different methods of signal processing in order to see which set of results comes closest to matching our ground truth."

The radar system's minicomputer produces current maps on the spot. Blasingame has been redesigning some of the software in order to simplify data-taking. Another improvement will come soon when telemetry is added to the system. "This will enable us to get the data quickly from the radar sites to a field processing center, where current maps can be produced within just 15 minutes of the observations."

Though there are refinements yet to be made, the basic radar system was designed and built from the ground up in a period of only eighteen months, in spite of the fact that personnel regulations prevented the hiring of full-time, experienced engineers. Blasingame is proud to have been a part of it all. Speaking of the rapid, on-site data output aspects of the system, he says "Until we tried it in Florida, it was only a theory. Now more and more people are taking an active interest in our work."

In the world of remote sensing, it's just a step from ocean currents to wind currents. In terms of NOAA Corps involvement, that "step" takes us down the hall and around the corner into the territory of Lieutenant Hans Ramm. He will spend the coming year on the Antarctic plateau with a device much like Blasingame's — it sends one type of wave in search of another. But this instrument emits sound waves rather than radar waves, and its targets are waves and patches of atmospheric turbulence rather than the waves of the sea.

Ramm will share space with GMCC's Lt. (j.g.) John Osborn at the National Science Foundation's South Pole Clean Air Facility. The object of his attention in the area of remote sensing is WPL's acoustic echo sounder. This Doppler wind-sensing system got its sea legs on the foredeck of the Oceanographer during the GATE project in 1974 and, in a simplified version, began its first polar mission the following year.

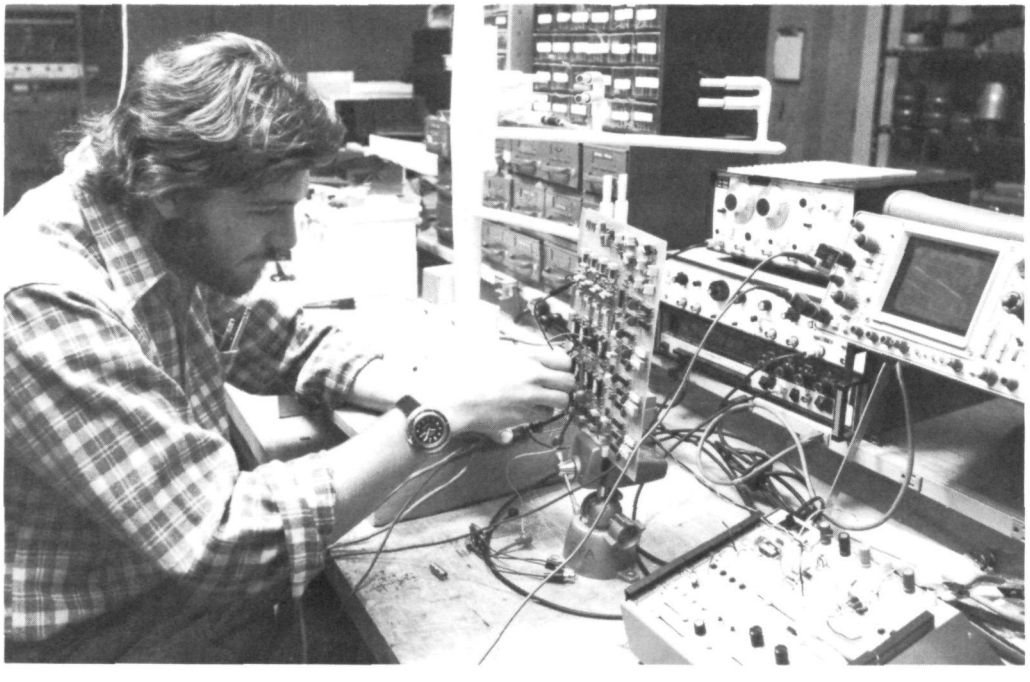
Lieutenant Ramm first encountered the sounder during its pre-GATE sea trials aboard the "Oceo". He was a civilian survey technician at the time, but soon departed to the east coast for training at the NOAA Officer Training Center on Long Island. I joined the ship shortly after he left and was one of about 120 souls who grew to accept the sounder's measured chirping as a natural accompaniment to that tropical summer's work. Dr. Kirby Hanson, now director of GMCC, was chief scientist of the project, and Drs. Freeman Hall and Peter Mandics, along with Ed Owens, all still with the Wave Propagation Lab, were the sounder's caretakers. We all are in Boulder now, and the sounder is still a common element in our lives.

This device has come a long way in the past few years. It's more sophisticated now. It is smaller, less expensive, more accurate, and comes with a microcomputer for instant calculation of wind data. However, old friends will be glad to know that its distinctive chirp has been preserved.

Ramm has spent part of the past year designing and building the circuitry to link up a sonic anemometer with the sounder's computer. This instrument will measure the wind and turbulence near the surface, something the sounder cannot do. Like Lieutenant Bruce Johnson, Ramm came to the job without electronics experience and appreciates the chance to acquire some. While sitting at his laboratory work bench, he explained that "the use of the microcomputer to control the Doppler system and process the data is our first step toward developing remote unmanned stations. Another goal is to make this miniaturized, low-cost technology available to the commercial sector. We're trying to push the state of the art as far as we can."

Both physicist Ramm and meteorologist Osborn are looking forward to their Antarctic stay. "I don't expect that we'll get too bored," said Ramm. "We'll keep busy taking care of all this exotic electronics equipment."

These two officers are destined to become members of a rather exclusive group. Those



Boulder-based NOAA Corps officers receive a variety of challenging assignments. Lt. Jeff Calebaugh (above) volunteered for a year at the South Pole, and Lt. Hans Ramm (right) checks circuitry from the Wave Propagation Laboratory's acoustic echo sounder, which he will take to the South Pole to monitor wind velocity and shear.

who winter over in Antarctica achieve a rare distinction — not only have they been there, they have endured the rigors of the long winter's night. Those who stay at the South Pole have the opportunity to achieve an even higher distinction — membership in the "300" Club, attained by "streaking" in boots around the geographic pole at - 100°F temperatures after dashing out of a 200° sauna.

One polar veteran now working in Boulder is Lt. Jeff Calebaugh, who was NOAA's seismological-geomagnetic observer at the South Pole Amundsen-Scott station in 1974, when Antarctic sauna technology could only support a "200" Club. Another is Lt. Steve Knott, who has received a suitable reward for his polar service — the assignment of his choice. He was able to set up a schooling arrangement with the Wave Propagation Lab which is moving him in the direction of a doctorate in Astrogeophysics, specializing in atmospheric waves, from the University of Colorado.

A wide variety of schooling goals can be pursued in this college town. One that has attracted several NOAA officers is the Master's degree in Basic Science, an appealing choice for some because the program can be tailored to a student's particular science interests. Separate course-taking is possible too, either on campus or on video tape, in NOAA territory.

NOAA's Boulder territory is not restricted to ERL. Building RB-3 also houses the National Geophysical and Solar-Terrestrial Data Center, a key branch of NOAA's Environmental Data Service (EDS). This is where NOAA Corps data-takers learn to become data managers.

Calebaugh, formerly of the Antarctic ice dome, now works with tsunami data for EDS. He is building a tsunami data base that pulls together all scientific observations of these destructive sea waves. "EDS wants a consumer-usable system," he explains. Most of the information is in the form of tide gauge charts that contain evidence of tsunamis — "We call them tsunamigrams." Calebaugh is assembling a catalog of tsunami data, in three parts. The first part will be a chronological listing of all known tsunami events, whether due to underwater earthquakes, landslides, volcanic eruptions, or other causes. "The earliest recorded tsunami occurred in 476 B.C.," he says. "I have almost 1000 events listed so far." An offshoot of the list is a world chart showing the generating centers of these disturbances.

Lt. John Nelson displays a preliminary plot of the epicenters of tsunami-generating earthquakes.

The catalog will also include a summary of key facts about the tsunami events and recordings. Calebaugh is excited about this, because it will be the first summary to deal with the world wide picture. A photograph inventory will round out the catalog. This entails sending out requests to people all over the world for photos and slides of tsunami activity and tsunami damage.

Another big project is the creation of a microfilm file of "all the 'grams I can get my hands on" from the United States and other countries participating in the Tsunami Warning System. His goal is to do quality microfilming of original tsunamigrams. "No more copies of copies," he vows, "except as a last resort."

He has found that two factors have been crucial to the success of his work: contacts and computers. "I have to know the right people in order to do my job. It's amazing what just picking up the phone and talking to another officer in a key position can do for you in the way of cutting through red tape." But the first thing he did after reporting to the job was to start learning about computers. He's had to learn a great deal about them to do all he wants to with the data, and he finds that "knowing enough is still a problem."

This has been a gratifying assignment for Calebaugh. But after a year at the South Pole and a thousand tsunamis in Boulder, he's "ready to go back to sea." He will entrust his hard-won tsunami facts to his computer-wise replacement, Lt. John Nelson.

A quick meander through the hallways from Calebaugh takes us to an officer whose seagoing experience has been very helpful in his present EDS assignment. He is Lt. Kit Lawrence, and his goal is to see that marine data get into the hands of the users quickly and conveniently.

He is presently helping to develop a data base management system for ship trackline data. The computerized system will provide quality control for magnetic field, gravity, and bathymetric data, as well as that always-crucial element, ship navigation — the information is useless if it isn't nailed down to a time and a place. This new management system will also boost efficiency, by helping his division to pin down exactly what information it has and where it is.

The biggest part of Lawrence's work here has involved him, indirectly, with a program that has wide-ranging benefits — the automated production of nautical charts. This chart automation program is being carried forward by NOAA's National Ocean Survey on two fronts. The first involves the development of automated hydrography — the electronic sensing and recording of positions and depths.

The other aspect of the automation program involves the transfer of a tremendous amount of conventionally-observed historical data from the original hydrographic "smooth sheets" onto magnetic tapes. This is done by tracing the depth curves with a hand-held electronic digitizer. After "the graphics have been transformed into a digital file," as the NOS cartographers put it, the soundings can be processed by computers. This is where Lawrence comes in. He uses both sources of digital data — the new (to be available soon) and the newly transformed — to service a large group of customers in search of information that nautical charts can't easily provide.

A basic feature of this service is a young and growing data catalog entitled "Digital Bathymetric Data for United States Coastal Regions". It shows the location and sounding coverage of the one-degree square area devoted to each magnetic tape.

Next comes what he terms "product development". This is the payoff stage, in which the taped soundings are processed by computer to produce a variety of tailor-made plots. In addition to discrete depths, these plots may include depth-versus-distance profiles, bottom characteristics, navigational hazards, and even gridpoint depths for use in computerized research projects. Users can also specify a plot's projection, scale, latitude-longitude boundaries, and depth units.

The value of this increased consumer-power was demonstrated by a call Lawrence received from a firm in need of a sounding chart and several depth profiles for a 15,000-square-mile area off the east coast. Lawrence used his catalog, computer, and sounding tapes to come up with automated plots of the information on a 30" by 50" chart. "Without digital data," he says, "this company would have had to settle for photocopies of several old, dog-eared smooth sheets plotted to various scales and then work for several days to extract the desired information and plot it to a common scale. We were able to help them for a tenth of what that would have cost."

By expanding the variety of its data products, EDS has also expanded the variety of users. "In fact," says Lawrence, "the digital sounding data will probably be used most heavily for products other than nautical charts within a few years." The shipping industry will then be just one of several major users of this information, along with such industries as fisheries, petroleum, and marine construction.

In order to hasten the spread of this wealth of data, "we're advertising it pretty extensively," he says. "We've sent flyers to over 1,000 individuals and put notices in over 80 trade journals."

Requests for the data have been heavy, both inside and outside of NOAA. One was filled for plots of depths and bottom characteristics that will help NOAA to evaluate the environmental impact of brine pumping operations in the Gulf of Mexico. "The plan is to pump out salt domes for oil storage," Lawrence explains. "They have to be careful where they dump the brine. They don't want it to collect in a natural pocket, because it could wipe out the marine life there. Our computer products will help them to avoid that hazard."

Computers are an indispensable tool of the trade throughout EDS. Lt. Greg Kosinski went to Boulder to work full time with them. It all began during his college years, as a math major, but it was only after joining the corps that he became "hooked" on them. "I really got interested in computers during my first sea duty tour, aboard the Fairweather," he says. "I had a lot of fun with their PDP-8."

After coming to EDS, Kosinski was put to work processing solar flare and ionospheric data. He explained that this information "had to be quality-checked and formatted on magnetic tape so scientists could use it." This was high-priority work, but not what he originally had in mind.

"What I really wanted was to get into scientific programming — to dig into the physical processes behind the data." As he got further into his work, he discovered that he also wanted to explore the use of computers for "other things than just crunching numbers," by looking at the data management aspects too.

An example of this kind of work is the computer program he is writing that will help local EDS personnel "talk" to the computer through a conveniently-located terminal and tell it in simple terms just what information they need and how they want it presented. "In other words," he says, "this job is teaching me how computers can make everybody's life a little easier." Now that he has had a taste of it, he is actively seeking more opportunities to use computers creatively.

Kosinski came to Boulder after writing a few letters of inquiry to EDS, discovering an opening in the Solar- Terrestrial group, and informing the Officer Assignment Board of his preference. What are some of the other ways that officers go about making the "Boulder connection"?

Increasingly, NOAA-wide assignment openings for officers are advertised in the monthly Corps Bulletin. The semi-annual assignment roster can also be used to pinpoint potential job opportunities, and the ERL and EDS liaison officers provide assignment information too. Whatever the original source of information, officers are encouraged to discuss the facts with other officers working in the area of interest and with the prospective immediate supervisor, before making an

assignment request. To quote Adm. Nygren, "The chain of command does not intervene when people are looking for help or advice."

The NOAA Corps liaison officer for ERL is Capt. William Jeffers, Boulder's senior NOAA Corps officer. He often serves as go-between from laboratories to officers who are, or might like to be, assigned to them.

He has another job too, one that goes back to his ties with the sea. He recently served as Commanding Officer of the Surveyor, one of NOAA's three Seattle-based "energy ships". Together with the Discover and Miller Freeman, the Surveyor has been plying the Alaskan continental shelf on behalf of the nation's energy needs. The studies they conduct will help to determine which areas can be opened up for gas and oil development without serious threat to the marine environment.

Now that he is in Boulder, Capt. Jeffers serves as logistics officer for the Outer Continental Shelf Environmental Assessment Program (OCSEAP), working with other officers here and in Alaska to assure that the ships and shore parties have what they need to do their jobs.

Another man involved with national resources is Lt. Andy Armstrong. The resource in question is seaworthy young scientists and engineers who, as a recruiting pamphlet states, "desire travel, a variety of assignments, and meeting nature on her own terms."

Amstrong, a geologist and ex-Navy officer, is the only non-ERL/ EDS officer in Boulder. He is attached to Adm. Nygren's staff as NOAA Corps recruiter for the mid-continental United States. He has been, and continues to be, a man on the go. His Navy years took him to Viet Nam as a Deck Officer on an amphibious ship and in and out of Naples, Italy, as Executive Officer on a patrol gunboat. Now, after more sea duty on the Rainier, a hydrographic survey ship out of Seattle, he spends several months each year making the rounds of about thirty-five colleges and universities between the Rocky Mountains and the Mississippi and Ohio Rivers.

This assignment came about as a compromise. He had been slated for mobile duty with a geodetic field party, but he wanted to work for ERL's Pacific Marine Environment Laboratory in Seattle. Since this couldn't be arranged, he was happy to come to Boulder, where he has the option of working with one of the research labs here during the summer.

During autumn and winter, "I visit two or three schools each week and return to Boulder on weekends," he says. "I've talked to people with nearly every science major you can think of. In three-and-a-half months of travel, I'll interview about 400 people and give applications to those that are interested and qualified. I'll get back about 50 applications and perhaps 10 or 12 of these people will be selected. Last year about one-fourth of these were women."

Although the corps has been able to maintain a rigorous selection process, Armstrong finds that it is not easy to come up with a large pool of qualified candidates. The hardships associated with sea duty are a big factor, as is the higher pay offered by industry. "Nevertheless," he says, "I make it a point to be sure that they're aware of the drawbacks. There's no longer a period of obligated service, and it's wasteful to everyone if we bring someone into the corps for only a few months."

A lot of his time goes into the search for minority candidates, but "our success is less than we would like. The ratio of applications to interviews is about the same for minority candidates as for others, but the real crunch comes in getting the interviews. There are relatively few minority students in the engineering and hard science fields, and competition for them is great."

Armstrong is not alone. Recruiters in all the services are finding that their jobs are tougher these days. But the other side of the coin is that the corps retention rate has been on the upswing. Several years ago only twenty per cent of NOAA officers stayed beyond their third tour of duty, but the rate then rose to a solid fifty per cent, where it still stands today.

Where does the other half go? The officers here have kept track of several who have used this mile-high city as a jumping-off point. One worked for the Peace Corps in Swaziland, where he married a corps-girl at a native style wedding. Another, who may yet return to the service, stayed on as a work-study student in musicology before leaving for the Vienna International Music Center on a one-year scholarship. Then there is the Fresno fireman who attends graduate school part-time, the missionary working in Nairobi, the computer salesman, the medical student — and a few who have settled here as NOAA civilians.

All told, Boulder-based officers make up five percent of the corps — the present numbers are about 20 out of 370. That makes this science center the home of one of the corps' major land-based contingents, although Miami, Norfolk, and Seattle are clearly the "big three" in terms of NOAA Corps operations.

A quick rundown on the rest of that five percent brings us first to Lts. John Murphy and John Kineman. John M., formerly a computer programmer with the Atmospheric Physics and Chemistry Laboratory, is now an at-the-ready OCSEAP troubleshooter whose job frequently takes him back to the Alaska of his seagoing days. John K., one-time SEL solar forecaster, now tracks oil spills for OCSEAP in the role of SOR (Spilled-Oil Research) Team Biologist.

Cdr. Bob Ganse was recently in charge of the Norfolk-based twin wire-drag vessels Rude (pronounced "Rudy") and Heck, with the job of pinpointing submerged navigational hazards, such as sunken ships and coral heads. Now, as holder of a Ph.D. in seismology, his job is to zero in on new ideas for managing, moving, and using EDS' growing inventory of digital seismic data.

Lts. Christine Carty and Tom Clark recently demonstrated their spirit of adventure by applying to become a part of NASA's astronaut corps. While pondering odds of about 1 in 40 of becoming Space Shuttle candidates, Carty helped to research and write environmental planning proposals for the Marine EcoSystems Analysis (MESA) Program Office. She has since become project manager for the Prince William Sound Ecological Study, aimed at safeguarding the beauty and vitality of Alaska's south coast near Valdez, end of the pipeline for North Slope oil. Clark, when not manning the SEL forecast desk, pursues several lines of solar-terrestrial research that may help the forecast center to meet a big challenge — support of none other than the Space Shuttle Program, commencing with the lift-off of the successor to the Enterprise in early 1979.

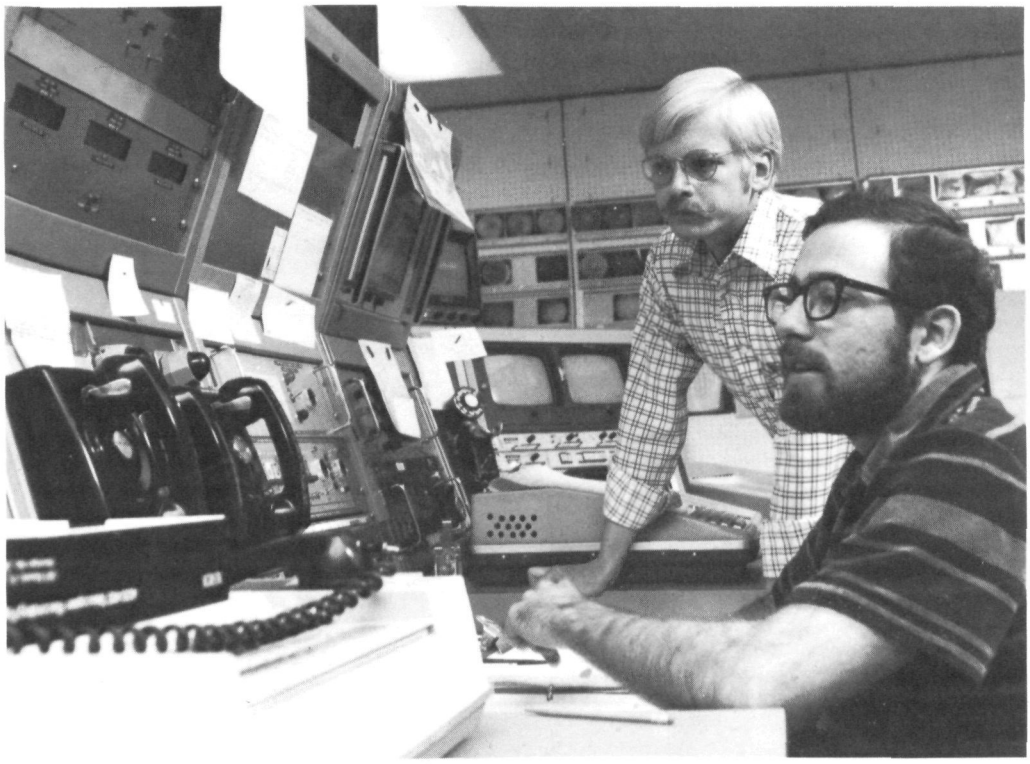
Three more SEL workers round out the Boulder roster. All are involved with the data funneling into the forecast center, but none works there. A former solar forecaster on special assignment to the Australian solar observatory in Culgoora is Lt. Cdr. "Carey" Fuller, who is now on his second tour of duty with SESC. A solar forecaster-to-be, just beginning a one-year assignment to the Mauna Loa Observatory in Hawaii, is Lt. (j.g.) Kent Doggett, who is helping to operate the solar coronograph there. And I, a frequent visitor to the forecast center, work with the geomagnetic data stream that's rushing in via satellite from ground stations in the Americas and the Pacific, with the aim of verifying its quality and helping apply it to studies of the magnetosphere, the earth's near-space environment.

What do their supervisors have to say about these NOAA Corps officers? Not surprisingly, their views reflect the positive outlook of the officers themselves. As one supervisor puts it, "We welcome all types of visiting workers, whether post-doctorals, foreign scientists, or NOAA officers. They come to us with a variety of talents and skills. The results is that we are exposed to new approaches and ideas and they are exposed to a new environment too."

Many organizations have room for more officers than are readily available, particularly the service-oriented ones like the Environmental Data Service and Space Environment Services Center, and those that support extensive field operations, like the Wave Propagation Laboratory and OCSEAP. These groups need people with a good mix of technical training and operational experience and have challenging jobs waiting for just about any NOAA Corps officer that might be assigned to them. A few, however, seek officers with advanced training in a specific subject area.

When these organizations and officers are brought together in the right way, everyone benefits. Attainment of this goal is simplified by the nature of the assignment process. Assignments are funded through the corps rather than the organizational elements involved. Furthermore, they do not involve a permanent "slot" within the gaining organization, but are work opportunities which the NOAA Corps Director may fill if the job priority, the officer's qualifications, and his availability permit. A central objective of the assignment is that the officer's knowledge and skills be utilized and developed as fully as possible.

The common denominator of sea-going experience is most often cited by supervisors as



Research building RB-3 on the University of Colorado campus houses elements of both the Environmental Research Laboratories and the Environmental Data Service. Some of the NOAA Corps officers working there are (from left) Cdr. Robert Ganse, Lt. Andrew Armstrong, Lt. John Murphy, Lt. Stephen Kott, and Lt. Christine Carty. At left, (j.g.) Tom Clark, in foreground, introduces Lt. (j.g.) Kent Doggett to the complexities of the forecast desk at the solar-terrestrial forecast center.

a valuable asset. This stems from the fact that much of the data and equipment that these agencies work with have marine origins or counterparts.

Job structuring is often guided by the feeling that "the officers should tackle a problem that's theirs from start to finish." Most can expect a strong measure of independence and responsibility in their work. They sometimes undertake important projects that their agencies wouldn't have otherwise been able to deal with for several years. In any case, they often become the in-house experts in their fields.

Working relationships between officers and their co-workers are generally excellent. "There is no officer clique here. They mix well, and fit right in with the group," says one supervisor. Another comments, "All of our people have scientific backgrounds. The distinguishing factor tends to be on-the-job experience, and all the officers that have come to us have been quick and enthusiastic learners."

The officers that work here observe that much of the local population is possessed by an affliction called "Boulderitis", a disease that makes newcomers want to dig in and take root. Most NOAA officers do not succumb to this malady. In its place they have what some would consider a more serious affliction — that chronic occupational disease characterized by itchy feet, which responds only to periodic exposure to generous amounts of salt water. In fact, about half the corps is seagoing at any given time. In spite of this disability, most who come here readily adapt to the way of life and have no quarrel with civilians who sport bumper stickers reading "Boulder is Better".

In the Rockville office of the NOAA Corps Director is a small wooden box, containing a carefully-crafted momento of his last sea command. It was presented to him by the officers and crew of the Surveyor, when he departed nearly ten years ago to assume his present duties. The box contains a one-of-a-kind, genuine, "gimbal-mounted spherical predictor", and in the hands of an old NOAA sea-captain, this crystal ball might be said to represent the quest to perceive and predict not only the ways of the sea and atmosphere, but also those of the earth and sun. It's an environmental quest that all of NOAA shares in, and one in which all NOAA Corps officers, wherever they serve, are actively engaged. □

An ambitious NOAA goal--

A NATION OF BELIEVERS

By NANCY PRIDGEON

EVERY MAN, WOMAN AND CHILD in the United States is a potential flood victim.

This is one of the nightmares that plagues the National Weather Service's Disaster Preparedness Staff. With deaths from killer floods rising steadily during the 1970's, flash flood deaths now threaten to surpass those from lightning, or those from tornadoes and hurricanes combined.

"In the flash flood program, we are where we were back in the fifties with hurricanes and tornadoes, as far as watch, warning and preparedness are concerned," says Herbert S. Lieb, chief of the Disaster Preparedness Staff.

A flash flood is the sudden, often unexpected, raging water that tears through riverbeds after heavy rains, scouring everything in its path. Other floods can be seasonal, and expected, as when snow melts and drains down mountain slopes with too much water too quickly. Some floods are caused by the sudden collapse of dams.

Flash floods in the United States are relatively rare events. Unlike tornadoes, where as many as a thousand a year may occur, flash floods usually number fewer than 100 a year. Of those, only one or two may cause a significant number of deaths because most of them happen where there are no people downstream.

But the population in the U.S. has more than doubled during this century. Thousands vacation in flood-susceptible areas. Increasingly, people are building in the floodplain. Floodplain complacency is widespread.

It's not merely a matter of deceiving innocent buyers of buildings located where a major flood could sweep the land clean. Traditionally, floodplains have been perceived as desirable places to exploit. A stream or river — providing needed water, transportation, and perhaps hydroelectric power — can provide the focus for development, the necessities of life, and the surplus for founding fortunes.

Johnstown, Pa., for example, is built at the confluence of two medium-sized mountain streams that provided the impetus for the growth of the city's industrial complex.

More recently, population pressures and the movement of people from farms to cities has caused urban expansion to take in land formerly considered too marginal for continuous use. Recreational use of formerly remote or inaccessible areas has increased, too, taking people beyond the reach of the normal communication channels for watches and warnings should a flash flood threat develop.

The Disaster Preparedness Staff plans strategy for educating the public on protective action that can save lives. Left to right: Herbert S. Groper, Disaster Preparedness Chief Herbert S. Lieb, and H. Michael Mogil.

"The key to preparedness for a city or a flood-prone area lies with its state and local officials, with the Defense Civil Preparedness Agency, the American Red Cross, and its concerned citizens ready to react in a preplanned manner when disaster is imminent," said Lieb. "The plan must be drawn up, and rehearsed well in advance, because sometimes there are only minutes in which to take action."

Lieb calls the watch-warning-preparedness procedure the "Weather Service Chain." The links in the chain are the detection by Weather Service operational offices of a dangerous combination of meteorological events; the estimate of what the events mean; the forecasting, as complete as possible as to just what might happen and when; the dissemination by all available means — radio, TV, telephone, NOAA Weather Wire, NOAA Weather Radio; and the user response, the action taken by the person who receives the information.

"None of our accomplishments or projects in meteorology does a bit of good if people do not respond," Lieb said. "The whole chain of watch, warning and preparedness can be broken if any link fails.

"The cutting edge of everything we do is preparedness — providing individuals and communities the training in what their vulnerability is, what to do when floods

come — and what to do when they don't come."

Sometimes, there is no time for a formal warning. There only may be an "environmental cue" — stationary cloud masses, heavy rainfall, normally placid streams and rivers running heavier than usual. To the trained eye, the situation itself is apparent: trouble may be on the way.

"The individual must respond, and he or she must believe," said Lieb. "One of the reasons we've found that people don't believe is because nothing like what they're being told will happen has ever happened before."

Part of the problem may be that most people do not think of water as a threat. Giver of life, constituent of our very bodies, water is thought of as something in a glass, a refreshing shower or swim, a gurgling brook, a placid lake, an expanse of ocean. Being on it or in it or near it is often a soul-satisfying experience.

But, like fire, water is a good servant, a bad master. The physical properties of water are so constant that the specific gravity (the density) of all matter — solid, liquid, gaseous — is measured against that of water. It maintains its integrity so well under pressure that a measured volume of water is nearly impossible to fit into a smaller space.

It was this property of water that led to the invention of the force pump, a simple cylinder fitted with a piston that can force water through a small hole or pipe great distances up or down or away. The force pump, with its refinements, forms the basis for complex hydraulic systems that ease human burdens in such diverse places as the automobile and the faucet.

And it is this same noncompressible property of water that turns it into a battering ram when a great amount is suddenly released with nowhere to go except through narrow valleys or canyons. Of course, it will run downhill, picking up speed as it goes. And it may burst onto a floodplain backed up by enough force to tumble boulders weighing hundreds of pounds, toss two-ton cars like chips, sweep forests, buildings, and all living things, inexorably before it.

The popular term, "wall of water," refers more to the flood's irresistible force, before which few objects are immovable, than to its appearance.

In the face of such a calamity, what can an individual do?

"Get out of the way, get to higher ground," says Lieb. "And get out of your car."

"The highest death toll in flash floods is of people drowned in their cars. They may have thought they could ride it out, that the car would hold against the water as they'd seen rocks in streams parting the water around them. Or more likely, they just didn't know what to do when the car began to float away."

But cars get washed along with other debris, tangle with flotsam torn loose — trees, fences, trailers, anything — and flip end over end, or submerge, or pile up against bridges or other obstructions, so the person inside has almost no chance of surviving.

And long before that, the person needed to be told what to do if it ever happened. That's where the Disaster Preparedness Staff comes in.

The Weather Service's Disaster Preparedness Staff is a direct result of past natural disasters that were costly in lives and property. Weather Service's role traditionally has been one of observation, forecast, and warning on a broad spectrum.

The busy meteorologist in the forecast office, and his staff, lacked time and manpower to go into the streets with one-to-one warning of impending disaster. The forecast office was, and is, the place where the latest information centralizes and from which the most up-to-the-minute forecast and warning is issued.

But in 1972, after Hurricane Agnes traveled inland and dropped millions of gallons of water on mountainous areas in her path, the National Advisory Committee of Oceans and Atmosphere (NACOA), in its post-audit of NOAA's storm and flood warning systems, pointed out that the Weather Service should have capability to monitor the state of readiness of people to react effectively to disaster warnings.

An added impetus came when the tornado outbreak of April 3-4, 1974, devastated parts of 11 states in a wide swath extending from the Gulf of Mexico to the Chicago area. Among the recommendations of the NOAA National Disaster Survey Team were that community preparedness activities should be expanded as rapidly as possible, and that preparedness specialists be assigned to Weather Service Forecast Offices.

So it was that in mid-1974, the National Weather Service Disaster Preparedness Staff was formed as a staff level unit in the Office of the Director, Dr. George P. Cressman. Lieb was chosen to head the newly created function.

Lieb, a journalist by profession, nevertheless has had a deep and abiding interest in meteorology — he began his Federal career in 1950 as a meteorological technician. A 1949 graduate of the University of Missouri, he joined the Public Information Coordinator's staff at Weather Service headquarters in 1965, and from there became the NOAA Public Affairs Deputy Director.

For his staff at Weather Service headquarters, Lieb now has two meteorologists: Herbert S. Groper, who formerly was the National Weather Service Flash Flood Program Leader and H. Michael Mogil, who formerly was with the NWS Public Services Branch.

And Barbara Pakenham, who helps with the program's administration by collecting statistics and keeping the information flowing.

Their job is to use every means available to get the preparedness message "to the world." They conduct workshops, train disaster prepardness specialists, administer the program, and write articles, guidelines and brochures.

One such campaign is the "Owlie Skywarn" posters. Owlie began by taking its cue from the Weather Service SKYWARN program — a network that started out to be just tornado spotters recruited and trained by the Weather Service Offices in tornado-prone areas. But now the Owlie Skywarn concept has broadened into "being prepared," and Owlie posters tell school children everywhere about the perils of lightning, rules for winter storm safety, and other weather phenomena with potential for disaster.

Weather Service's Southern Region Headquarters encouraged the late Dr. Benjamin F. McLuckie, a sociologist with the University of Delaware, in his study of the human response to disaster. From this study came McLuckie's training course, "Warning — A Call to Action," which has been taken by scores of Weather Service personnel.

The course is aimed at helping the forecaster be sure his message is couched in terms that users will believe. It also dispels many common myths about people's behavior during a crisis.

"Sociologists keep telling us," Lieb said, "that the human being's most common response against a hazard is to say that it doesn't exist."

But where people are convinced, there's a long list of success stories. Take, for instance, the tornado preparedness drills that are now routine in many schools across the country.

A concerted effort by Lieb and his staff, the Public Affairs staff, other NOAA and National Weather Service offices, consultants and contractors, that spread the word about the safest places to be in schools, the recommended crouch position, and what not to do when a tornado is coming, is credited for the saving of many lives in situations like the Pleasant Hill, Mo., tornado of 1977 where the school was virtually demolished but there were no deaths and injuries were minimal.

NOAA recently completed a 20-minute film designed to train spotters in how to identify a tornado quickly. Heretofore, spotters were trained from slides, so the time-lapse color motion pictures offer a great advantage. The film shows the precursor clouds and the tornado that develops from them. Just as important, it shows tornado look-alikes — types of cloud formations that look dangerous, but will not lead to tornado formation. The film is scheduled for wide distribution.

The second nightmare in disaster preparedness is that a tornado will strike a school in session, a hospital or nursing home, or a stadium filled with people — and there will be no preparedness plan ready for use.

To assist hospital and nursing home administrators to protect their helpless patients — a complex problem indeed, Lieb recently commissioned a leading magazine writer, William Barry Furlong, to write a guidance manual, to be published and distributed nationwide by NOAA.

Tornado deaths have fallen sharply in the past two decades. Lieb credits the fact that more people are prepared to take evasive action when a warning is called. But more preparedness is needed.

State and local officials have cooperated fully, but their fingers, too, are crossed. They know some schools have been spared through quirks of fate. In 1977, several schools were involved where the school year hadn't started yet or the tornadoes were on Saturday or Sunday. To keep the death rate down, tornado drills, like fire drills, are a must.

The third disaster preparedness nightmare is that when a hurricane strikes, there will be no place to go.

Here, as with tornado preparedness, much has been done. At the beginning of the hurricane season, NOAA invites radio and TV broadcasters, state, local, and Federal officials, and others, including NOAA components involved in the watch, warning and preparedness cycle, to a hurricane conference to remind and rewarn of the steps to hurricane preparedness.

Unlike the random, destructive tornado funnel, which may dip from a cloud unexpectedly, hurricanes give more warning. Tracked by satellites and reconnaissance planes, the hurricane allows protective action to be taken ahead of the landfall of the storm.

But the greatest number of deaths in hurricanes is from drowning during the storm surge — abnormally high tides and a dome of ocean water pushed ashore by the storm's fury. Storm surges range from nine to greater than 18 feet above normal, driven by winds from 111 to more than 155 miles an hour.

In a Statement of Concern by the American Meterological Society, in July 1976, the question was asked, "Is the United States building toward a hurricane catastrophe?"

Of the nearly 40 million persons now living along the Gulf and Atlantic coasts, it is estimated that more than three-fourths have never experienced a major, devastating hurricane. And in many of these areas, the elevation of the land is no more than a few feet above sea level.

Owlie Skywarn

Dr. Neil Frank, director of the NWS's National Hurricane Center in Miami, Fla., long has been vocal about the potential risk. The continually increasing coastal population has him worried. Where the level of the water would inundate these communities and evacuation of large numbers of people might be next to impossible, he sees vertical evacuation as the only answer. The concomitant question is, can existing structures withstand the power of the water?

And what about the millions who flock to beaches from North Carolina's Outer Banks to the seashores of New Jersey? With limited access roads, can they escape in time?

Here again, the twin demons of disbelief and inexperience come into play. Persons who have not experienced a hurricane's full force may find it hard to imagine. Persons who think of water as a friend may find it hard to think of it as an implacable foe.

There are other threats to human life about which the Disaster Preparedness Staff takes a part in educating the public. One is lightning safety. Another is when winter storms pose a hazard.

But the present focus is on flash flood preparedness — including ways of saving oneself. It is here that much work is being concentrated. NOAA has requested additional positions and funds to augment the existing preparedness network that now comprises 20 or so DP meteorologists in about two dozen states and in the Regional Offices.

These disaster preparedness meteorologists go into communities to assist with preparedness plans, especially in schools, and coordinate their efforts with other Federal agencies — Defense Civil Preparedness Agency, American Red Cross, Army Corps of Engineers, and so on — and with State and local officials. If time and resources permit, other NWS field personnel nationwide participate in disaster preparedness activities.

The specialists also recruit and train spotters and set up spotter networks; enlist the aid of radio, TV, and the print media in safety education programs and warning dissemination; participate in disaster surveys, and conduct studies to help improve local government and public response to warnings.

"Right now, the flash flood problem is the most important single problem that exists as far as the Weather Service is concerned," Lieb said.

"The flash flood workshop in Boulder last fall came up with a number of recommendations. One was that the flash flood program be centralized in one office that would coordinate the effort with the Corps of Engineers, the USDA Soil Conservation Service, the U.S. Geological Survey, and all other agencies involved in solving the problem.

"The focus has been put by Dr. Cressman into the Disaster Preparedness Staff, so that he can take a daily, personal interest in the developing program, We have an imperative to follow through. And we will." □

Major boost for marine education

Turning Landlubbers Into Sea Lovers

By Brian Gorman

ONCE UPON A TIME, not so very long ago, much of the world could be generally divided into sea people and land people. The sea people, who were few in number, knew about the sea because they lived by its shores. They made their living from the sea. They built boats. They fished. They hunted whales and seals. They traded across the Mediterranean and the Atlantic and Pacific. They gathered driftwood to heat their homes. They knew where the seas' harvests were and how they could be gathered. They knew how to foretell the weather, what a squall line was and a mackeral sky and a northerly.

By contrast, their upland brothers, the land people, knew very little about the sea. They knew so little, in fact, that long ago in another place, a Greek named Odysseus, fed up with his life wandering on the sea, threatened to put an oar over his shoulder and walk inland, settling at the first place where someone should ask if what he was carrying was a threshing flail, knowing that eventually someone *would* ask.

The sea people's modern upland brothers, the farmers and tradesmen, the factory workers and bureaucrats and industrialists, almost all of us in fact, are far more sophisticated than Odysseus' imaginary rustic. It is unlikely that anyone would fail to recognize an oar now. Ironically, while land people have learned more about the sea — thanks in large part to television and mass circulation magazines — people who live by the sea and are crowded into great cities often know far less about their water environment than ever before. The three and a half million residents of that island in the middle of New York City called Manhattan, for example, are probably far less aware of the sea and its importance to their lives than the 350 year-round residents of Block Island, a much larger but admittedly less important piece of insular real estate off Rhode Island.

Nor is ignorance about the sea limited to the megalopolis. It can be found as easily in the cities of Seattle or San Diego, the coastal regions of Virginia or Hawaii. In spite of the fact that we are reminded that the coastal zone is home to 75 percent of the nation's population, most of us are abysmally uninformed about the seas. While we may be able to distinguish between a yellowtail flounder and a soybean plant, we are unable to say much intelligent about either.

All this ignorance would be of mere academic interest — provoking the clucking of a few well-meaning educators — if it weren't for the fact that as adult citizens we

Marine education specialist David Smith introduces a youngster to the ubiquitous, and harmless, horseshoe crab at a Sea Grant marine science session conducted by Clemson University at a 4-H camp.

Legends of northwest Indian sea cultures are retold in the Kwakiutl longhouse at Seattle's Pacific Science Center (top) while the University of Hawaii Sea Grant program shows children, to their merriment, that a whiff of heliox gas causes them to sound like Donald Duck (above), and stimulates them to discuss what they see in the 25-foot wave generating machine (right).

are called on to make decisions about such diverse environmental topics as offshore oil and gas exploration, power plant siting, or harbor development. And even if we live hundreds of miles from the seas, our daily lives are affected by the availability of oil and gas, the price of electricity, the cost of food, and the tax dollars that go toward cleaning, protecting, and exploiting the oceans and Great Lakes.

Yet the number of persons who understand the marine world — the sea people — grows ever smaller while the importance of such an understanding grows greater every year.

However, the picture is beginning to change. Through a small but disproportionately important part of NOAA's National Sea Grant Program, thousands of teachers and tens of thousands of youngsters all across the country are learning about the oceans and the Great Lakes, in some cases for the first time in their lives.

Sea Grant of course has been involved in education from the time of its first grants in 1967. In fact, it was part of the design of the law that set up the nationwide marine program of matching grants that education, along with research and advisory services, would play a major role in furthering our understanding and intelligent use of America's marine resources. Occasionally, however, the role that education played during Sea Grant's formative years seemed not to catch the public's eye to the degree that its more visible research and advisory services did. Furthering aquaculture, modeling oil spills, seeking drugs from the sea, tracing Great Lakes pollutants all seemed so much more exciting than plain old education. Fortunately, there were people in the Office of Sea Grant in Washington and at local Sea Grant institutions throughout the country who recognized the need for sound marine education.

Young visitors to Oregon State University's Marine Science Center learn about intertidal animals from Vicki Osis of OSU's Sea Grant Marine Advisory Program.

And so there began, about two years ago, a significant change in emphasis, not only within Sea Grant but within American education. Moreover, heightened awareness of the problem by marine educators, many of them already familiar with Sea Grant's work, coupled with an increase in Sea Grant's Congressional appropriations specifically earmarked for marine education, added a positive impetus to the change.

Initially, starting in late 1975, the Office of Sea Grant began to receive an increasing number of proposals, many of them from institutions already part of the Sea Grant "network," for highly innovative marine education ideas. Among them was a proposal, since funded and now drawing to a close, aimed at developing a national policy on marine education in the United States. Administered through the University of Delaware's Sea Grant Program, the project involves about 20 workshops, more than half of them already held, for teachers and school administrators, primarily in the public schools. The project's principal investigator, Harold Goodwin, hopes to gather a consensus of opinion from both the lay public and professional educators on where American marine education is now and where it's likely to go.

Although the project is not yet over, it has already resulted in the publication of an 87-page booklet entitled "Americans and the World of Water," a collection of essays on the importance of the marine world, written by such marine notables as John Craven, Dean of Marine Programs and Director of the Law of the Sea Program at the University of Hawaii, and Joel Hedgpeth, Emeritus Professor of Oceanography at Oregon State University.

This is part of the Sea Grant method, working through professional educators — teachers, administrators, state and federal officials — in order to articulate policy, create marine oriented curricula, inform teachers, advise administrators.

One such program designed to reach students by reaching their teachers first is taking place at the Pacific Science Center, a state supported institution founded in 1962, in Seattle, Washington. There, Shirley Pauls, manager of the Center's marine science project, is developing a far-reaching marine curriculum for junior high school faculty. The project consists of a number of what Paul calls "activity packets," day-by-day plans including suggested quizzes, speakers' names, slides, films, and bibliographies on more marine topics than you could shake an oar at. Packets already developed or planned for the near future deal with marine industries, ships on Puget Sound, tides and beaches, waves and currents, literature from the sea, marine careers, Northwest Indian sea culture, and energy from the sea.

"Because the sea has something for everyone," says Pauls, "we thought it would make sense for a marine curriculum to reflect that same diversity." The topics themselves, which can take from a week to a month to teach, have been well received by Seattle-area teachers, according to Pauls. "Teachers have been very willing to help us develop various topics and even more eager to use the 'activity packets' once they're put together," she claims.

Teachers and school administrators, although they are clearly an audience of primary importance to Sea Grant's marine education advocates, are only part of the story. The atypical audience mentioned earlier — inner city kids, adults whose potential exposure to the seas is minimal — are an equally important adjunct to NOAA's marine education effort. Both the State University of New York and the University of Rhode Island, for example, have educational programs aimed specifically at such people. Rhode Island's project involves converting part of one of the museum buildings on the grounds of Rober Williams Park, a nineteenth century garden *cum* zoo, into a marine exhibit whose principal visitors will be school kids and adults from the greater metropolitan Providence area.

Perhaps the project reaching the most atypical marine audience is going on at the University of Southern California. Its principal investigator Dr. Dorothy Bjur, is developing a marine curriculum similar to several across the country, but with an important twist: many of the marine science teaching materials are being translated into Spanish, with the obvious effect of increasing the number of school children, and adults, who will have an opportunity to learn about their own ocean and coastal areas.

There has also been increased attention given to Sea Grant's support of technician training — preparing young persons for the practical aspects of marine careers. Emphasis most recently has been on energy and extended fisheries, including technical training of boat operators for the offshore oil industry in both Louisiana, where highschoolers in Terrebonne Parish are in a special work-study program, and Texas, where community college students can receive similar technical training. The University of Rhode Island has a special program for observers who will work on foreign fishing vessels. Their training will assist the Coast Guard and the National Marine Fisheries Service in carrying out the provisions of the Fishery Conservation and Management Act, the so-called 200-mile bill.

Although clearly statistics don't tell the whole story, they do indicate what Sea Grant's director Dr. Ned Ostenso called a "salutory change." The number of marine education projects — from kindergarten through college — that Sea Grant has funded has increased from 84 to 100 in the past year. Financial support has risen as well: from $2 million last year to over $3.2 million at present. □

They Sting, Bite, Puncture, Lacerate, Shock and Poison

The Not-So-Friendly Denizens of the Deep

Puffer

Lionfish

Moray Eel

By GERALD D. HILL, JR.

On an overcast day in 1963, a 10-year-old child was swimming in shallow water at a beach just north of Cairns, Queensland, Australia, when he was suddenly struck with searing, excruciating pain throughout his body. He struggled, screaming, to the beach, and collapsed. Bystanders rushed to his aid and administered mouth-to-mouth resuscitation and external heart massage to no avail. He was dead in less than 10 minutes from the moment of the attack.

The child was a victim of what is probably the most dangerous, venomous marine animal known, the sea wasp. The sea wasp is a jellyfish found in the tropical waters of the world, primarily in the South Pacific. It is a translucent light blue color with tentacles that extend down from its dome-shaped body as it floats passively on the current. Because of its light color, it is very difficult to see in the water. When an unwary swimmer or diver collides with the creature, he is stung with the tentacles, some of which break off from the body and continue to inject venom into the victim until they are removed from the skin.

A life is a high price to pay for an afternoon at the beach. The beauty of the sea and the unusual life within fascinates us all. We are drawn to the edge of the sea, and then to its depths, to swim, to dive, to fish, to marvel at an existence that is almost unreal to us, air-breathing intruders. But the price tag for pleasure is not always visible.

NOAA divers have to be particularly aware of dangerous sea creatures. The NOAA Diving Manual contains a chapter on hazardous marine animals, descriptions that recreational divers may also find useful.

Surprisingly enough, most poisonous marine life is, like the sea wasp, small enough to pick up in your hand. Therein lies the temptation to disaster. One of the most appealing aquatic creatures is the blue-ringed octopus of Australia. Measuring about three to four inches across the tentacles, it is dull brown in its usual docile state. It is often found in quiet bays and estuaries, resting in small pools of water among the rocks.

In 1954, the small creature caught the eye of a skin-diver. He spotted it in a rock pool and marveled at its miniature size as he picked it up and it nestled in the palm of his hand. Moving his hand about from side to side, admiring it, he saw the color become beautiful as blue rings appeared on its body, brightening up the dull brown. Completely charmed with this tiny innocent baby, he laid it on his shoulder. It shifted position, moving over toward his exposed neck. The tiny bite he felt brought immediate results. He became limp, his muscles relaxed, and he was unable to move or to breathe. Death from asphyxiation came within two hours.

Even then no one realized exactly what had happened. It was assumed he died from an allergy to the bite. Not until 1968 when the next fatality occurred did it become obvious how lethal this charming diminutive was. The second victim was bitten picking one up in Sydney Harbour. He, too, became paralyzed in 20 minutes and died within two hours.

Another venomous handful is the beautiful zebrafish. While temptingly exotic and lovely as it swims fearlessly past, this ornate member of the scorpionfish family displays 18 featherlike fins with spines capable of injecting venom similar to that of a cobra bite. Swimmers are advised not to approach one of these fish too closely as they have been known to attack when upset. The poison has a wide range of effect from mild to fatal, depending on the individual victims. Developing complications can cause gangrene, delirium, cardiac failure, and possibly even death. About 60 species of this tropical fish can be found along the Pacific coast with most off California.

A far cry from its decorative zebrafish cousin is the ugly stonefish, which inhabits the Indian Ocean and South Pacific waters. Of the scorpionfishes, this one is the deadliest. It lies completely camouflaged in the sea bottom of shallow waters waiting for prey. Swimmers and fishermen easily miss its body until they step on some of the 14 venomous spines. The pain is immediate and death will follow within hours without effective medication to block muscle paralysis. Even if the antivenin is applied in time, there may be some permanent physical debilitation.

Writer Calvin Hurst tells us in his article about stonefish, *Nohu: Devil in Paradise* (Oceans 1972), "The Tahitians fear of the world's most venomous fish ranks with their fear of Moa, the shark; but their fear of Nohu is more imminent because Nohu dwells in the shallow waters inside the barrier reef near the beach. This is where children play in depths of from one to five feet. If Moa is seen you have a chance to swim away, but Nohu is invisible for it hides completely in the sand, sticking out its venomous spines only if its

sandy cover has been disturbed by a wader's foot."

The scorpionfishes' deadly poisons have been well noted by the aborigines of Australia, as well. In his article, *Stonefish; Scorpion of the Sea* (Oceans 1976), Tracy Brash mentions a report made by Kelvin Green, an Australian anthropologist, on "an ancient ritual dance performed by the aborigines: a dancer imitates the actions of a man paddling in tidal pools searching for fish. He begins by taking short, cautious steps, but gradually the steps become longer until he treads on a clay model of a fish with 13 wooden spines embedded in its back. The dancer screams in agony, writhes on the ground and finally wails a death song." Perhaps the natives hoped the dance would suffice in prepayment for sustenance from a harsh and demanding sea.

While it might be tempting to reach out underwater for a beautiful zebrafish, no one in his right mind will try it on a sea snake. Easy to spot, the sea snake has a paddle-shaped tail which its land counterpart does not have. Not especially aggressive, except during breeding season, they seldom bite except when caught in fishermen's nets or when a bather accidentally steps on one. Their venom is considered more potent than that of the King Cobra. When bitten, a victim does not feel the pain that usually accompanies attacks from many other venomous marine animals. It is only a tiny prick, and the symptoms that follow — in 20 minutes to several hours — are such that there may be no awareness of the connection between symptom and bite. Usually it is about an hour before the first definite signs of gradual muscle stiffness or aching occurs. Paralysis follows, beginning with the legs, and then the rest of the body, with lockjaw becoming quite obvious. Difficulty in speaking and swallowing, and spasms, also accompany the paralysis. In severe cases, the skin becomes cyanotic, convulsions begin, and death follows after unconsciousness. The mortality rate is around 25 percent.

Sea snakes are found in the tropical Pacific and Indian Oceans. They prefer sheltered coastal waters near river mouths. They tend to collect in some regions in such large numbers that reports exist of more than 100 snakes taken in one net haul.

They sometimes appear in schools well offshore. Bruce W. Halstead writes in his *Venomous and Poisonous Marine Animals*, "Lowe . . . encountered the largest concentration of sea snakes ever reported while en route between the Malay Peninsula and Sumatra. A mass of Stoke's sea snakes was about '10 feet wide and full 60 miles long.' The group . . . was thought to be either migrating or breeding."

Blue-ringed Octopus

Some concern has been expressed that sea snakes might get through the Panama Canal and reach Atlantic waters. But to date, this fear does not seem well-founded.

Swimmers off the east coast of the U.S. shores already have enough problems with poisonous creatures such as sting-rays that attack 1,500 people in the United States each year, the catfishes, and moray eels.

The most prevalent poisonous marine life on the east coast is the jellyfish. This venomous little piece of almost nothing travels in schools large enough to seem like marine mine fields, and disrupts many inland and coastal swimming pleasures. It is a member of the Coelenterate group, which also includes the Portuguese man-o-war and the sea wasp. Jellyfish are found all over the world and range in size from the common nine-inch variety we see to Arctic species measuring eight feet across the top. While medium sized jellyfish can trail tentacles up to 50 feet, these Arctic creatures have tentacles estimated at as much as 100 feet in length.

The venom conveyed from the jellyfish tentacles has an effect ranging from mild dermatitis to almost instant death, depending on the type of animal, the area of exposed skin, and individual sensitivity.

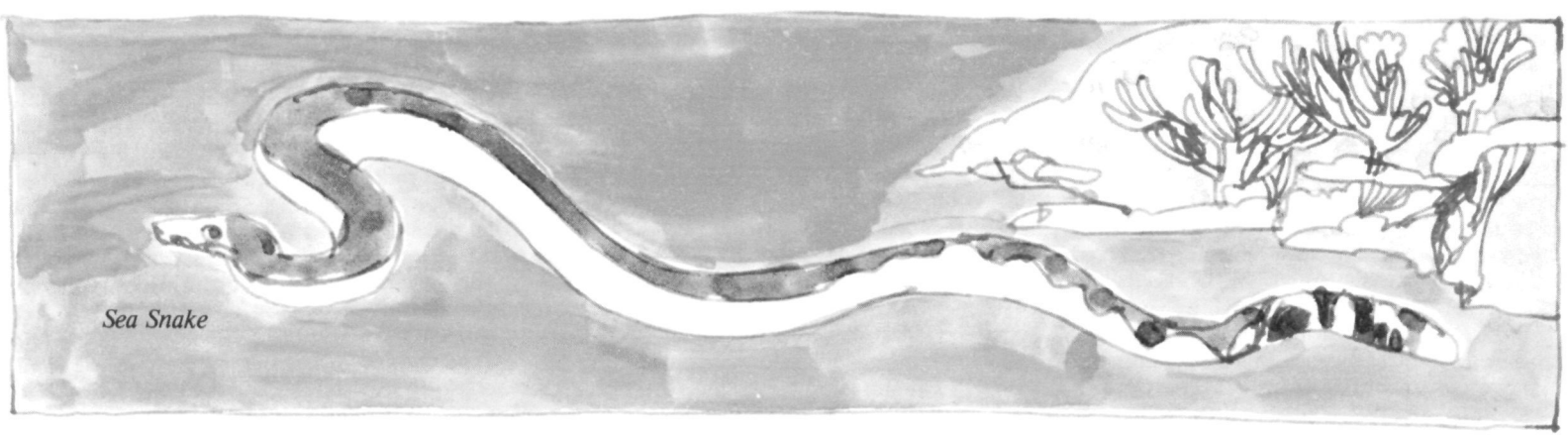
An incident related by Willard H. Porter in his *The Deadly Beauty of Tropical Seas* (Oceans 1971) describes the Portuguese man-o-war. "The most horrifying man-o-war encounter I know of took place several years ago in the lower Florida Keys 25 miles offshore of Marathon. James C. Jones, a saltwater diver and collector, his wife, and two sons were forced into the open ocean after their boat sprang a leak and sank. The family lashed themselves together by lines and life jackets and waited rescue, for Jones had been able to send a marine radio SOS to the Coast Guard before abandoning the foundering hull. According to Jones, the water was warm.

It was not very rough and there were no sharks. But there was something else. Floating sacs carrying spidery appendages began to drift into the four castaways. And wherever the viscid, barbed trailers brushed human flesh, the blowtorch suffering began. In the dark (they left their boat at 5 p.m. and were picked up 14 hours later), Jones estimates he was stung hundreds of times. His wife was paralyzed and could barely hold her head upright. The boys were nearly overcome. But, somehow, they managed to cling to consciousness. William Tucker, reporting the incident in the National Observer, quotes Jones this way: 'I just wouldn't let the jellyfish beat me . . . and I was too selfish to let any of the family die.' "

To make matters worse, you don't even have to be in the water to be poisoned by fish. It has been known for some time that there are certain species of fish that when eaten are toxic to man. Some species of sharks, toad fish, rays, and eels have been included in this group.

One of the primary concerns to fishery biologists today is Ciguatera poisoning. This is a type of poisoning in which normally edible fish suddenly become toxic. Natives of one island in the tropical Pacific where most cases occur can eat a certain species one year but find it poisonous the next. Or the fish of a species occasionally can be found lethal in one place and edible in a nearby area. Research on this puzzling phenomenon has been carried on under Sea Grant auspices, as well as by the World Health Organization.

The only sure facts available are a list of known poisoners (at one time or another) and



Sea Snake

that most are tropical reef fish.

The more common symptoms are tingling and numbing of the arms and legs, muscular pain, burning urination, lack of muscular coordination, and difficulty in breathing. The mortality rate is between seven and 12 percent. However, there are only 500 implicated species out of an estimated 20,000 or more species of fish, which greatly limits the chance of poisoning.

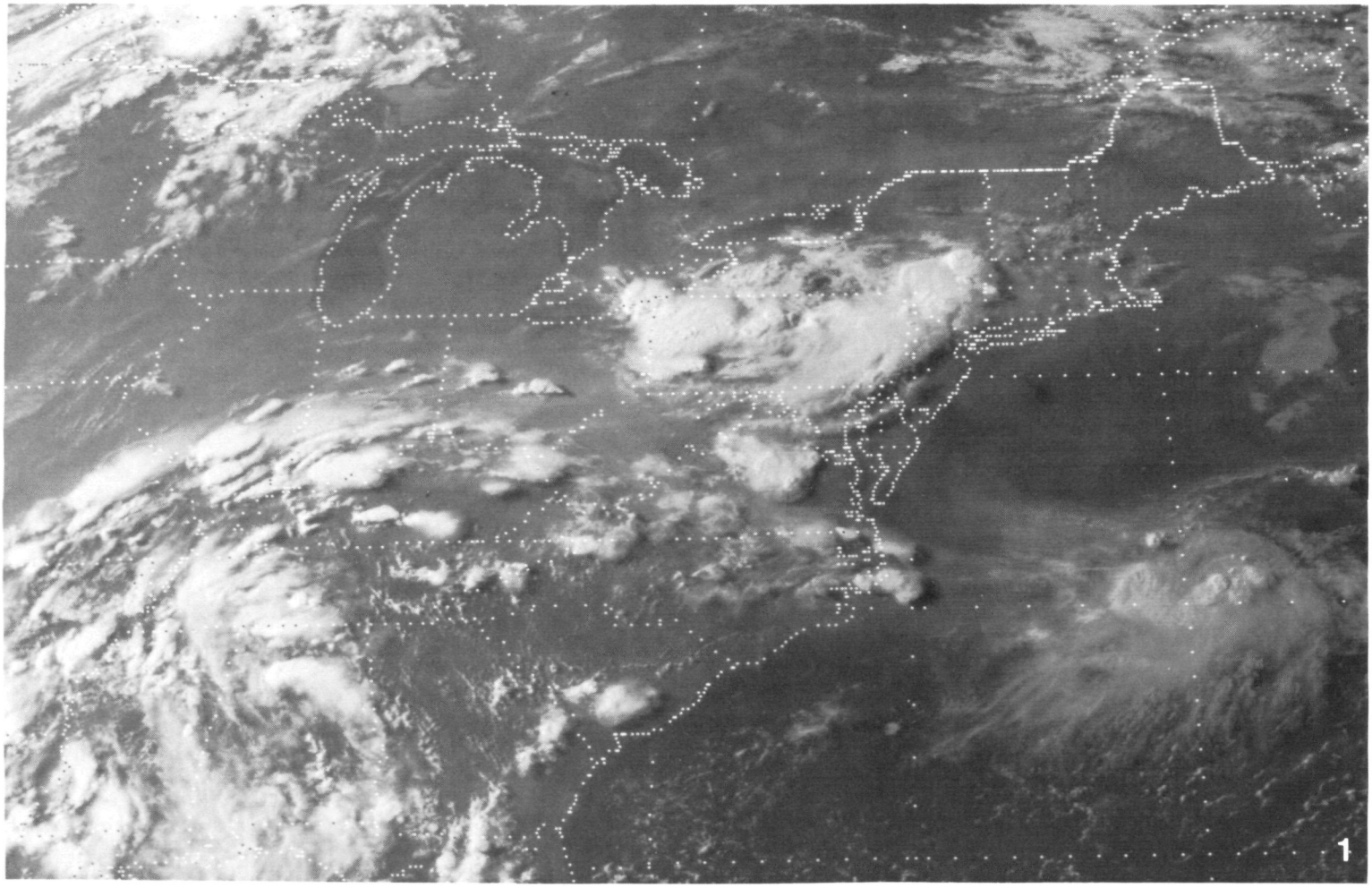
The U.S. Naval Research Laboratory, Washington, D.C., offers several recommendations to avoid this problem. One should only eat fish caught in open waters and avoid large reef fishes such as snapper, grouper, barracuda, and jacks. Tropical moray eels and the roe of tropical fish should be avoided, as well as the viscera, liver, gonads, and intestines of any tropical fishes. Remember, normal cooking methods do not destroy the toxins in the fish.

Surprising as it may seem, not everyone wants to avoid fish poisioning. The most common and notorious of the poisoners, the puffer, related to the highly toxic porcupine fish which is often seen dry-mounted in curio shops, is considered a delicacy In Japan. Preparation of the puffer, called fugu, is controlled by State regulations. Because of the strict rules for preparation, the aftereffects of the poison are reduced. The name comes from its ability or habit of inflating itself, by taking in water and air, nearly three times its normal size when disturbed.

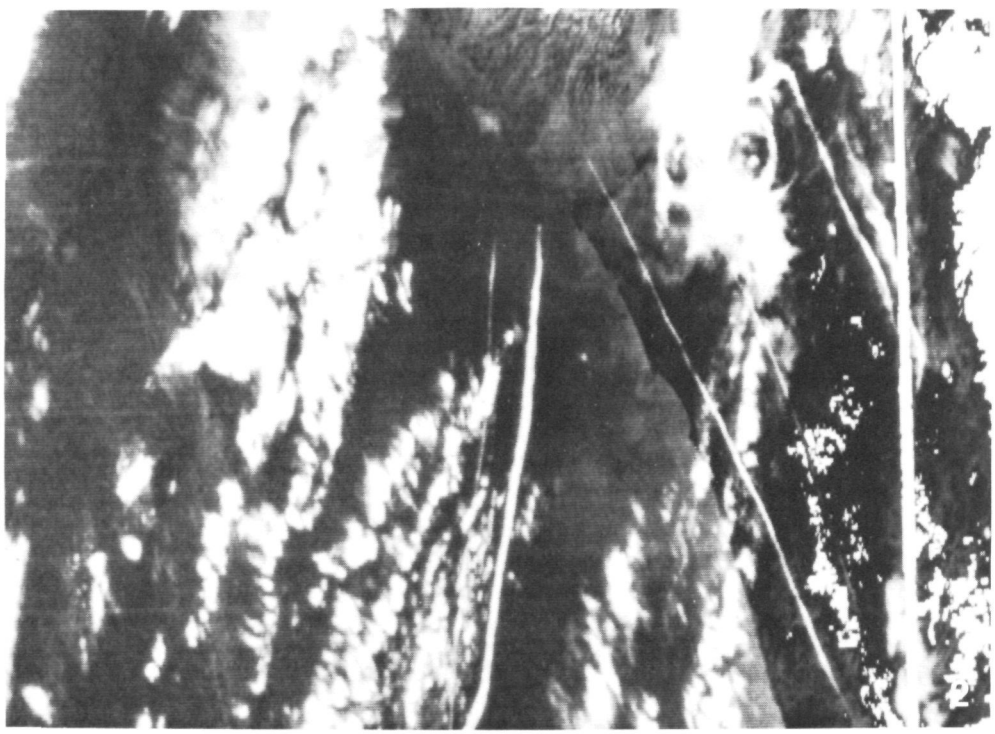
The toxins are heat stable and cannot be destroyed by cooking. Yet despite its proven deadliness, the fish has a tremendous appeal. The flesh of the fish when properly prepared tastes like good chicken, and eating it produces a euphoric state of sensations of warmth; tingling of the tongue, lips, and extremities; flushing of the skin; and, in general, a sense of intoxication. These physiological effects draw patrons to the fugu (pufferfish) palaces where trained and licensed cooks are authorized to prepare it.

With a mortality rate averaging 100 deaths a year from the fish, the Japanese know the hazards they run with this fad. A seafaring people, the Japanese became concerned with puffer poisoning at the turn of the century. Experimentation was done by feeding it to cats and dogs, and a preparation that was less chancey was developed, based on discarding known heavily toxic parts (skin and viscera) and perhaps making use of the fact that the toxin is water soluble. The four species most commonly eaten are violently toxic, varying with the individual fish, its sex, part of the body, and the season of the year. Although pufferfish commands the highest prices in Japan ($15.00 per pound wholesale), fugu enthusiasts eat large amounts of the paper thin flesh in one meal to get the after effects. Eating of puffer could be considered almost a national habit, at least among the upper income groups.

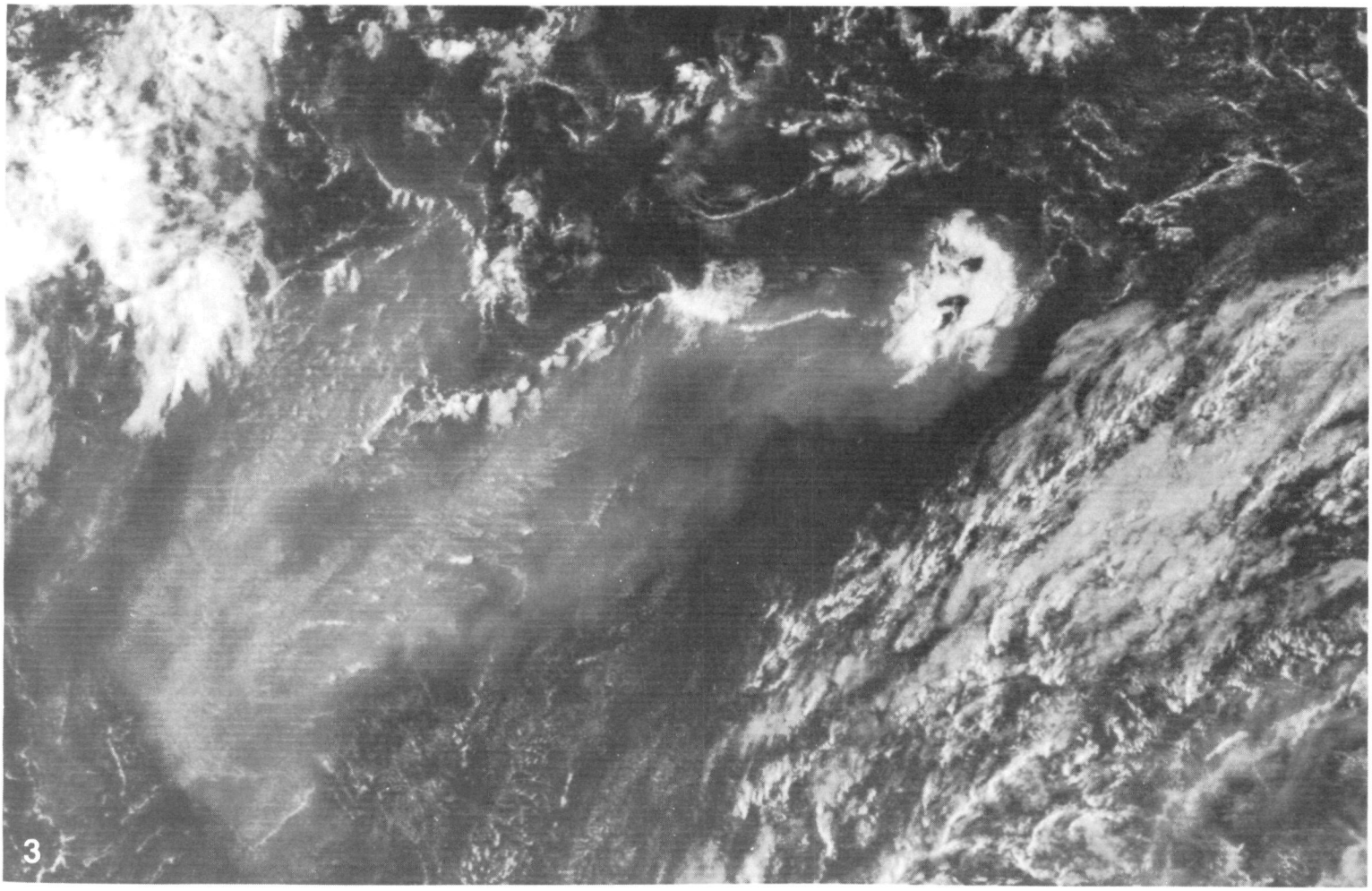
Since the exhilarating effects depend on the poison present in the flesh and the amount of poison varying in each fish, the gastronomical "trip" as it has been called, could vary from mild to "way out." Sounds interesting. Anyone for a little Russian Roulette? □

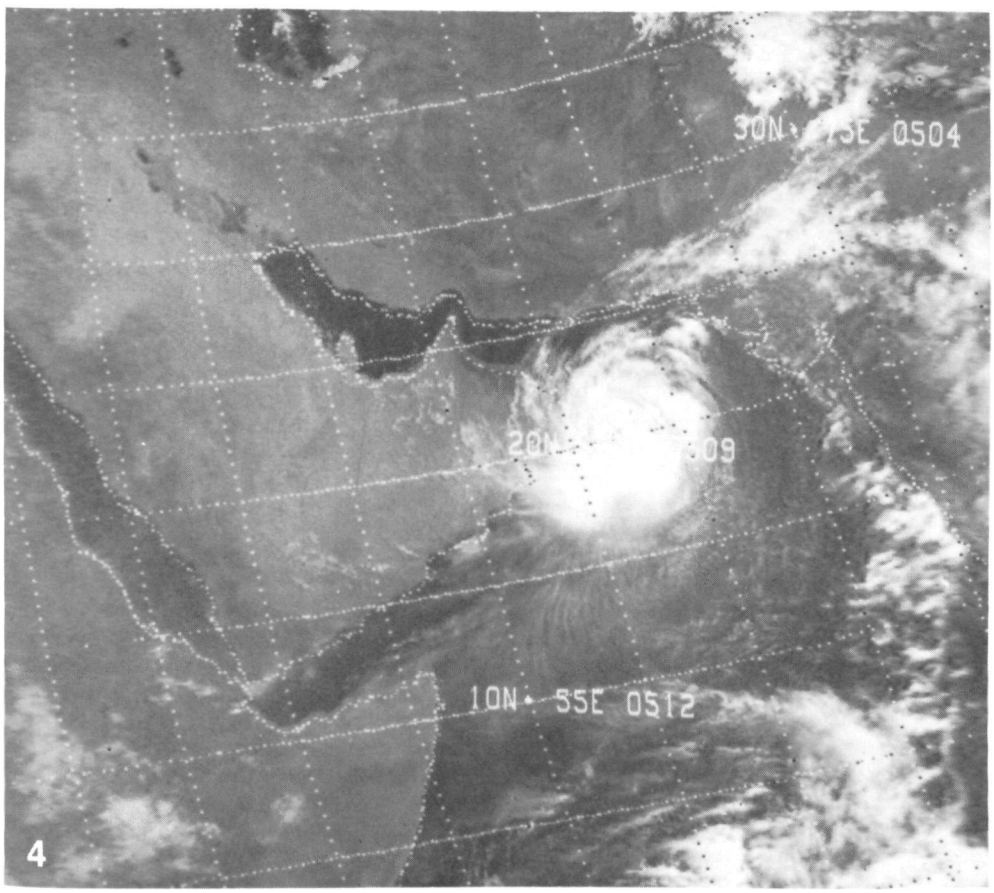


THE VIEW FROM SPACE



There's never a dull moment viewing Earth from space. If it isn't severe weather, it might be a volcanic eruption. And on days when Mother Nature is behaving herself, there's always something else of interest, like airplane contrails. The images from NOAA satellites reproduced on these pages are proof.





1 Clouds over Pennsylvania, in this GOES-1 image, look innocuous enough, but on the evening of July 19 they were only hours away from inundating Johnstown, Pa., causing a tragic flash flood in that much-abused city.

2 This enlargement of a portion of NOAA-5 imagery recorded in October shows a sight many have seen, but rarely from this angle; jet aircraft contrails in the sky. Several aircraft are converging over the coast of Washington, while the holding pattern flown/by another jet over Seattle-Tacoma airport shows up as a gigantic figure 8.

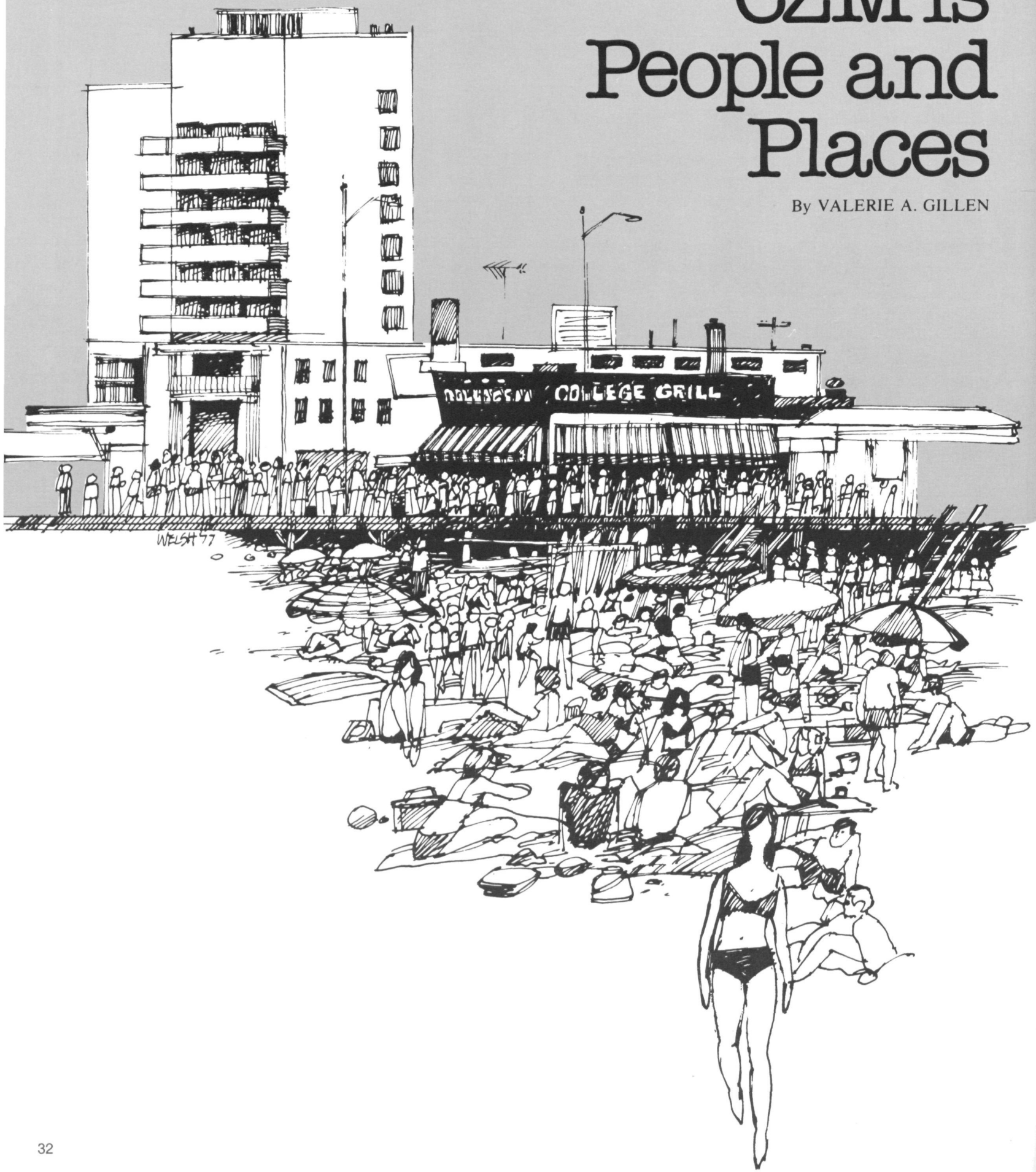
3 The eruption of a volcano in Hawaii was big news in mid-September, and the NOAA-5 satellite had a grandstand seat, watching smoke from the volcano — on the "Big Island" of Hawaii — drift for hundreds of miles out into the Pacific.

4 A tropical cyclone in the Arabian Sea approaches the coast of Oman on June 12, under the watchful eye of NOAA-5. NOAA's National Environmental Satellite Service alerted meteorological services in Pakistan, Saudi Arabia, Aden, and India of the storm's location, movement, and intensity.

Not just plans and policies

CZM is People and Places

By VALERIE A. GILLEN



WINTOSTA, an Indian maiden betrothed to the brave Ogontz, fell in love with a young French traveler. So says the old Ohio legend. The two men met in trials of skill and strength, and although Flamaron, the Frenchman, bested Ogontz — ultimately killing him — Flamaron and Wintosta were themselves killed by the brothers of Ogontz. Grief-stricken, Wintosta's mother threw herself into the waters of a creek that empties into Lake Erie, and she perished.

Today the little stream is still known as "Old Woman Creek" in memory of the legendary Indian mother. Located on the south central shore of Lake Erie, it drains an area of about 30 square miles east of the city of Huron, and it has been named an estuarine sanctuary by NOAA's Office of Coastal Zone Management.

While the story of Flamaron and Wintosta will be preserved forever in legend, it took a great deal of present day knowledge and hard work to preserve the beautiful and ecologically important site where the story comes to its end.

A relatively small sanctuary, it extends approximately a mile upstream from the lake, and consists of marshland, the stream bed, and a 15-acre island within the marsh. A variety of Lake Erie fish spawn there, and migrating and local waterfowl flock along the shores and wade the shallows.

The area is protected under the Coastal Zone Management Act, which was designed to assist states in developing coastal management programs along the Nation's coast and around the Great Lakes.

Estuaries are generally where fresh water rivers or streams meet salt water bays or seas (in the Great Lakes, of course, fresh water streams meet fresh water lakes). They are among the most productive ecosystems on earth, providing a vital link in the life cycles of thousands of fish and other animal species. Estuarine sanctuaries were created to help preserve some of these valuable places for a wide variety of purposes such as education and research and for the benefit of the people who live in and visit the area.

In addition to the vital natural functions performed by the ecosystems, there are many competing demands to use the coastal zone . . . commercial fishing, energy development, transportation, and recreation. In addition, about 40 million Americans live on the coasts. An important characteristic of the coastline is quite simply, access. Manufacturing depends on access to adequate water transportation and to a reliable source of water. Transportation depends on access to port facilities. Recreation depends on access to beaches, boat ramps, marinas, and even the sight of the sea itself. The Coastal Zone Management Act was created to help the states plan for these often competing uses as effectively as possible, for the optimum benefit of the Nation's citizens. The Act requires the states to inventory the resources and areas of particular concern, identify the major issues of the concern in the coastal zone, develop policies to address those issues, and assure that the policies can be enforced under state law.

In Alaska, the program will deal with important native cultures. For example, about three quarters of the people living in a village of 800 called Yakutat are native Tlingit Indians. They are on the northernmost fringe of the northwest coast Indian culture and their livelihood is based on harvesting the sea.

Native Alaskans in Yakutat and elsewhere are intent on preserving native culture. Until now, the Yakutat tribe's isolation has helped to preserve their old ways. However, their coast is the most convenient in the eastern gulf for Outer Continental Shelf operation. The citizens are determined to shape and limit development of this sort so that the traditional way of life can survive.

Coastal Zone Management is a National program that communities such as Yakutat may call upon, through their State governments, for help in meeting a variety of problems, including the impacts of coastal energy development. This is a matter of great concern to the many small communities that face big expenses in meeting the needs of newcomers before their tax base has expanded enough to cover the costs of new public services.

Because of the sensitivity of issues related to the regulation of private property, in the early years CZM has concentrated on the landward side of coastal management. But, the Act establishes a basis from which states can make decisions about how to use resources within their waters as well.

Commercial and recreational fishermen are receiving assistance through CZM in their coastal waters. Last year the Office of Coastal Zone Management made its first grant under its fisheries assistance program, to North Carolina. It was the first Federal grant linking coastal zone management and fisheries assistance. The Office of Coastal Zone Management is working with NOAA's National Marine Fisheries Service, using this program to link fishery information with coastal management and assist local commercial fishermen to determine where they may make their best catch. Developers are another group of citizens who stand to gain from CZM. Many developers and their site planners have been confused by the maze of legal requirements in obtaining permits. In Connecticut, the State's Department of Environmental Protection administers a large number of environmental laws and regulations covering such diverse areas as dredging, filling, burning, and polluting. There are requirements for permits in each of these activities, and each permit program has its own requirements for applications, plans, public notices and hearings.

To help make this legal maze more manageable and to provide some basic information and advice on subdivision planning, the Department of Environmental Protection and the State coastal zone planners developed a handbook. In a non-technical, graphic format, the handbook has helped developers avoid expensive corrective measures and costly delays in obtaining permits.

In Maine, the state government developed a publication called "Maine's Coast . . . Special Considerations for the Municipal Planning Process." As the name implies, it is intended to acquaint its readers with the local planning process, especially as it relates to Maine's coastal region. It focuses on areas and resources that deserve special planning and management consideration and points out that areas of special interest should be integrated with other information about a locality's natural, cultural, social, and economic resources in making planning decisions.

CZM works in other ways to enable the people of the nation to enjoy their shorelines.

In Wisconsin, the state CZM organization set up a summer sailing and boating instruction program for low-income and minority residents. Enrollment in the initial year's boating course consisted mainly of low-income youths who lived near the lakefront, and who gathered almost daily along the shore hoping to become involved in water-related activities.

This project demonstrates how a small investment can increase access of people with moderate and low incomes to coastal recreation opportunities.

Many states have created coastal history trails and interpretive walks along their shorelines to bring about an awareness of the coastal zone, it beauty, and its uses to the people of the states. In Illinois, the state developed an interpretive walk along the coast of Illinois Beach State Park. The walk includes information on the natural history of the park, reasons for the types of vegetation found on the shores, how the dunes were formed, and plans the state may have for the future of these resources.

State parks have also been created with assistance from CZM. An example is Liberty State Park in New Jersey. The site lies within a few miles of the urban centers of Jersey City, Newark, Hoboken, and New York. Adjacent to the New Jersey Turnpike, and closely related to the New Jersey rail service, Liberty Park will be available to 16 million people in its nearby region.

A master plan for the park was developed by the State's Department of Environmental Protection. The goal of the project is the complete transformation of a decaying open space into a new, vital, useful, and beautiful landscape. On the edge of New York Harbor, the Park will offer public access to the waterfront and new recreational activities at the center of the New Jersey/New York metropolitan region.

The park will serve as a stimulus to the revitalization of the northern New Jersey waterfront on New York Bay and as a vital step in the urban development for nearby cities and communities. It will include recreational and cultural amenities that will attract millions of visitors each year and will include harborfront walks, a serpentine waterway, a wildlife habitat, and marine and boating facilities.

In Hawaii, the League of Women Voters working with the coastal management program for the state, assisted in staging a poster contest for students from Kindergarten to high school. The posters described "What Hawaii's Coastal Zone Means to Me." Many youths expressed their interest in the coastal zone and pointed out interesting views on the shorelines. Prizes included tours within the coastal zone, airplane tours, and boat rides which added to the student's awareness of their coasts.

An integral part of the Coastal Zone Management program is coastal awareness.

The citizens of coastal states . . . and inland states . . . should play a large role in the management of the shorelines. Citizen participation in making management decisions is brought about through workshops, public hearings and meetings, and coastal awareness celebrations — which attempt to bring people to the coastal zone so that they might realize the beauty and important uses of the resources.

Robert W. Knecht, Assistant Administrator for the Office of Coastal Zone Management, was interviewed on his views regarding the future of coastal zone management.

Q. Mr. Knecht, you emphasize that CZM is not only plans and policies, but also people and places. What do you mean by that?

A. Clearly, the purpose of the CZM program is for the benefit of people and places along the coasts. There is a danger, I think, of Government becoming preoccupied with the administrative process and procedures that are needed to put a program like this into place. Ultimately, though, the program must produce benefits for the people.

Q. How?

A. The whole purpose of CZM is to affect the way we deal with the shorelines of the Nation. The objective is to see the coast and its resources become of maximum value to the people of present and future generations. In effect, what is being done by coastal zone management programs will ensure that coastal places continue to be as productive, as attractive and as useful as they are now.

Q. How will these programs affect the country as a whole?

A. If the program succeeds as I think it will, the shoreline of the 30 coastal states will be under state coastal management programs. We think this will benefit both the people of the coastal states concerned and the people of the inland states.

Q. How will coastal zone management affect people of the inland states?

A. If the people of the inland states go to the ocean or Great Lakes for recreation, they will benefit from the improved planning and management of those recreational resources. They will also benefit from the port and commercial activity that is aided and facilitated by a rational coastal management program. And they will certainly benefit from improved conservation and development of such marine resources as fish and shellfish.

Q. How many states do you expect to have approved coastal zone management programs in 1978?

A. As you know, three states already have Federally approved programs, Washington, Oregon, and California. By the end of FY 1978 we anticipate up to an additional 12 states having approved CZM programs, or a total of 15. Eight or ten additional states are scheduled for approval in FY 1979 and the remaining six or eight in the early part of FY 1980.

Q. Which states are closest to final approval?

A. Maine, Massachusetts, Rhode Island, Wisconsin, and Michigan.

Q. Which areas of the country will receive grants under the Coastal Energy Impact Program?

A. Coastal energy problems of the nation are found all around the shorelines of the Nation. Naturally, however, they tend to cluster in areas where most of the resources are located. The Gulf states, especially Texas and Louisiana, will continue to have major involvement in the CEIP because that is where the oil and gas are.

The activity in Alaska is going to become increasingly important, and we can expect to have a lot of activity with that important state. If the current drilling activities beginning off New Jersey and Delaware reveal important amounts of oil and gas then surely CEIP activities will become important in those states as well. Similarly, if the drilling which is scheduled next spring off New England and George Bank shows important deposits of oil and gas, we can expect activity in New England — especially Rhode Island.

Q. What will be the value of the Fisheries Assistance program in OCZM?

A. This is very important. It was natural and inevitable that states turn their first attention to developing the dry and wetland portions of their coastal zone programs. These were the areas where development pressures were most urgent, where the political problems in dealing with local governments were most severe, and where conflicts with private property were most marked. Now the states are completing this portion of the CZM program and will be turning their attention to the "wet" portion — the territorial sea. The most important element in planning and managing this portion of coastal zone effectively is dealing with the living marine resources. It seems to me that assistance from the CZM program can go some distance toward filling a gap that may have developed with the implementa-

Connecticut held two Coastal Awareness Days — one in Mystic and one in New Haven — housing exhibits on shorebirds, submarines, appreciating the seacoast from a bicycle, watershed management, and Scuba diving.

The states recognize the need for individuals in the coastal areas to appreciate the value the coast contributes to their lives, and with assistance from various state organizations have undertaken coastal awareness projects.

The State of Virginia also held a Coastal Awareness Celebration in more than ten locations, including Virginia Beach, Richmond, Portsmouth, Norfolk, and Wachapreague. Events in the celebration included a seafood feast, a boardwalk art show, coastal exhibits, lectures, and movies, a boat parade, and a fishing tournament.

Also during the Virginia celebration, tours were conducted on naval vessels and at water treatment plants. Norfolk held a Waterfront Garage sale for used boats and nautical accessories at its downtown waterfront. People went on a night hike in Dismal Swamp, received free instruction in surf casting, used binoculars on a beach bird walk, and had a choice of a number of art shows. A natural shoreline protection project was instituted by the Boy Scouts and special cruises were available. The League of Women Voters and Old Dominion University held a conference on coastal management called, "It's Your Coast Virginia."

The Connecticut and Virginia events were coordinated by the state coastal management offices with substantial assistance by a sizeable number of voluntary groups, institutions, government agencies and business . . . all working to bring about an awareness of the diversity and marvels of the coastal area.

Alaska has special problems with public participation workshops, because there is a very small "public" and an enormous territory. Some of the Alaskan workshops took place 1100 miles from Fairbanks. As remote as they were, they served an important function in bringing about communication through people in the far reaches of Alaska and their government.

Another problem faced by people living along the coasts may be brought about by offshore drilling, energy facility siting, and consequent increases in population and production activities. To meet the needs of these affected citizens, Congress enacted legislation under which CZM created a Coastal Energy Impact Program. This program strives to meet these needs in an environmentally sensible manner that is in harmony with the objectives of emerging state coastal resource management programs. It was developed to put in place a critically important system for helping state and local governments lessen any adverse effects of necessary energy development along their coasts. It seeks to balance the need for encouraging energy development with the need for wise management of the Nation's coasts.

Funds under the CEIP come from two sources . . . a Coastal Energy Impact Fund that helps states and localities cope with future energy activities and formula grants that help them deal with the onshore effects of previous energy activities such as production from offshore oil wells.

The first grant under the CEIP went to the

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tion of Extended Jurisdiction — the 200-mile fishing limit. The gap I speak of is the zero to three mile region, the territorial sea. Some states have traditionally done an admirable job using fully adequate resources with regard to their fisheries programs. In other states it would appear that additional financial resources and other features that the CZM program could bring would be helpful in assisting the states in dealing with marine resources in this zone.

Q. How does this program fit in with NOAA's NMFS?

A. It is complementary, and fully coordinated with the important work of NMFS. We will ensure that grants and assistance that we provide are coordinated closely with the NMFS and with the Regional Fishery Management Councils.

Q. Do you see CZM getting an extension of the program if all the 30 states do not achieve approved programs?

A. I personally hope that Congress and the Administration hang tough with regard to the expiration of the program development phase of the effort due to expire September 30, 1979. I think adequate time and adequate financial resources will have been made available to the states so that they can complete this phase of the program. A possible exception may be the state of Alaska, which has a phenomenally long shoreline and a number of problems related to the creation of appropriate local government institutions.

I do however feel strongly that it would be premature for the Federal government to back out of the partnership with states after completion of the program development stage. In my views, states will continue to rely upon Federal financial help to institutionalize and fully implement these newly developed CZM programs. Also, I think that it will turn out that state programs will be achieving important national purposes and enhance the continued operation of these programs and over the long term will clearly be in the national interest. Finally, I would hate to see anything happen that would jeopardize the states' ability to continue to operate an effective Federal consistency apparatus to ensure that the myriad of Federal actions that affect states' shorelines are fully consistent with good coastal practice and state and local plans.

Q. What would it take for CZ to continue throughout the implementation stages?

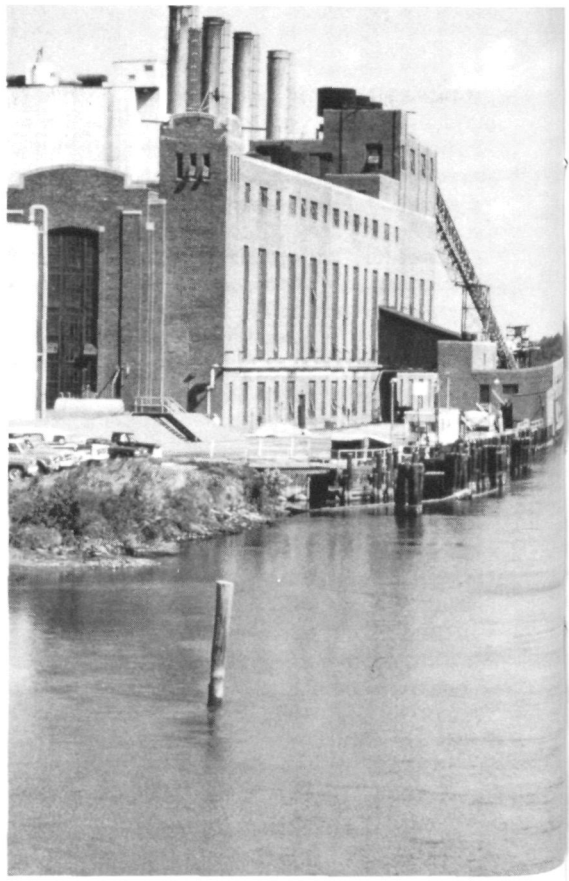
A. The key authorizations in the legislation expire in FY 1980 in any event and will have to be reauthorized or extended. This is typical of all legislation and in the CZM Act case these authorizations have been for 5-year periods.

Q. What factors do you think Congress and the Administration will be considering as they consider extending the program or phasing it out?

A. I think Congress would be looking at the benefits that are being produced by the state programs. They will want to ensure that the programs are making a difference on the ground — that indeed the problems that gave rise to the legislation in 1972 are being addressed effectively and efficiently; that improved public access to the public shorelines for recreational purposes is being achieved; that pollution of estuarine areas and of shellfish beds is being relieved; that states and localities are giving increased priority to the water dependent aspect of developments before authorizing their location along shorelines; and that the fisheries stocks of the territorial sea are better managed and conserved.

Q. Mr. Knecht, do you see any important changes in the direction of state CZM efforts from this point onward?

A. Yes, it's my feeling that as state programs are approved and implemented we will see an increased emphasis on the water — the "wet" dimension of these programs. It's understandable that the early effort was placed on the "damp" and "dry" portions because this is where the pressures for increased development and the political problems were most severe. But in the future attention will be turned increasingly to the water side. Uncertainties remain with regard to the nature of our resources, both living and non-living, the carrying capacity of our coastal waters, and the most appropriate uses the resources can be put to. The CZM approach, I believe, is just as appropriate for dealing with these problems as it has been for dealing with land use-related problems along the shoreline. I also believe additional emphasis will be placed on natural hazards along shorelines dealing with hurricane and flood related problems in close association with the NWS and the Flooding Insurance Program of HUD. In other words, I see in the future more emphasis on living marine resources on the wet side of the coastal zone, natural hazards of coastal areas, protection of wetlands and continuing effort to deal with the difficult issues of the siting of energy or related facilities.



state of Louisana to provide a critically-needed water supply facility on Grand Isle in Jefferson Parish. The island's water supply was adequate to handle the town's permanent residents, but could not meet the increased recreational demand stimulated by the coastal energy activity.

Grand Isle is the base for several oil companies' operations and also attracts visitors, fishermen, campers, and beachgoers by the thousands in the summer and during weekends year round. The site of much of the recreational activity is a 100-acre state park. Frequently during the previous year, the park had to be closed because of a water shortage, and the Louisiana Department of Public Works was forced to postpone construction of two additional bath houses there because of insufficient water supply. The new system provided an adequate water supply for the state's needs and enabled full recreational facilities to be restored.

Louisana was also awarded CEIP funds to finance a project to prevent further deterioration caused by saltwater intrusions into the wetlands at Violet, and to restore some of the area already affected by the influx of saltwater. The intrusion, which the state officials characterized as "unavoidable." was brought about in part by dredging, oil and gas pipeline operations, and by the construction of the Mississippi River Gulf Outlet.

Engineers there are building a diversion structure that will siphon fresh water from the Mississippi River over the levee into the marshes of Violet. The fresh water is expected to help flush out the salt from the marsh.

In addition, Louisiana received a grant under the program for Our Lady at the Sea Hospital in Lafourche Parish for hospital equipment needed as a result of Outer Continental Shelf activities. The hospital is located approximately 25 miles north of the Gulf of Mexico. Currently, more than half of the patients are employees or dependents of employees working for energy-related companies operating in OCS activities. There have been occasions when injured were flown in from as far as 75 miles out in the Gulf.

The Coastal Zone Management Act has been an incentive and assistance program for coastal states and territories to plan for an implement rational programs for management of this highly productive, diversely valuable, yet limited natural resource.

Because the Federal Act looks to the states to identify coastal issues, much of the most important work is done by citizens who define the coastal issues, and decide what should be done about them. Old Women Creek is an example of something the people of Ohio thought was important last year. Next year it could be a new port in Toledo, a waterfront park in Cleveland, or a program to preserve the vineyards which benefit from the breezes off the eastern shores of Lake Erie. □

"Like searching for a pebble in a mountain of mud . . ."

The Quest for Seabed Minerals

By JOAN VANDIVER FRISCH

FACED with dwindling mineral and petroleum reserves ashore, industry has begun looking seaward for new sources, hoping to tap the minerals that are known to be there but that cannot readily be found. The reason for the difficulty, according to Dr. Peter Rona of NOAA's Atlantic Oceanographic and Meteorological Laboratories in Miami, Fla., is that mineral deposits anywhere are a small detail on an enormous geologic canvas. The traditional approach to locating such deposits is systematic exploration — propsecting on the grand scale. But such exploration, difficult at best, is limited value for finding minerals in the sea.

"Imagine how little we would know about the mineral deposits of the world if our sampling procedure were limited to flying in a balloon at an altitude of up to six miles, scraping up loose rocks from the surface of the earth with a bucket suspended at the end of a long cable," Rona said. "The chances that we would find the major known ore deposits, which generally underlie areas of less than a square mile, would be very small."

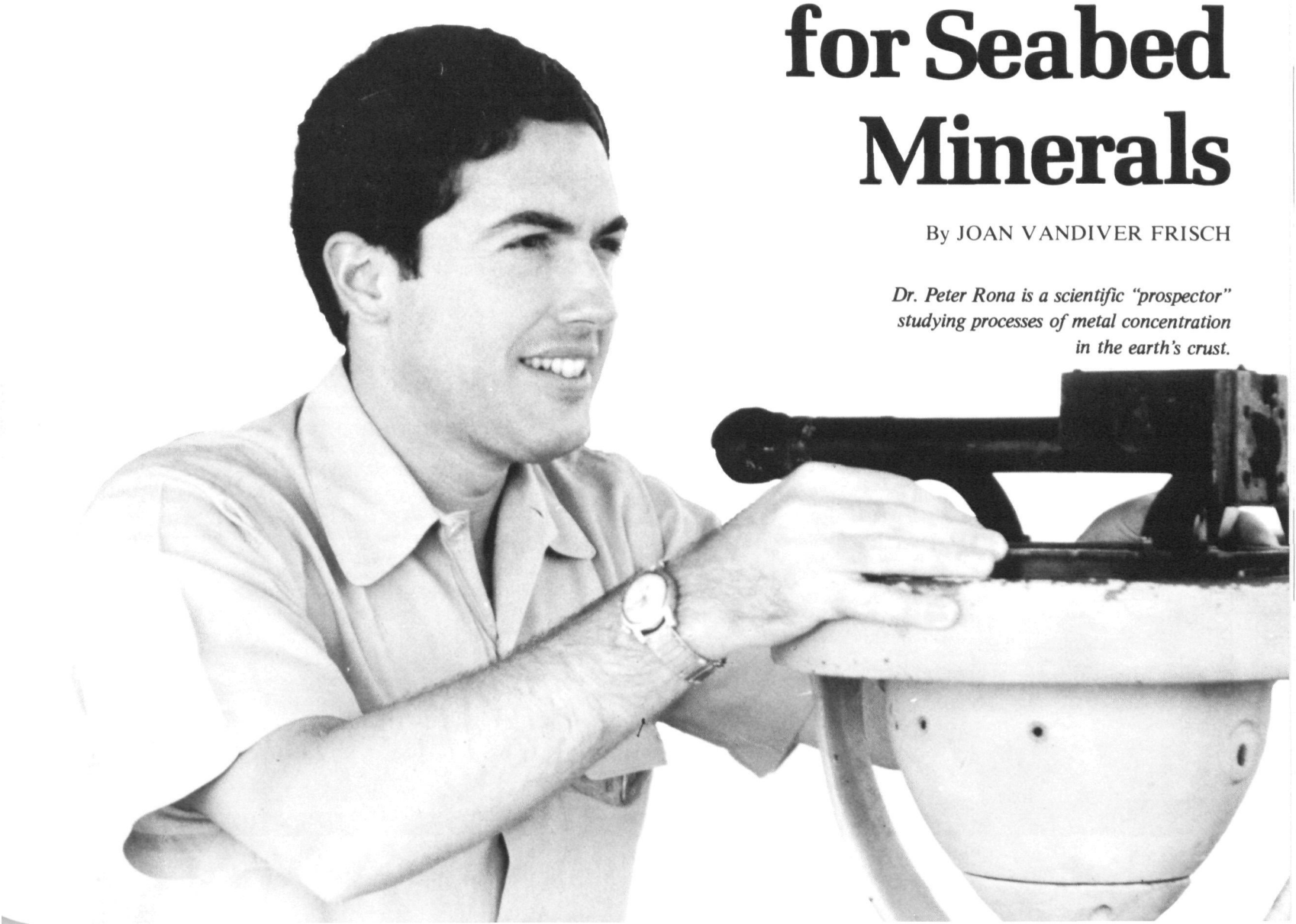
Yet, said Rona, this analogy accurately describes mankind's present capacity for sampling the various sediments and rocks on the ocean floor using coring, drilling, and dredging devices lowered from ships through opaque waters over an areas twice the size of all the earth's continents.

He estimates that the disgribution of seafloor rocks have been sampled to date, averaged over the world's oceans, is only about three dredge hauls per 400,000 square miles (one million square kilometers).

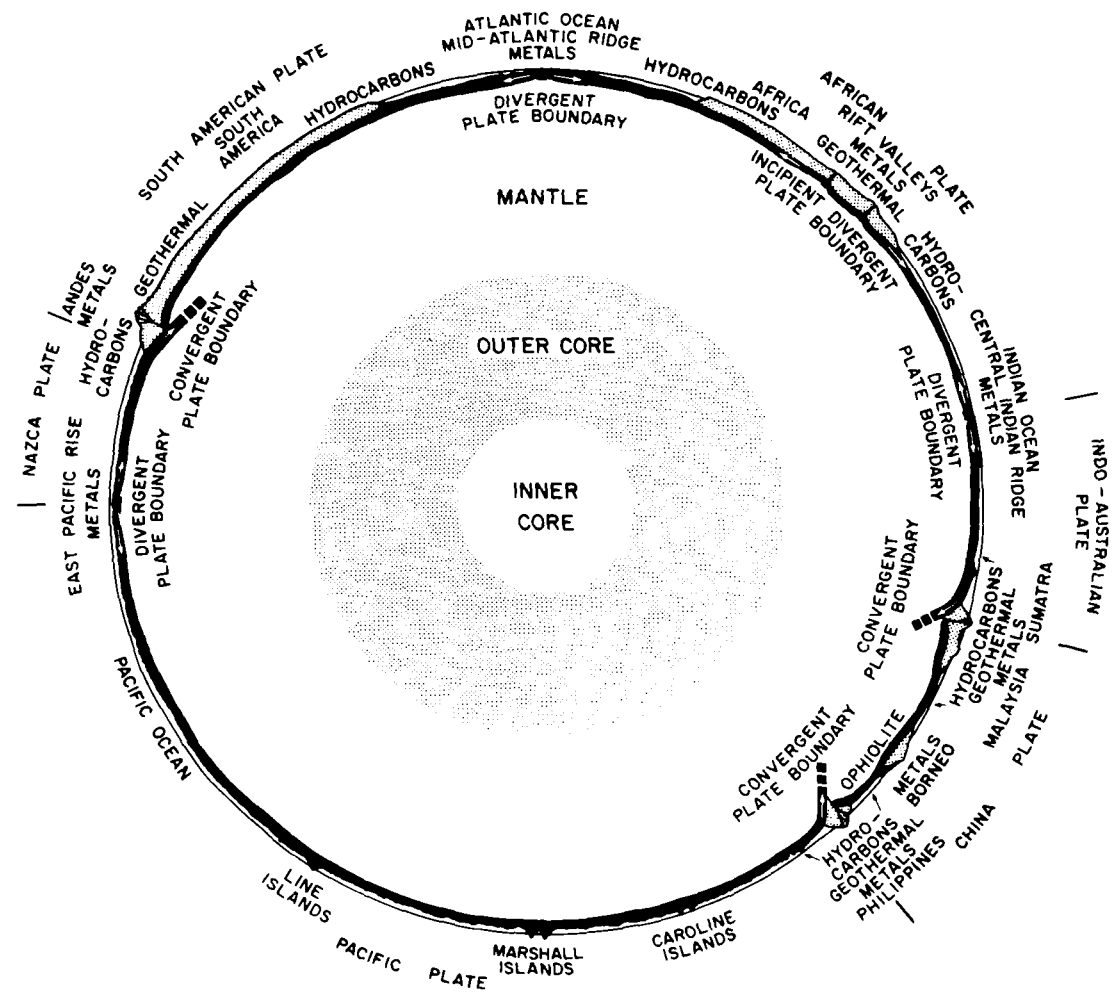
An alternative to such blind, random probing, Rona and his colleagues in the Marine Geology and Geophysics Laboratory believe, is to focus systematic exploration on areas where mineral deposits are most likely to occur, using the geological theory of plate tectonics — a theory that is revolutionizing understanding of the earth's geology.

Plate tectonic theory holds that the earth's crust is a made of of moving plates, pulling apart at the mid-ocean ridges of the world, and converging along certain continental margins. These openings and closings, these regions of spreading new plate and eroding old plate, in Rona's view, identify potential sites where new sources of hydrocarbons, geothermal energy, and critical metals including iron, manganese, copper, silver, and gold may be found thousands of feet beneath the sea, as well as on land.

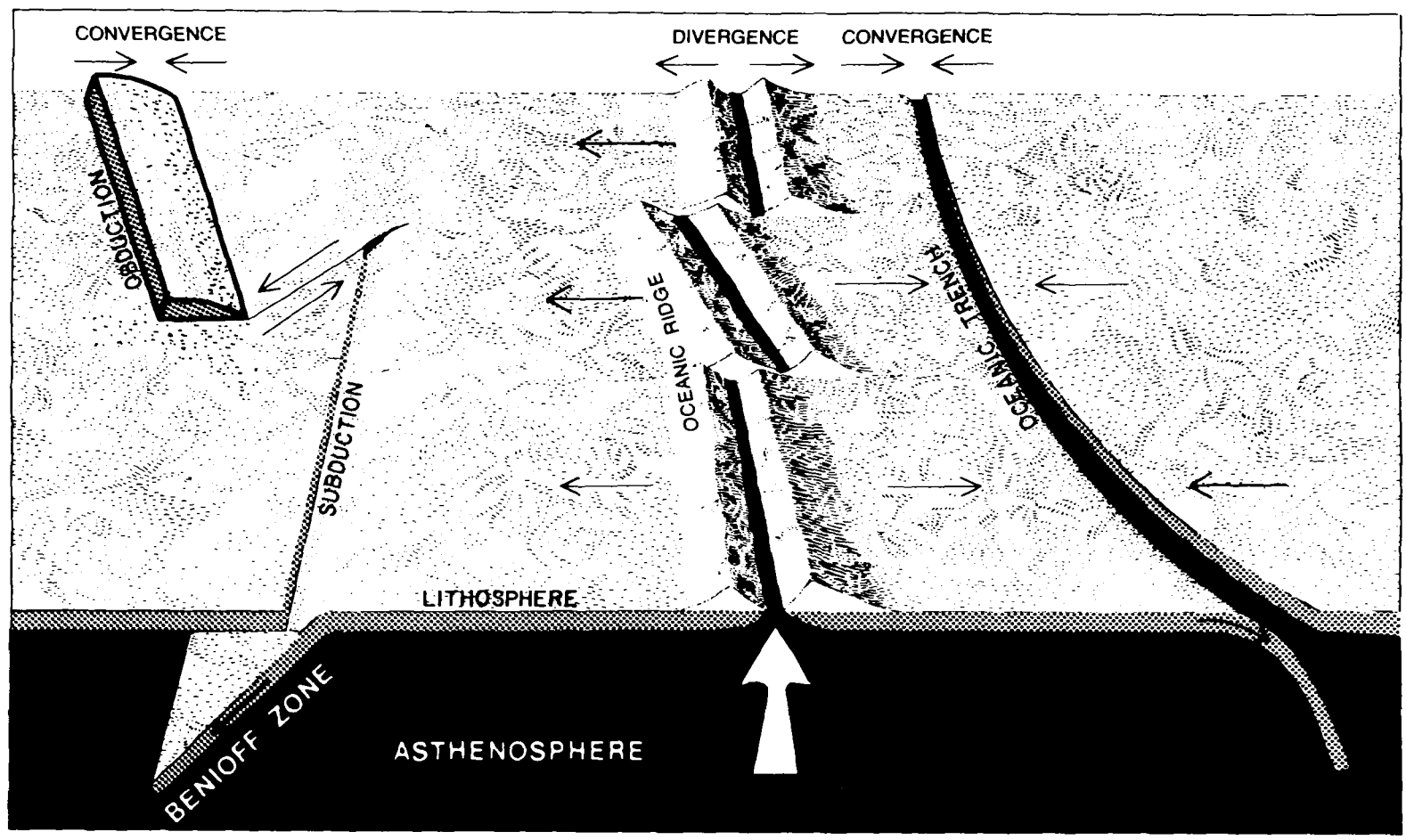
"Geological processes at the plate boundaries tend to concentrate petroleum and metal deposits," Rona said. "What we see today permits us to reconstruct the geologic past — that is, we can use observable relationships between mineral deposits and plate boundaries to infer past relationships and to guide us to ancient mineral deposits."



Dr. Peter Rona is a scientific "prospector" studying processes of metal concentration in the earth's crust.



Schematic cutaway of the earth's equator (right) shows lithospheric plates, plate boundaries, and occurrences of energy and mineral resources. Lithospheric plates move like conveyor belts (below) from a divergent plate boundary (oceanic ridge) to a convergent plate boundary.



A major portion of the major metal deposits now being mined on land, Rona noted, were concentrated by processes at boundaries of convergent tectonic plates, such as the convergent plate boundaries around the Pacific Ocean basin. Extrapolating from these deposits, and applying plate tectonic theory, should bring insights that can be used to predict where such deposits should occur elsewhere along convergent plate boundaries.

This seems to apply both where the oceanic plate rides up over the contintenal plate — a process called obduction — and where the ocean plate slides beneath the continental plate and is pushed back into the earth's mantle — a process called subduction.

Regions of obduction can be identified on land by the geologically trained eye, and provide an economically important link between plate tectonic theory and the search for mineral deposits. The Troodos Massif of Cyprus in the eastern Mediterranean is a classic example of obduction of an oceanic plate. For centuries the island has been known to contain economically important metal deposits, including copper (for which the island is named), which was an important resource for a mining industry in Roman and even Phoenician times. One of several metallic sulphide ore bodies within the oceanic crust exposed on Cyprus contains an estimated mass greater than 15 million tons with average composition of 4.2 percent copper, 48 percent sulphur, 43 percent iron, 0.14 percent zinc, and traces of gold and silver. The value of mineral products exported from the small island just during 1970 amounted to more than $30 million.

Other slices of oceanic crust along present and former convergent plate boundaries are exposed within major mountainous regions of the Middle East, the Urals in the Soviet Union, as close to home as the coastal ranges in eastern and western North America and western South America. Oceanic crust is also exposed in the volcanic island chains along the western margin of the Pacific Ocean.

A convergent plate boundary — where one plate descends under an adjacent plate and is reabsorbed into the earth in a subduction zone — may also be the site of mineral deposits, according to Rona. These metal deposits are carried shoreward on the spreading oceanic plate, melted and remobilized during subduction, and redeposited in the volcanic rocks that characteristically erupt above subduction zones. The rich copper deposits of the Andes mountains of Peru and Chile are believed to be an example of this metal-concentrating process. Thus, application of plate tectonic theory is helping to narrow the search for mineral deposits on land.

But until recently, a theoretical gap persisted in the attempt to link mineralization and plate tectonics in the sea. The old consensus among earth scientists, Rona explained, was that no concentrated metals were associated with divergent plate boundaries, which occur along the mid-oceanic ridges of the world. The evidence for this was that the rock produced there is primarily basalt, which forms the floor of the world ocean basins and which is not itself economically important.

Then came two discoveries revealing that mineral-forming processes are indeed active at mid-oceanic ridges where plates diverge.

The first of these two discoveries was the metallic ore-bearing sediments in the Red Sea found by earth scientists participating in the International Indian Ocean Expedition (1963 - 1965). The richest underwater metallic deposits known were discovered in three relatively small basins of the Red Sea at a depth of about 6,000 feet (2,000 meters). The estimated market value of the metalliferous sediments is some $2.5 billion. But the discovery holds implications that could make these deposits still more valuable — for the Red Sea represents the earliest stage of opening of an ocean basin about a divergent plate boundary that has rifted Africa and Arabia apart. The discovery suggests that mineralization occurs along with the evolution of such basins.

The second of the two discoveries regarding metal deposits at divergent plate boundaries is the TAG Hydrothermal Field discovered in 1973 by NOAA and university scientists collaborating in the NOAA Trans-Atlantic Geotraverse (TAG) project directed by Rona. The TAG Hydrothermal Field is an area at least five miles (7 kilometers) square on the Mid-Atlantic Ridge (a divergent plate boundary) at the latitude of Miami, where hot springs enriched in various metals are discharging from the sea floor and depositing a solid layer of nearly pure manganese oxide up to two inches (five centimeters) thick. It is not technically feasible at present to drill through the manganese oxide layer into the underlying hard rock (basalt). However, observations of oceanic crust exposed on land, like the Troodos copper deposits described from the island of Cyprus, suggest that the manganese oxide layer may be underlain by metallic sulfide bodies which are an economically important type of deposit on land. The metalliferrous deposits of the Red Sea and the TAG Hydrothermal Field indicate that hydrothermal processes of metal concentration in oceanic crust can act continuously from the sea stage through the ocean stage in the opening of an ocean basin about a divergent plate boundary (mid-oceanic ridge).

The TAG Hydrothermal Field is an important clue to metal-forming — metallogenetic — processes in the deep ocean floor. "Because it is the first field of its kind discovered and the only such field known to date in the Atlantic, it provides a unique opportunity to study an ore deposit in the process of formation," Rona said.

Pursuing that line of research, Rona initiated a new NOAA project in 1975 conducting a series of month-long interdisciplinary cruises each year to study processes of metal concentration at the TAG Hydrothermal Field to extend exploration to other portions of the Mid-Atlantic Ridge.

Rona pointed out that every major discovery of a hidden mineral resource in recent years has been anticipated by a scientific theory. For example, once field geologists recognized the definite association between a certain type of sedimentary structure and accumulations of oil and continents, they knew where to drill. The result: the rate of discovery of oil deposits accelerated. In like manner, the studies of metallogenesis in oceanic crust should be a useful guide in the exploration for metallic mineral deposits in oceanic crust both beneath the sea and exposed on land.

"Metal deposits in oceanic crust have both a short and long term significance for mineral exploration," Rona said. "The short term significance is that large slices of metal-rich oceanic crust are exposed on land by obduction accessible to present exploration and exploitation. The long term significance is the promise of eventual recovery of metal deposits, as well as manganese nodules, from the ocean floor — a process that involves new technology and huge costs, but that may become economically feasible when more accessible metal deposits are depleted. Because their distribution is not sufficiently well known, the volume of metal deposits in ocean ic crust can not be estimated at present. However, they may become an important resource for the future because the oceanic crust containing them covers over two-thirds of the earth."

To bridge the gap between their investigation of metallogenesis at oceanic ridges and actual exploration for metallic mineral deposits in oceanic crust exposed on land, Rona and his co-workers keep in close touch with scientists engaged in exploration. They keep abreast of the work of state and federal geological surveys and industry, and exchange information with members of geological surveys of other nations and of the United Nations Development Program. Such communication helps guide actual exploration for metal deposits in oceanic crust exposed on land and at the same time provides feedback in the form of "ground truth" to orient the work at sea in useful directions.

To further their knowledge of mineral occurrence and distribution beneath the sea, Rona and his colleagues at AOML plan another month-long scientific expedition in the mid-Atlantic. Nearly 100 scientists from about 30 domestic institutions and 20 foreign facilities are collaborating in the NOAA "Metallogenesis at Dynamic Plate Boundaries" Project.

"The immediate payoff in our research is to learn of the occurence of metallic minerals and the process of ore formation in oceanic crust to guide industry in their exploration for new sources of critical metals in the as-yet-unexplored extensive regions of oceanic crust exposed on land throughout the world."

New Tool For Physicists: The SUBMARINE

WHEN THE PARTNERSHIP between science and technology achieves a "critical mass" the results can be both productive and exciting. The advances in human knowledge achieved by basic research rest on creative technical advances; conversely, the innovative juices of technology are stimulated by the challenges posed by scientific needs.

Such a partnership has made possible a significant cosmic ray experiment now under way 1000 feet under the ocean, off Grand Bahama Island.

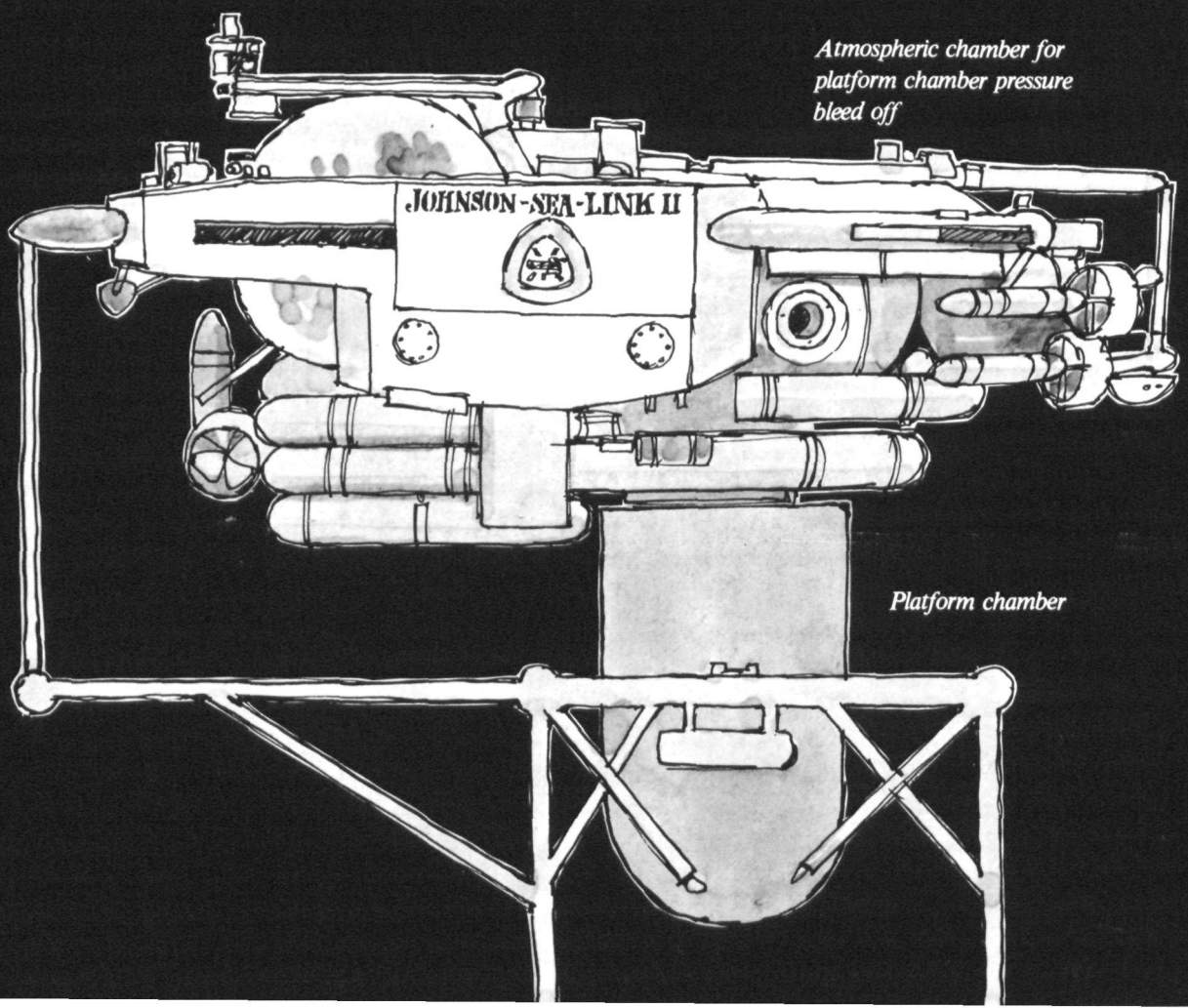
Cosmic radiation is ubiquitous. Cosmic rays stream onto the earth from outer space in the form of high energy subatomic particles — protons, neutrinos, muons, and others. There are so many of them that, quite literally, thousands of muons and neutrinos pass through our bodies every second. And everywhere in the earth's atmosphere these particles are colliding, breaking apart, showering into "sparks" of other particles of varying energies.

A certain number of primary particles make it through the crowd without colliding, as do some high energy particles resulting from collisions. These penetrate deeply into the earth.

The high energy physicist studying cosmic radiation has three ways to go. He can rev up a huge nuclear accelerator such as the one at the Fermi laboratory in Batavia, Ill., and try to reproduce in a controlled manner certain of the moderately energetic natural radiation. This will produce particles in the medium energy range, from which he can deduce some of the characteristics of high energy cosmic rays. He can prepare and expose photographic cosmic ray detectors in his laboratory. But the sea level environment with its multitude of particles records so many tracks on the plates that it is impossible for him to separate and analyze individual cosmic radiation "events." Or he can try to get far above or well below the "fog" of particles at sea level.

Scientists have used balloons, high-flying aircraft, and satellites to get above the "fog." The experiments have been very useful; each type of platform has some advantages, some disadvantages. One recurrent problem is that preparing the emulsion detectors at sea level inevitably exposes them to some of the sea level radiation before they can be lifted to altitude.

Scientists have gone down in mines and have lowered emulsion detectors into lakes and bays, to try to record the particles that have escaped collisions and that have not been screened out by earth or water — a screening effect that acts primarily against the low-and medium-energy "noise" parti-



cles. Again, much has been learned. Problems remain because of the non-homogeneous nature of the earth "filter," and because of the necessity of preparing detectors in a relatively unfiltered environment.

Thus the scientific need, as defined by Dr. Kurt Stehling of NOAA: to be able to prepare, expose, and develop photographic radiation detectors deep under water.

The technological answer, made possible by Harbor Branch Foundation, Inc., Ft. Pierce, Fla.: to use the special capabilities of its submersible Johnson-Sea-Link II combined with innovative techniques developed by its Operations Director, Roger W. Cook.

Dr. Stehling had first suggested underwater techniques, and NOAA's Manned Undersea Science and Technology program supported such experiments in Hydro-Lab in 1972 through 1975. The current project originated a year ago, in February 1977, when Dr. Stehling, Senior Science Advisor to the Office of Ocean Engineering, and Dr. Robert Jones, Director of the Harbor Branch Foundation's Johnson Science Laboratory, convened a meeting at HBF. Participating physicists were Dr. Peter Kotzer of Western Washington University and Drs. Jere Lord and Seth Neddermeyer of the University of Washington. Scientific objectives and requirements, technical capabilities and needs, and operational possibilities and limitations were thoroughly discussed. Following the meeting the participants drew up proposals for a submersible-based cosmic ray project using the Johnson-Sea-Link. The missions were approved in March by the Harbor Branch trustees, J. Seward Johnson and Edwin A. Link, and by NOAA's Office of Ocean Engineering through its Manned Undersea Science and Technology program. Sea Grant also added funding support.

The first dive took place October 4, as the small submersible descended to the ocean floor where it "mated" with a unique docking platform previously deployed by the Harbor Branch vessel Sea Diver. The platform is capable of withstanding the great pressure of the sea at the depth required (at that point, 1015 feet below sea level). Within the platform is a pressure chamber that can be kept at one atmosphere (sea level pressure) while the outside pressure is more than 30 atmospheres.

Submersible pilot Tim Askew landed the Johnson-Sea-Link on the platform, and completed the mating by venting sea water, trapped in the pressure chamber, into holding tanks on the submersible. This produced a watertight, pressuretight seal between submersible and platform chamber, making it possible to open a hatch between the two.

There are two compartments in the submersible. Dr. Stehling, in the forward compartment with the pilot, served as scientist-observer and over the intercom system provided instructions, from a checklist, for preparing the film emulsion detectors. In the darkened dive compartment Dr. Kotzer, assisted by Harbor Branch diver Richard Roesch, performed the delicate operation. So sensitive was the work that it was performed in the red light of a photographer's darkroom, and the ports on the submersible were covered to prevent penetration of any flickering outside light from a bioluminescent sea creature.

In the confined space of the diver compartment they heated the film emulsion and poured it on chilled glass plates, which were laid on a cold table in an icewater bath. The emulsion was permitted to jell. The plates were then heated for several hours, until the emulsion was dry and inflexible, and stacked like tiny pancakes, alternating in the stacks with X-ray plates and lead plates to be used for reference purposes.

The completed stacks were placed in a special black box — designed and fabricated, like so much of the special equipment on the project, by Harbor Branch — and this was enclosed in a nine-inch pressure-resistant glass sphere.

After nine hours in the darkened chamber, Dr. Kotzer and diver Roesch were able to take the completed package and transfer it into the pressure chamber of the docking platform — a simple but record-setting procedure that constituted the first dry transfer of a scientific package at greater than 1000 feet depth.

They closed the hatch; the mating seal was broken; the Johnson-Sea-Link returned to her berth aboard the tender Sea Diver. The four men had completed a wearying eleven-hour mission.

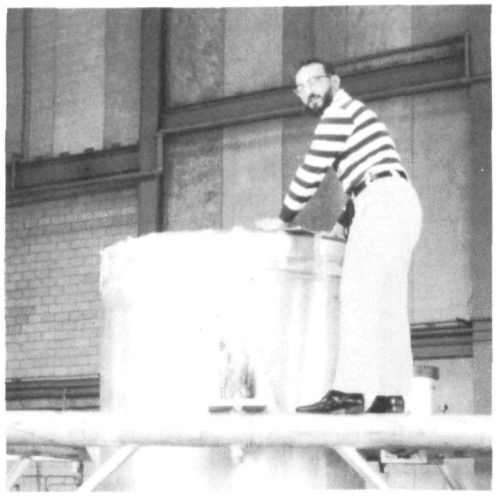
Two days later the mission was repeated, this time with Harbor Branch pilot Jeff Prentice. The second detector was placed alongside the first in the docking chamber.

On October 7 the final step in preparation of the experiment was taken. Cook piloted the submersible, with Dr. Jones aboard as scientist-observer, on a return to the docking platform. Using Johnson-Sea-Link's manipulator arm to place a protective cover over the platform chamber's mating surface, they also took one of the detectors up the sloping sea bottom to a depth of 400 feet, where it was emplaced.

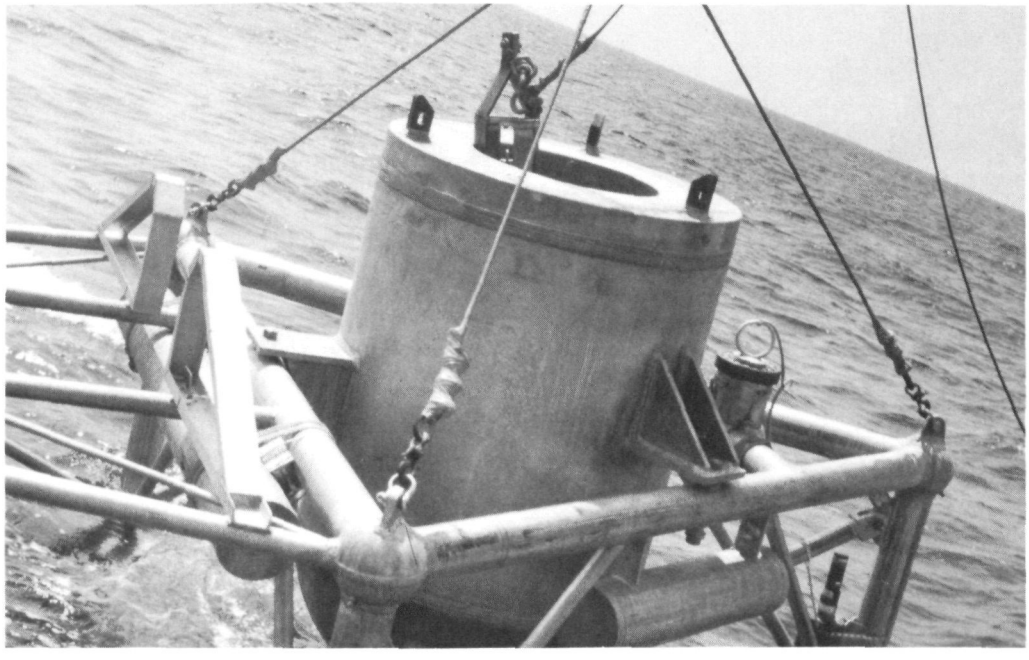
At the end of six months — in April — one of the detectors will be recovered and the film developed in the submersible at depth. The other will be recovered and processed at the end of twelve months.

Scientists will then analyze the photographic plates, using computer scans, to identify the tracks of the particles recorded three-dimensionally in them. If the experiment proves successful, scientists may be able to infer the physics of elementary particles and the dynamics of star explosion and collapse. Better understanding of the particles may yield clues for high-energy physicists studying the nature of matter and the galaxy, with possible implications in the physics of fusion energy.

And technologically, the operation will have been an important advance both in opening possibilities for future undersea cosmic ray physics experiments, and for numerous other scientific applications that require an ocean-bottom experimental environment. □



Dr. Peter Kotzer inspects docking platform in which film emulsion will collect cosmic rays for a year (left); docking platform is lowered into the sea (below) in preparation for experiment.



A trigger for great storms?

MYSTERIES OF THE MESOSCALE

Though they are separated by hundreds of miles, residents of the little town of Hillsdale, Michigan, have a nightmare in common with the people of Jones County, Mississippi — and with citizens of Brandenburg, Kentucky, and many other places. They all live in areas hit by weather disturbances that spawned a string of tornadoes on April 3 and 4, 1974. During a 16-hour reign of terror, mushrooming thundercloud systems produced a record 148 tornadoes in 10 states between the Canadian border and the Gulf of Mexico — twisters that killed more than 300 people, injured an additional 6,000, and caused property damage and destruction amounting to millions of dollars.

The birth and growth of thunderstorm groups such as those that unleashed their fury that terrible April of 1974, or those that caused the devastating 1972 flash floods in Rapid City, South Dakota — and more recently, in Big Thompson Canyon in Colorado — depend upon the development and interaction of weather systems ranging from large midlatitude cyclones — the "low" pressure area on weather maps — to microphysical processes such as water or ice particle growth in individual clouds.

Traditionally, meteorological research has concentrated on the large and small ends of atmospheric scales of motion. There have been only limited initiatives into "mesoscale" or medium-scale, weather. Recently, however, meteorological researchers have discovered that in certain severe storm situations this intermediate scale plays a crucial role in organizing and focusing the atmosphere's energy. New programs are evolving to study the middle range of weather phenomena.

One such program is the Mesoscale Meteorology Program headed by Dr. Charles F. Chappell of the Environmental Research Laboratories' Atmospheric Physics and Chemistry Laboratory. The primary mission of the laboratory is to provide a better understanding of atmospheric mesoscale processes. It works closely with the National Weather Service, NOAA's operational weather arm, to help improve short-range forecasts and warnings.

Chappell's group has analyzed past severe storms such as those that brought destruction pressure south and west of the threatened areas. Strong easterly to southeasterly winds near the surface pushed abundant moisture into higher terrain, and combined with light winds aloft, tended to keep new thunderstorm to Rapid City, South Dakota, and to the Big Thompson Canyon in 1976. The scientists hope to establish certain recognizable criteria that NWS meteorologists can use in forecasting particularly dangerous thunderstorms several hours ahead of time.

Photo: SFC Ray Jewett, U.S. Army

Bill Beattie (above) recovers bike from remains of his home after tornado hit Rochester, Ind. Photographic sequence (opposite page) shows the development of a large thunderstorm west of Lyons, Colo., from near 6:10 p.m. to 6:45 p.m. on July 31, 1976, the evening of the Big Thompson Canyon disaster. Photographs were taken at Mitchell Lake, Colo., near the Continental Divide, courtesy of John Asztalos of Waukesha, Wis.

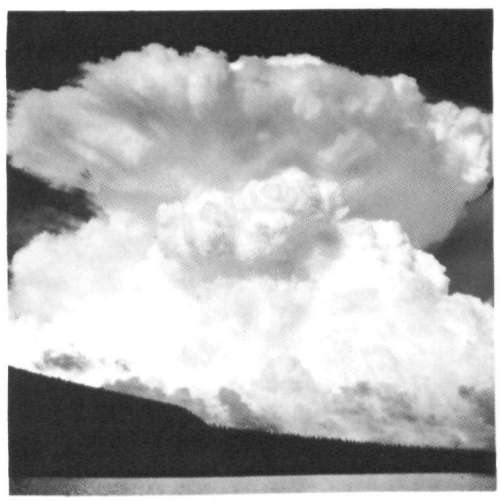
Comparing the Big Thompson thunderstorm with the storm that caused the Rapid City disaster — a flash flood that killed 238 and caused millions of dollars damage — the NOAA scientists find marked similarities.

"In both storms," Chappell explains, "we had surface conditions dominated by large polar highs to the northeast, with lower development fixed over the same higher terrain."

These similarities, Chappell believes, may provide clues to a better understanding of flash flood situations, especially in mountainous terrain, and could lead to improved flash-flood watches — the messages that alert the public to the possibility of a flash flood.

In their study of the Big Thompson thunderstorm, the researches note that Colorado's foothill thunderstorms typically form in the afternoon over the mountains, then drift out over the eastern plains. But the Big Thompson system was no ordinary afternoon thunderstorm.

This is how the NOAA scientists reconstruct events behind the flash flood that killed 139 and caused an estimated $35 million in property damage.



On the early evening of July 31, 1976, very moist air flowed from the east into northeastern Colorado and was maintained there by high pressure to the northeast. As this easterly flow was forced into the Front Range of the Colorado Rockies, the moist air was lifted orographically (by mountains), and cooled. The resulting condensation of this moisture — and the enormous quantities of heat energy liberated by condensation — triggered massive vertical development of the cloud system.

"One of the most remarkable features of this storm," Chappell notes, "is that everything conspired to improve its rainmaking efficiency. The triggering of the storm by extremely moist air rising up the foothills combined with light winds at higher levels kept the storm anchored in one place. And, because the cloud base was nearly on the ground, there was very little loss of rainfall to evaporation."

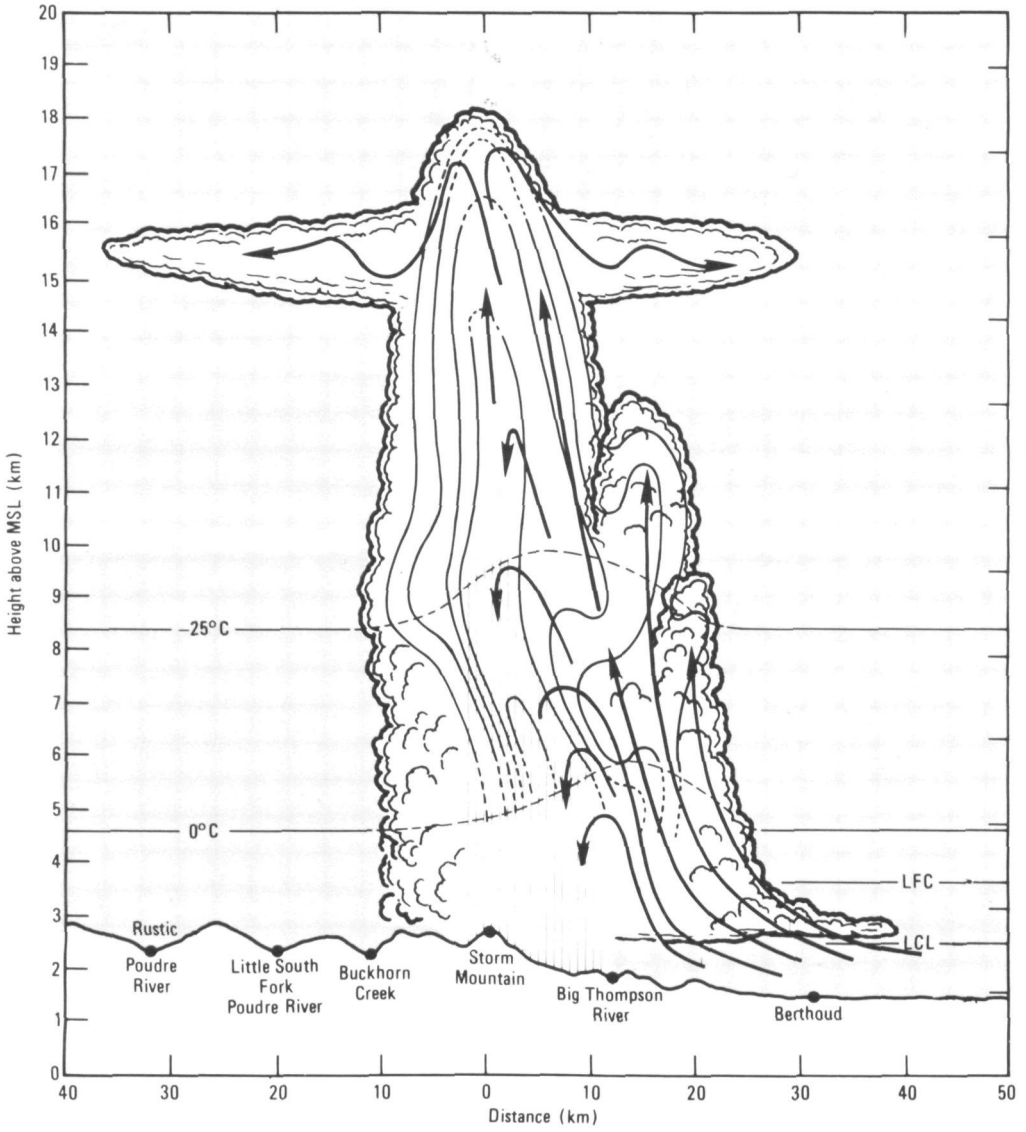
This rainmaking efficiency is reflected by rainfall-rate data assembled in their study. The scientists estimate that at Glen Comfort, in the Big Thompson drainage area, 7.5 inches (191 millimeters) of rain fell between 7:30 and 8:40 p.m. local time. Twelve inches (305 millimeters) of rain were measured there in the 48-hour period ending the night after the flood.

Chappell's group is now working with NWS and NESS scientists on events that took place in the late evening of July 19, 1977, when Johnstown, Penn., was hit by a devastating flash flood. More than 10 inches, (250 millimeters) of rain fell on the community, causing at least 76 deaths and over $200 million in damage. A preliminary analysis of this event shows some similarities to the Rapid City and Big Thompson storms, but also several significant differences. "This only points out that we've still got a long way to go in understanding the atmosphere," notes Chappell.

Low level wind shear, another very important thunderstorm phenomenon, is being investigated by Fernando Caracena. It is associated with thunderstorm downdrafts, which create strong gusty shifting winds near the earth's surface — a notorious hazard to airport operations. Caracena's research began with a study of the crash on takeoff of Continental Flight 426 at Denver's Stapleton International Airport in August 1975. Caracena will participate in a field study next spring to determine if these invisible shifting and hazardous winds can be detected by an infrared radiometer, which subsequently could provide a basis for a cockpit alert system.

The NOAA group also is participating in observational projects in Colorado and California and using insights developed there to construct numerical models of important atmospheric phenomena.

The scientists are involved in modeling both stationary and traveling mesoscale weather systems such as those which frequently occur over the Florida peninsula, across the Great Plains, near the Great Lakes, and along the Front Range of the Rockies. These mesoscale weather systems are classified according to the length of the system: regional scale, 200 to 2000 kilometers (meso-alpha); squall-line scale, 20 to 200 kilometers (meso-beta); and cloud scale, 2.0 to 20 kilometers (meso-gamma).



NOAA researchers constructed this model of one of the large thunderstorms in the Big Thompson Canyon on July 31, 1976. Vertical lines show regions of heaviest rainfall. Curved arrows depict the areas where storm experienced largest updrafts. Elongated parallel lines inside visible cloud boundary denote general outlines of thundercloud observed on NCAR radar at Grover, Colorado. The two horizontal lines show the uniform temperature gradients at two levels in the thundercloud.

Chappell and his group are specifically interested in the squall line, or meso-beta-size systems.

"Stationary meso-beta weather phenomena include variations of weather elements across a large metropolitan area up to a sizable portion of a large state and are strongly influenced by mountain and lake effects," Chappell explains. "Transient meso-beta weather phenomena include thunderstorm squall lines, low pressure systems, cloud clusters, and the nocturnal low level jet stream."

Within this context, Mike Fritsch, another member of the Atmospheric Physics and Chemistry Laboratory, has developed a squall-line model characterizing deep convective air currents in severe-storm environments. "Fritsch's model predicts the genesis and evolution of squall lines similar to the tornado-producing squall lines that rake sections of the midwest," Chappell says. "In a broader sense, the model predicts the severe local storm environment in greater detail than has ever been done before." At present the model has not been run on any past squall line situations. Instead, Fritsch has developed a technique for mathematically creating initial conditions very similar to the real squall line situations. The model is being tested on these analytical conditions before being applied to actual squall line events.

The major feature in Fritsch's model is a scheme for incorporating the effects of deep convection — the towering cumulonimbus or thunderstorm clouds — on temperature and winds at evenly spaced grid points set about 20 kilometers (12 miles) apart. In other words, the model depicts how groups of thunderstorms get organized and how they influence the wind and pressure in areas around

them. The interaction of the squall lines with their own environment tends to generate mesoscale forces on the larger storm system. Thus thunderstorms create their own feedback mechanisms. In some situations squall lines composed of several thunderstorm clouds interact with their environment to create meso-beta high and low pressure systems. When mesoscale highs and lows develop, they in turn affect the thunderstorms that created them.

"We think this is the main reason the organized severe convective type of thunderstorm system persists so long," Chappell says. "Squall lines may last six or more hours. The typical pattern is that warm moist air tends to accumulate in front of the squall line and forms a low pressure area at the surface while a high pressure area containing cool air from the thunderstorm downdraft forms behind the squall line. This configuration can increase the horizontal flow of low level moist air into the thunderstorm, enhancing the fuel supply for the storm."

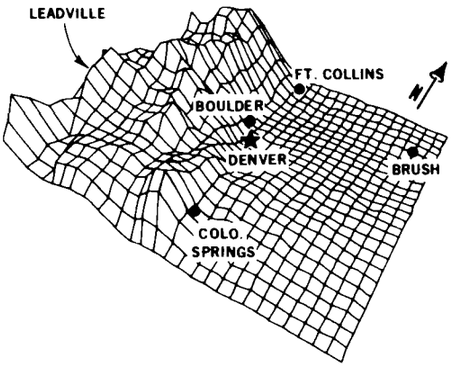
Until now scientists have not been able to construct mathematical models that can simulate effects of these squall lines in organized storms of this size.

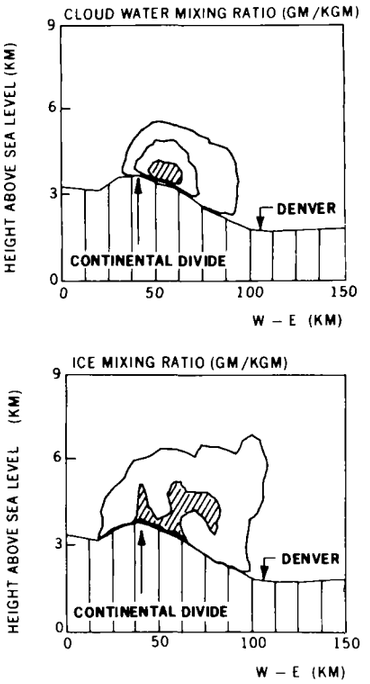
According to the NOAA scientists, no model used for daily weather forecasts at the present time gives the amount of unstable or convective-caused precipitation from thunderstorms, because the grid resolution of the computer models is much too coarse to resolve the relatively small scale convective weather systems and because there are not enough weather observations available. The larger computer model grid points are approximately 200 kilometers apart while the grid points in Fritsch's model are separated by only 20 kilometers. The scheme which Fritsch developed for including the effects of thunderstorms eventually will be put into a more comprehensive mesoscale model evolving under the guidance of Dr. Everett C. Nickerson and Elemer Magaziner of the same laboratory.

Numerical models now used routinely by the National Weather Service show considerable skill in 12- to 48-hour forecasts of large-scale weather disturbances such as hurricanes or other storm systems covering a large region of the country. However, heavy precipitation, tornadoes, and damaging thunderstorm winds often occur over a much smaller area and are therefore not directly resolvable by the large scale numerical models.

"Synoptic scale predictions of wind, temperature, moisture, and pressure fields do not in themselves indicate the occurrence of severe weather in a given locality, but their structure may indicate to an experienced person the likelihood of such occurrence", Nickerson explains. "Detailed forecasts for specific areas make use of information contained in the fields of large scale air flow, moisture supply and atmospheric stability as well as local climatological information."

Nickerson's mesoscale model is three-dimensional and able to simulate cloud formation and dissipation and the intricacies of air-flow patterns over mountainous terrain. Chappell and another APCL colleague,





Using three-dimensional, computer-generated models of mountainous terrain (top) ERL scientists can estimate how much snow a passing storm should leave over a mountain area. When meteorological information about a certain area is fed into the model, the computer generates a variety of maps. Top map is a vertical cross-section of the Rockies showing early development of a cold cloud and the formation of ice crystals (slashed area). As the simulated meteorological conditions advance through time, a more fully developed cold cloud (bottom map) forms over the area.

David R. Smith, have considerably expanded the capability of the model by developing and testing a cold cloud microphysical package. When weather data from a particular mountain area are fed into the model, the computer calculates when a cold cloud develops, ice crystals form, snow begins to fall, and finally, how much snow accumulates, and where.

At present, the NOAA scientists are attempting to demonstrate that the model is capable of satisfactorily simulating the significant snowfall features of a particular geographic location.

"A site with well-defined patterns in the winds, precipitation, and cloud cover can provide many opportunities for comparison between model results and meteorological data from a specific area," Chappell explains. "We currently are testing the model with weather data from the Boulder-Denver Front Range area of the Colorado Rockies to determine how well the model can predict snowfall over this complex terrain."

The numerical model is an imaginary box 250 kilometers (155 miles) on a side, with terrain forming the bottom of the box. To simulate the actual environment the NOAA scientists "prime" the model by introducing initial weather conditions consisting of moisture, temperature, and wind profiles. In the Boulder-Denver case, the winds blow from the northeast and hit the foothills, causing the air mass to rise and form clouds and precipitation. Locations of cloud formation and snowfall are determined by the shape of the mountains in the area, and the nature of the wind flow. A graphic display permits the scientists to view the model's progress at any point during the simulation.

After validating the model using Boulder-Denver area meteorological information, Chappell and his colleagues plan to run the model using data representing weather conditions in the San Juan mountain area of Southwest Colorado near Wolf Creek Pass, and in California's Sierra Nevada mountains upwind of Lake Tahoe in cooperative projects with the Interior Department's Bureau of Reclamation. Such model results are particularly useful for planning weather modification programs because the three-dimensional model can simulate the effects of cloud seeding before an actual field demonstration is carried out.

"For example, we can first run the model for a specific location with meteorological data representing natural snowfall conditions, then rerun the model, adding cloud seeding effects to determine what the outcome would be", Chappell explains.

"Until now meteorologists have had only one- and two-dimensional mathematical models of these processes available. Those models could not satisfactorily predict the extent or distribution of the effects of cloud seeding over mountainous terrain."

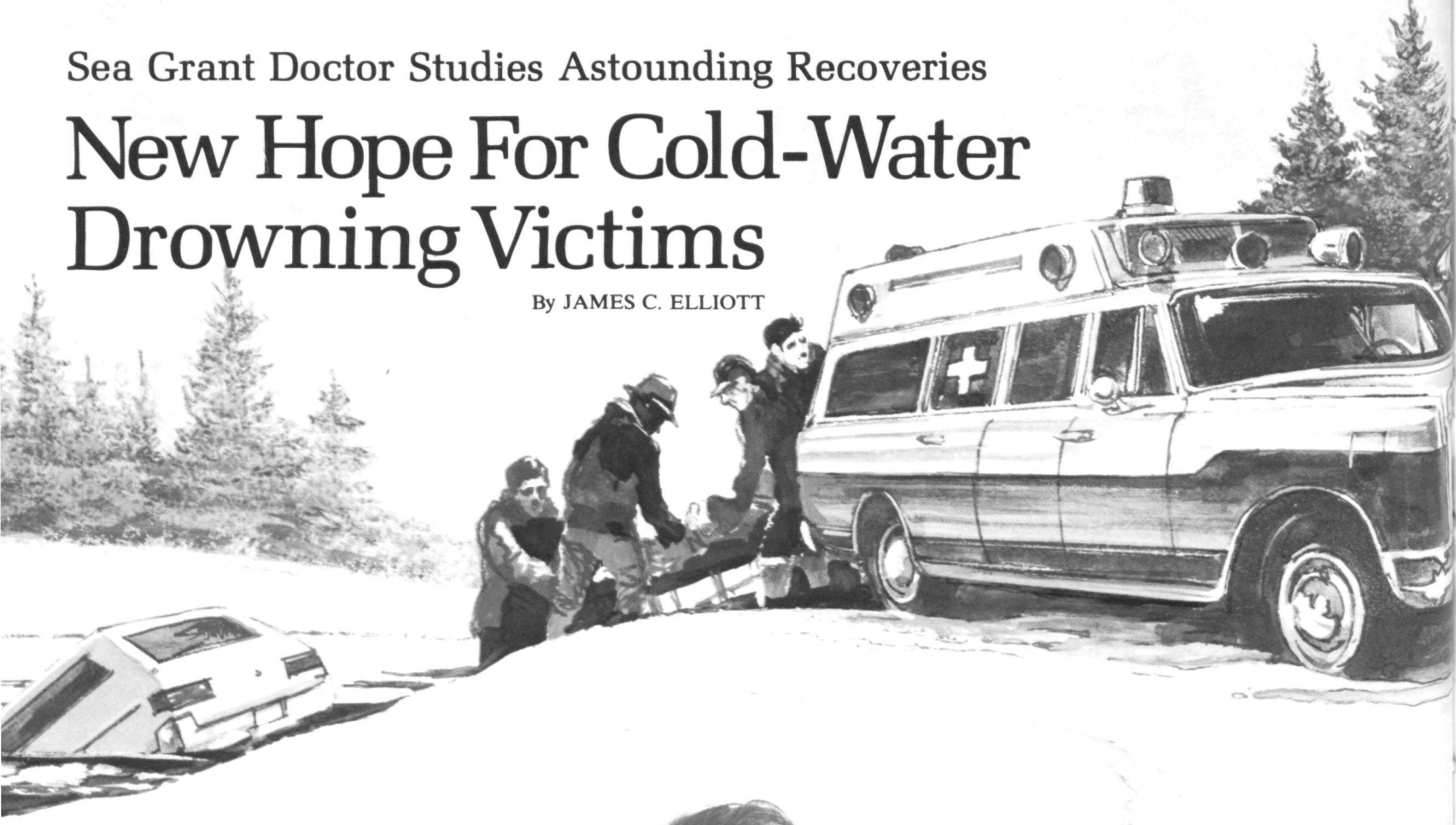
The model gives the NOAA scientists a powerful tool to assess the magnitude of downwind or extra area effects of a weather modification program. Using the model to study complex airflow patterns over mountains, the researchers can also determine where cloud-seeding generators should be installed and the resulting snow that would accumulate.

While the newly developed computer model of these processes adds no moisture to the earth, its potential as a research tool holds important implications. With such three- dimensional models, scientists will be able to estimate how much snow a passing storm should leave in a mountain area, and apply the versatile model to designing and evaluating weather modification experiments. Models such as these give NOAA scientists a chance to test their ideas before trying them in the harsh laboratory of the atmosphere.

Sea Grant Doctor Studies Astounding Recoveries

New Hope For Cold-Water Drowning Victims

By JAMES C. ELLIOTT



WHEN RESCUERS pulled Brian Cunningham from the car in which he had been submerged in a frozen Michigan pond for nearly 40 minutes, they had no intention of trying to revive the 18-year-old student. After all, the theory goes: stay submerged in water for four minutes, and the brain is irreversibly damaged.

There was no reason to believe that was not the case with Cunningham. Except that as the rescuers were placing him into the hearse, they heard him give a slight belch. And in spite of the fact that he had no pulse, his breathing had stopped, and his eyes were fixed, in a dilated stare, the rescuers began aggressive resuscitation efforts, which they continued throughout the highspeed ambulance ride to the hospital. Two hours of cardiopulmonary resuscitation and 13 hours of breathing assistance later, Cunningham regained consciousness. He not only had no brain damage, but he returned to classes at Jackson Community College where he maintained a 3.2 grade average.

Cunningham's story is unusual, but not unique. Through research sponsored by the National Oceanic and Atmospheric Administration's Sea Grant Program, Dr. Martin J. Nemiroff has documented about a dozen cases in which persons have been recovered from cold water and survived.

Dr. Nemiroff, 36, is a lung disease and diving medicine specialist at the University of Michigan. He has studied more than 60 drownings and near drowings in Michigan waters over the past two years. Of 15 victims rescued after a minimum of four minutes from chilly waters (under 70°F.), two died of lung infections and two suffered brain damage. But 11, including Cunningham and a physician who has successfully returned to his medical practice after a submersion of 15 minutes, survived without long-term injury.

Dr. Martin Nemiroff

The reason, suggests Dr. Nemiroff, is a combination of coldness, which lowers the body's requirement for oxygen, and a bodily response known as the "mammalian diving reflex."

The physician's findings offer new hope for Americans and for others around the world who might share the frightening, but ultimately gratifying experience of beating the four minute limit. Because of the importance of the findings and the promise they hold for mankind, here's a transcript, in part, of an interview with Dr. Nemiroff:

Q: Dr. Nemiroff, you and your colleagues have reported very interesting facts concerning what we might call "victims of near drownings." Would you tell us some of your findings?

A: Yes. We have studied drownings since 1968 and have seen victims who have had some survivability removed from the water and in some cases pronounced dead at the scene. We felt that there was an increased survivability, particularly in cold water — cold water near-drowings. We resuscitated some of these victims and they had an excellent response.

Q: What do you mean by survivability?

A: We find that some of our patients have a death-like appearance. They're cold. They're blue. They're not breathing and, to the layman, they look like they're dead. We have very aggressively resuscitated these victims — in some cases up to two hours — and had some survivals, particularly cold water recoveries.

Q: What makes you choose the person to resuscitate for two hours? Is there some physical evidence that you can tell that they are not dead?

A: This is the crux of our research. We are looking for early prognostic factors in near drowning victims. What will suggest that they are not going to have permanent damage? What is going to suggest that there is some survivability? Early studies showed that some patients, particularly youngsters, have a better chance of survival, particularly with very cold water submersion.

Q: Now, was there something that was evident to the rescuer at that time that the child was not dead?

A: No. In one case, it was by accident and, in another case, it was because the mother desired to try and save her child. The two-year-old child was found floating in a local lake in March. The mother was given the infant cold, blue, and lifeless. She began mouth-to-mouth resuscitation and closed chest compression and brought the child to the hospital in that state. The child recovered very nicely and was in the hospital for only 24 hours. It seemed to have no permanent brain damage.

Q: What is closed chest compression?

A: It is another way of saying pressing rhythmically on the breast bone to circulate blood to the body, at the same time or intermittently giving breaths of air into the mouth.

Q: Is that taught in First Aid courses?

A: That's a standard First Aid technique that's taught by the Heart Association, by the American Red Cross and other resuscitation-minded organizations.

Q: Now, what saves some of these children and doesn't save others? What's the crucial factor for survival here?

A: We believe the crucial factors are first the coldness of the water — water colder than 70°F is important in conserving oxygen and making the body use less oxygen. The other factor we feel is operating is the mammalian diving reflex.

Q: What exactly is the mammalian diving reflex?

A: Mammalian diving reflex was first outlined in the 1930's and proven in seals, whales, and other air-breathing aquatic mammals. They are able to go under water and spend 10, 15, 20 minutes and, in some emergencies, up to 30 minutes under water without suffering any damage. The reflex itself is stimulated by the cold water which sends messages to the brain. It stops the breathing and then starts redistributing the blood flow from the skin, the muscle, the gut, and other tissues that are not necessarily affected by low oxygen levels and sends the blood to the heart, the lungs, and the brain.

Q: Do all diving mammals have this reflex?

A: All diving mammals have this reflex to some extent. In man, it seems to be less active than in diving mammals. Man is a non-diving, air-breathing mammal but in some diving mammals, particularly seals and whales, this is highly developed.

Q: Do all humans have the reflex?

A: I believe that all humans have this reflex very shortly after birth and then as they grow older and older the reflex becomes less and less active.

Q: At what age is the reflex most likely to occur?

A: From our studies, we believe the reflex becomes less and less active in the later teens and probably is not very well demonstrated in middle age or older.

Q: In young children, is it most likely to occur?

A: We belived that it is most active in the 1- and 2-year-old age group.

Q: Is it more likely in males or females?

A: I don't believe there is a difference. No.

Q: Now, at what temperature are most swimming pools kept? Above 70° aren't they?

A: Most swimming pools are above 70°.

Q: So where is this most applicable?

A: This is most applicable in cold water areas, northern climate in the United States. I suppose most of the year in Northern States the water temperatures 1 or 2 feet below the surface are less than 70°F.

Q: So that the colder the water, in a sense if it were 50°, do you feel that it is more likely the mammalian diving reflex would happen?

A: Yes. I believe that very cold water, for example, ice water, makes the reflex quite active.

Q: Do you have a case which demonstrates that?

A: We believe one of the cases in our series demonstrates some effects, protective effects, of the diving reflex. This was a young man who drove his car onto a thinly ice-covered pond and submerged. He was under water a documented 38 to 40 minutes and ended up inhaling water and being "drowned." He was pronounced dead at the scene. He was cold; he was blue; he had no vital signs — no life signs present. As he was being carried into a hearse, he gave an agonal belch of air, and the people at the scene thought that he might be alive and started mouth-to-mouth rescue breathing and standard chest compression, which were continued for 20 minutes enroute to the hospital.

Q: Now what is an agonal belch? Is it what we traditionally think of as a death gasp?

A: Well, I believe that it is gas that remains in the airway and particularly in the stomach. When you press on the stomach you are liable to have a belch of gas. Not necessarily a death gasp, but people who are freshly "drowned" or who are recently deceased, may have gas remaining in their system, and if you press in the right place gas will come out.

Q: Does this agonal gas develop before the person is dead?

A: No. I believe this is post-mortem, following death.

Q: But since he gave it then was that an indication that he was freshly "dead" or able to be revived or what?

A: The only indication was that there was gas in his system somewhere that came out and made a sound. He was then given very aggressive resuscitation. It lasted 2 hours, and he eventually survived.

Q: What about his brain? Is it intact today?

A: Yes. He regained consciousness 16 hours after the submersion and eventually left the hospital after a two-week hospitalization. He returned to college, got excellent grades, and is now, I understand, helping his father in his construction business.

Q: Isn't it traditionally believed that if the brain is deprived of oxygen for more than 4 minutes that irreversible brain damage is a result?

A: I believe that is the current teaching. But our studies suggest that under special circumstances, where cold water submersion is involved, survivals with longer submersion are possible.

Q: It is only for cold water that oxygen deprivation can lead to survival?

A: I believe it is the cold water and the mammalian diving reflex acting together that has changed some of our thinking about length of time of submersion and survival. Yes.

Q: Would you explain a little bit more about the oxygen circulating in the brain during the mammalian diving reflex?

A: Well, during certain periods where the body is presented with low oxygen, there are reflexes that take place that help the body not to suffer permanent damage. This is very highly developed in the newborn because that is part of the birth process — that there is low oxygen level. If the newborn child was not able to stand periods where there is low oxygen, we would have a very poor survival rate of normal mammalian births. So, in the infant this is very highly developed, and they can get along for periods with low oxygen levels during birth without suffering permanent brain damage.

Q: Is this during the actual process of birth you are talking about?

A: This is during the actual process of birth and shortly after. The reflexes are very similar to the diving reflex that I have described, and this is one of the protective mechanisms that is built into human beings to enable them to survive better.

Q: What do you recommend to people who are faced with a drowning emergency?

A: What we recommend in a drowning emergency is: if the patient has been under water for a short period of time, we recommend a very aggressive resuscitation; if there is evidence that the patient has been under water for longer than an hour, half a day or day our findings are not helpful, and we would not resuscitate the patient. But, basically, in a cold water submersion — somebody in water colder than 70° who had been under water for example up to 30 minutes, we feel that there is an excellent chance of survival and complete recovery with very aggressive, immediate resuscitation and rescue breathing.

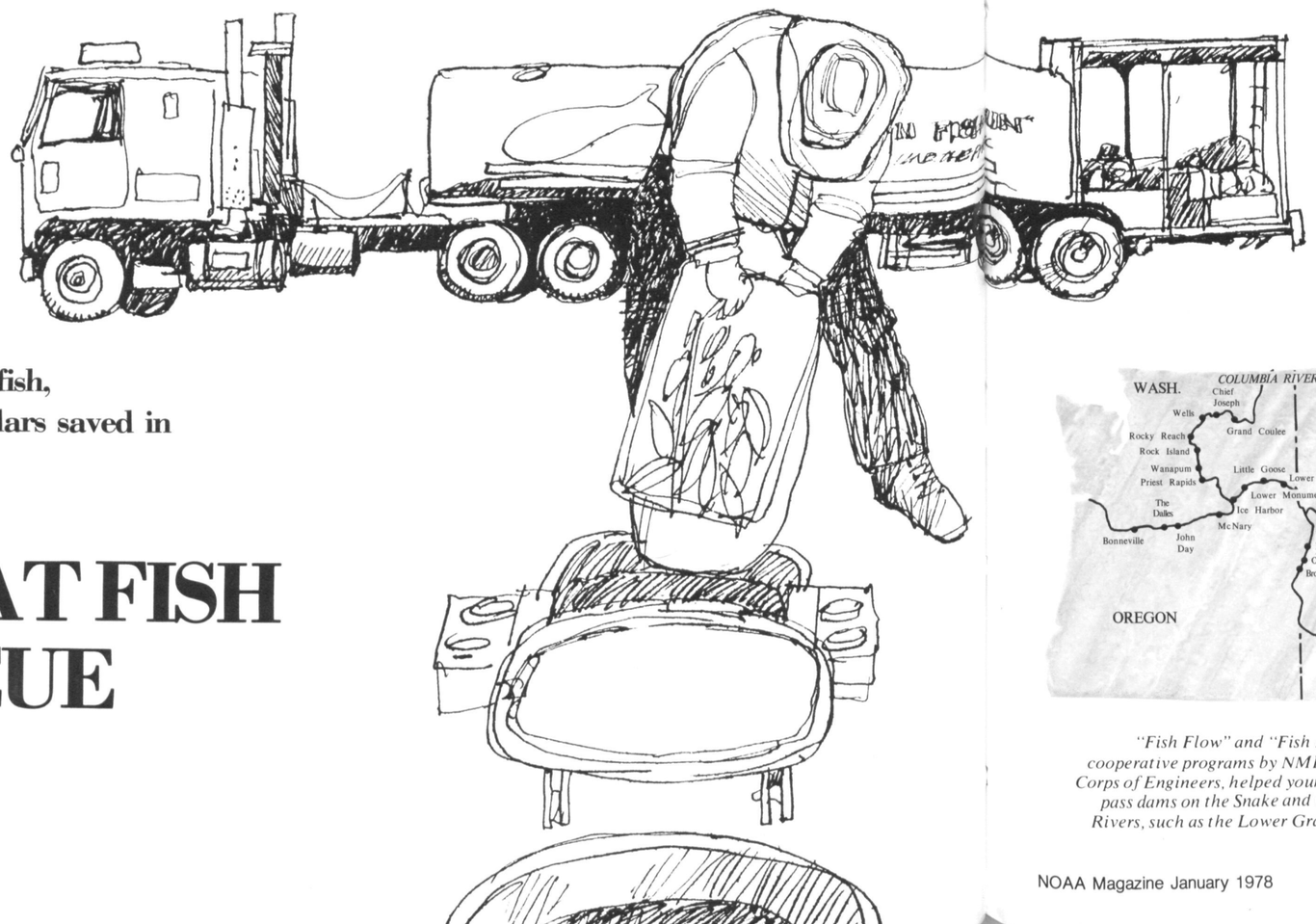
Q: By aggressive resuscitation you mean closed chest massage and mouth-to-mouth resuscitation?

A: By aggressive resuscitation, I mean closed chest massage and mouth-to-mouth breathing. These have to be done continuously both until the patient is seen in a hospital, is seen by a physician and recovers or is pronounced dead. □

Thousands of fish, millions of dollars saved in

THE GREAT FISH RESCUE

By HAL ALABASTER



THE Pacific Northwest Drought of 1977 might have killed an entire generation of salmon and steelhead from the Snake River — but it didn't.

The turbines of power generating dams on the Columbia River, working to ease the energy shortage, might have produced similar damage — but they didn't.

"Fish Flow 1977" and "Fish Haul 1977," cooperative efforts of the National Marine Fisheries Service, the Army Corps of Engineers, the Bonneville Power Administration, and other fisheries agencies prevented the virtual extinction of several races of fish passing down the two rivers, through the world's largest coordinated hydroelectric system, on their annual trek to the Pacific Ocean.

There was ample evidence to forewarn the various agencies concerned. During 1973, a year of low water flow, but still more than expected in 1977, approximately 93 percent of the young salmon and steelhead migrating south were killed.

Wesley J. Ebel, Director of the Coastal Zone and Estuarine Studies Division of the National Marine Fisheries Service's Northwest and Alaska Fisheries Center, said, "Two separate but related factors accounted for the 1973 disaster. First, the reduced spilling of water over the dams forced many of the young smolts to proceed downstream through the turbines." He added, "Many were killed outright, while others were injured or stunned and perished a short time later."

"Second," he said, "with water movement reduced, the young fish spent more time in the reservoir areas between dams." This delay resulted in increased deaths from predator fish, whose numbers had increased because of the more favorable conditions existing in the lake-like environment created by the reservoirs of the many dams on the Snake River and Columbia Rivers."

Consequently, "Fish Flow 1977" was developed to protect juvenile fish migrating down the Columbia River. The plan called for increasing the size of the flow to speed fish movement through the reservoirs, and the selective spilling of water over dams to reduce the numbers of fish killed. This required weeks of consultation and coordination between energy, fisheries, and water management specialists. They represented private and governmental agencies involved in resource management. Those efforts produced a plan which affected energy production least while providing increased protection for the endangered fish.

Concurrently, "Fish Haul 1977," under the leadership of Donn Park, Northwest and Alaska Center, was planned for the protection for young fish moving down the Snake River. No special flows were planned for that river. Rather, fish biologists from the National Marine Fisheries Service and experts from the U.S. Army Corps of Engineers developed a plan to collect virtually all the young salmon and steelhead heading south, load them either into barges or trucks, and transport them around the threatening turbines and slack water reservoirs.

Plans for both operations were completed in early April 1977. By mid-April, signs indicated the amount of water available to flow down the river for power would reach a record low. On May 1, the Columbia River Forecast Office advised the amount of water at The Dalles, Oregon, had been reduced to only 54,000,000 acre feet, the lowest in recorded history.

In comparison, the amount in 1973, a disastrous year for all fish, had fallen to just a slight bit over 71,000,000 acre feet. The previous record low had been in 1944 when the amount available fell to a little more than 60,000,000 acre feet. And so the plans to save the fish were put into effect without delay.

Gerald E. Monan, Deputy to Ebel, said "The overall movement of the fish down the Columbia, was conducted in three phases." "The first," he explained, "involved the span of the river involving five dams; the Well, Rocky Reach, Rocky Island, Wanapum and Priest Rapids. The second stretch ecompassed two dams, the McNary and John Day. The final segment included The Dalles and Bonneville, the last dams on the river. Different flow rates and spill levels were developed for each portion of the river."

The release of water on the Columbia River also involved three separate steps; the initial release of water, the duration of the flow, and the termination of the release. Each action had to be carefully coordinated and synchronized with the actions of the young fish themselves.

During the entire operation, the exact location and the numbers of fish were monitored at several sites. Howard Raymon of the Northwest and Alaska Fisheries Center was responsible for overall coordination and the provision of recommendations to the Corps of Engineers element at Reservoir Control.

The Corps then was responsible to insure sufficient releases of water from reservoirs upstream to provide the needed water movement, and spills at the dams downriver. It also kept project elements advised of the precise amount of water to be released and the length of time the release would last.

Water was spilled for only a few hours each day. This was done when the young fish were present in large enough numbers to make it most efficient. This routine provided for staggered spills which matched the movement of the fish, and also provided for maximum river flows during daylight hours. This moved the young fish through the reservoirs quickly with a minimum exposure to the older predatory fish.

At night, the flow through the turbines was held to a minimum, to enhance the effect of spilling the fish over the dam into the next section of the river.

Two other characteristics of the river flow were also coordinated. First, the regular flow of the river was occasionally increased to insure that the speed and volume of the river was sufficient to move the fish during each phase of the operation. Second, the water used to move the fish was used to produce power. The power production effort was coordinated by the Bonneville Power Administration with users through exchanges of power. Thermal power plants use river water for cooling. The shut-down of those plants, for maintenance purposes and other reasons, was coordinated into the overall scheme of water control.

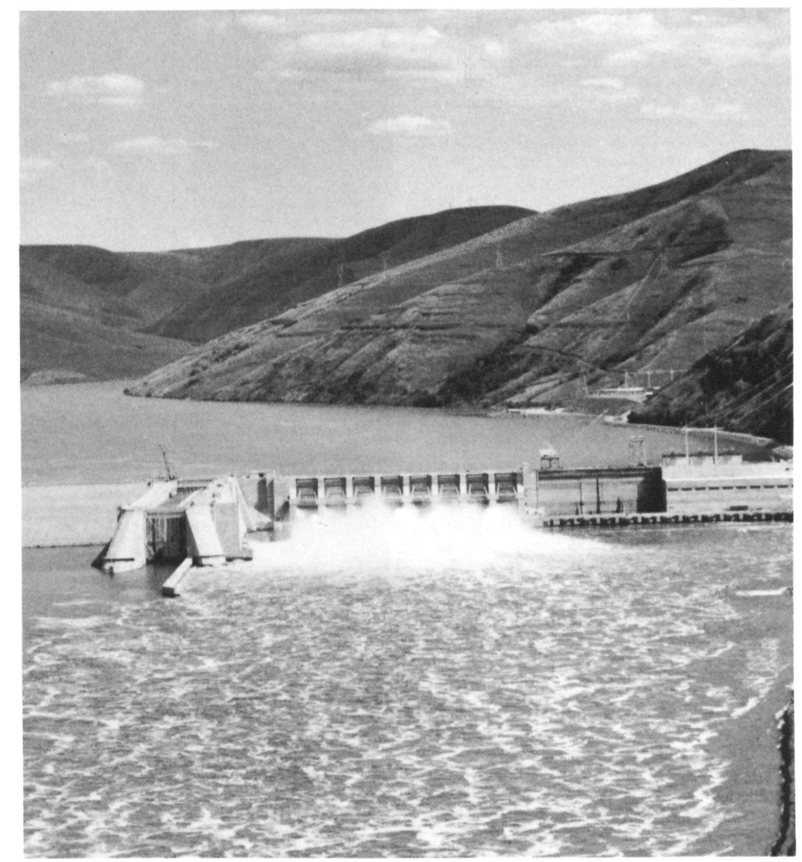
In the first segment of the river, that portion involving the Wells, Rocky Reach, and Rocky Island Dams, fish biologists from local public utility districts and the State of Washington kept track of the passage of the fish. Using sonic arrays, and some netting, they were able to evaluate the effect of each spill. They also marked some 2500 fish each week at Rocky Reach Dam. This provided a means of timing the groups as they proceeded downstream.

The movement of fish past the remaining six dams was monitored by the Northwest and Alaska Fisheries Center.

By marking fish collected from the turbine intake gatewells of each dam, and releasing them at key locations, the biologists were able to make decisions on the proper timing of each step in the process. This also provided a means to measure the ultimate success of the operation.

One of the more significant findings was that considerably less spill than anticipated was required to move fish successfully past a dam.

Through the use of a scanning sonar, Carl Simms of the Northwest and Alaska Fisheries



"Fish Flow" and "Fish Haul 77," cooperative programs by NMFS and the Corps of Engineers, helped young fish bypass dams on the Snake and Columbia Rivers, such as the Lower Granite Dam (right).

Center, was able to verify that it took only one to two hours of spilling, in conjunction with the sequential stopping of individual turbines at dusk, to move most of the day's gathering of young fish out of the area immediately behind the McNary and John Day Dams.

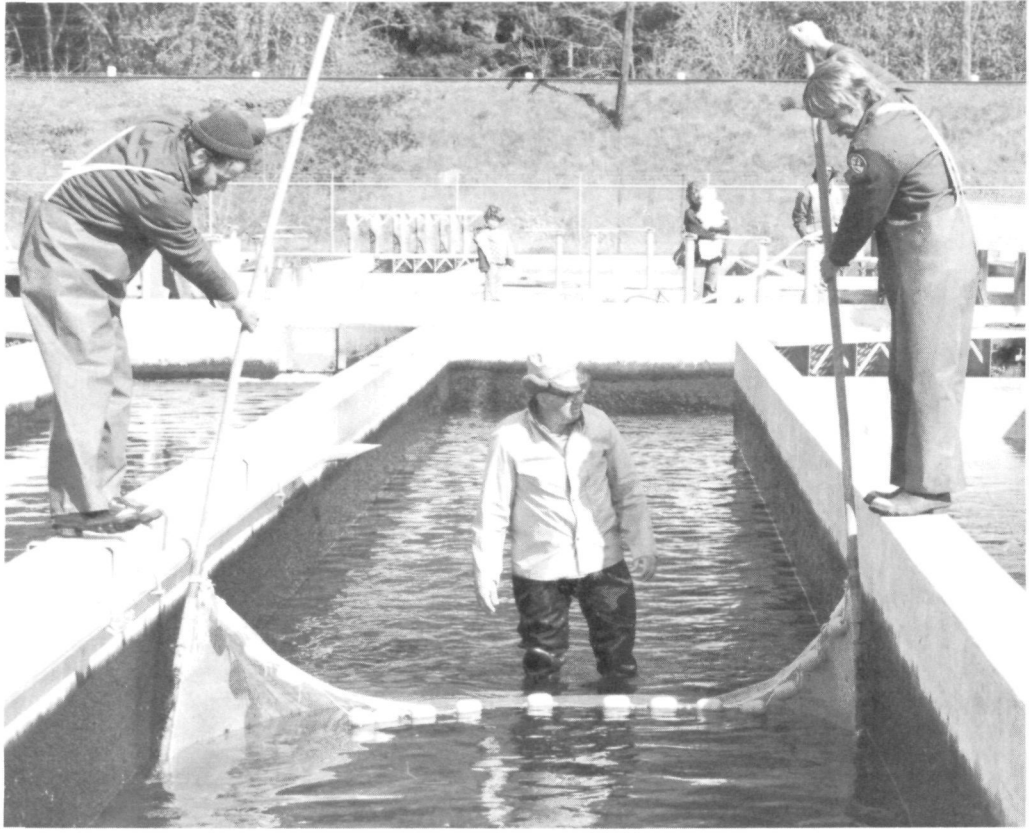
Simms said, "In most cases, the day's accumulation of fish moved over the spillway in 45 minutes. By observing the sonar, we determined there was very little additional accumulation of fish during the remainder of the night, since the fish had stopped upstream."

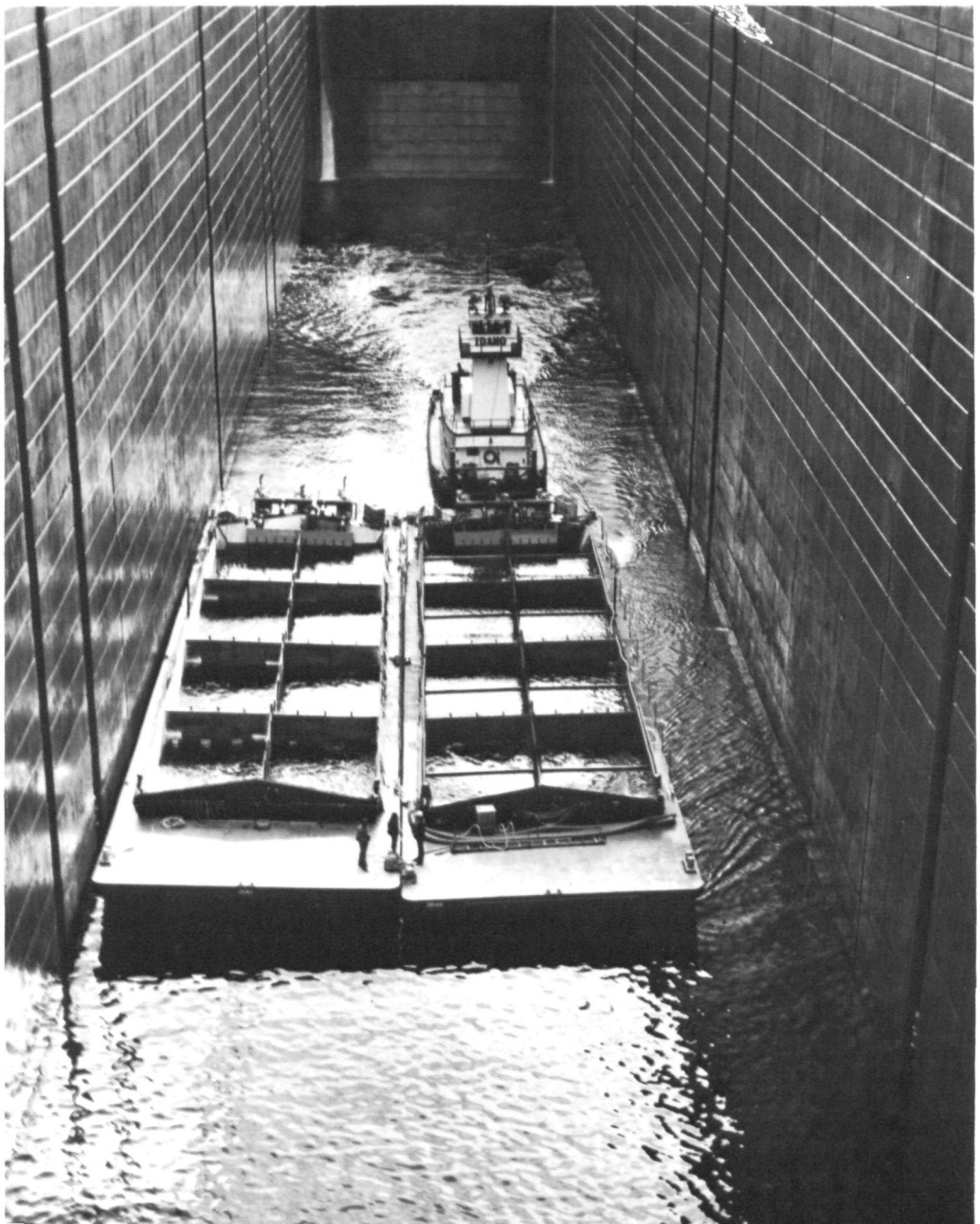
Employment of this technique at McNary, John Day, and Dalles Dams resulted in only 71 percent of the total water allotted for the spill being used.

"Fish Flow 1977" lasted from early May through the latter part of June. Fish biologists were later able to determine that the increased flow of water, and the specially controlled spills over the individual dams, did enhance the survival rate of the fish involved. The estimate is that 29 percent lived — three times the rate that would have occurred without the operation.

"Fish Haul 1977," the second element of the overall effort to save the fish runs, was the largest operation of its kind in history. The National Marine Fisheries Service and the Corps of Engineers ran that project cooperatively, using trucks and, for the first time, barges.

Their objective was to collect the small fish originating in the Snake River Basin and safely move as many as possible around the dams, with a minimum objective of 80 percent.





NMFS staffers load young fish onto truck for trip downstream (above) bypassing power turbines and low water on the Columbia River. Hatchery personnel from NMFS net young salmon (right above); specially designed barge moves young salmon through Snake River lock (right).

Summary of Fishery Benefits

	Thousands of adult fish estimated to return from the 1977 outmigration	Value (millions of dollars)
With "Fish Flow 1977"	1006 to 1070	$25.3 to 28.2
With no action	674 to 703	16.6 to 18.2
Net Benefit	332 to 367	8.7 to 10.0
With "Fish Haul 1977"	68 to 107	4.7 to 7.4
With no hauling	9 to 12	.7 to .9
Net Benefit	59 to 95	4.0 to 6.5
Combined Net Benefits	391 to 462	12.7 to 16.5

Survival Between Projects of Mid-Columbia River Juvenile Salmonids in Percent of the Number Leaving the Upstream Projects

Species	Pt. of Origin To Priest Rapids	Priest Rapids to McNary	McNary to The Dalles	Pt. of Origin to The Dalles
Chinook	67	67	67	29
Steelhead	75	65	33	16
Coho	67	27	67	13
Sockeye	67	63	68	29
All species	67	61	67	27

The first indication of the low run-off on the Snake River, and the need for special measures, occurred in February 1977. Again, using the low run-off of 1973 as the baseline for planning, NMFS biologists estimated 5 million chinook salmon and 5 million steelhead trout would have to be transported. These fish would be collected at the Lower Granite and Loose Goose Dams. However, only eight trucks were available for this purpose, six locally and the Idaho Department of Fish and Game could possibly provide two more. Biologists estimated that number could haul only 60 percent of the total fish to be moved around the dams.

The Corps of Engineers, advised of the need for additional hauling capacity, located and funded the modification of two large barges to fill the gap. The life system for the fish was designed by Cliff Long of the Northwest and Alaska Fisheries Center and the Corps. Both of the 750-ton barges were 147 feet long with two 110 by 14 foot raceways, holding nearly 55,000 gallons of water. Pumps provided for river water to be sent through the holding tanks at the rate of 5,000 gallons per minute. An additional feature provided for a closed recirculating system, with oxygen, if needed. These barges could provide transportation for as many as 500,000 salmon or 350,000 steelhead, from Lower Granite Dam to release points in the Lower Columbia, in about 32 hours.

They were first tested in early April, using young fish from Spring Creek National Fish Hatchery.

The initial 50,000 fish were released below the Bonneville Dam without difficulty. A second, large-scale effort, took place in mid-April. Again, using salmon from the Spring Creek Hatchery, 2 million Fall Chinook Salmon were carried down the river and released in excellent condition, below Bonneville Dam. The system worked. It was put into full operation on April 20, 1977.

Initially, some 400,000 juveniles, about one year old, were taken from the Kooskia National Fish Hatchery. These were moved from Lewiston, Idaho, down the river avoiding a total of eight dams. Approximately 35 hours later, they were released.

The barges were then placed on standby, to be used whenever the trucks could not meet transportation needs.

They were used again, in early May, when one barge carried 220,000 steelhead down the Clear Water Arm of the Lower Granite Reservoir. The other transported an additional 200,000 collected at the Lower Granite Dam. Both began the trip, down the river, on May 7 and the fish were released below Bonneville Dam on May 8. Subsequent to the May 5 operation, the further migration of young fish was delayed by the lower run-off.

The amount of fish remaining to be collected was then within the capability of the trucks. The barges were again held on standby.

The success of the effort will not be completely known for some years. A sampling of the fish from each group transported was marked with coded wire tags, and other permanent marks. They will return in from one to three years; then evaluation will be possible. It will be done at the lower Granite Dam, in the spawning grounds, and finally at the hatcheries. A separate, marked, control group was released normally in the river to provide a basis for comparison.

"Fish Flow 1977" and "Fish Haul 1977" were designed and implemented to overcome the record low run-off from the Columbia and Snake Rivers. However, the future use of water from both rivers, for the generation of hydroelectric power and other purposes, will present a continuing serious problem.

What was abnormal for 1977 will, in the years immediately ahead, become normal. The time is near at hand when all the water from both rivers will flow through the power generating turbines even in years of normal run-off.

Ebel commented on "an exciting possibility evolving from the barging. In the future," he said, "we may be able to transport fish directly from the hatchery. A major concern would be the loss of homing or 'imprinting' information. One possible solution may be to pause en route downstream, and permit water with local characteristics to flow through the barge for periods up to 24 hours. "This," he said, "could give the fish the necessary cues to find their way back to the hatchery."

This was, in fact, tried during the 1977 operation. As a test, fish being moved from the Dworshak and Kooskia Hatcheries were held in the Clearwater River in the barges for 24 hours. During that time, water was pumped through the raceways. To test the effect of this experiment, special groups of fish were tagged and released, both at the hatcheries and after being transported below the Bonneville Dam. The return of adults from those groups will give some insight into the potential of this technique.

Regarding the benefits of fish flow, Howard Raymond estimated, "The minimum benefit from Fish Flow 1977 will be the 332,000 to 367,000 adult fish that returned from the 1977 run." He added, "That number of fish would have a dollar value from $8.7 to $10 million dollars."

As to what would have happened without Fish Flow 1977, he said, "It is difficult to assign a dollar value to a race of fish lost forever." Donn Park estimated that Fish Haul 1977 will enable "from 68,000 to over 100,000 adult fish to return to the Columbia River. Without the transportation program, 90 to 95 percent of the fish would have perished, and we would have had a return of only 11,000 adults," he said. "It is questionable," he concluded, "that such a small number could serve to maintain the run on that river."

In his assessment of the project, Gerald E. Monan said, "I would estimate the combined benefit, from both elements, to be in the neighborhood of from $12.7 to $26.5 million dollars. That is based on the expected run between 390,000 to 462,000 adult fish." Monan compared those benefits to the cost of the project, which was from $3.2 to $9.4 million dollars.

The water used for Fish Flow 1977 was also used to produce power. Excess power, through cooperative agreements, was sent to other users, for return at a later time. It is expected that all such power will be returned. This will permit the recovering of about half a million acre feet of water in the reservoirs. Thus the net loss will be approximately .23 million acre feet. This amount represents about .002 percent of the total load of the entire system.

It will not be difficult, in the future, to place a value on the continued presence of the salmon and steelhead runs on the Columbia and Snake Rivers. The commercial fishing industry of the Pacific Northwest will continue to exist. Sports fishermen will continue to enjoy the benefits of the project for many years to come. □

Five Men in a Boat

(to say nothing of the dog)

On the fifth floor of the Mendel Rivers Federal Building in Charleston, S.C., Lt. Stanley C. Iwamoto, one of the 381 commissioned officers of the NOAA Corps, met with Willard Mizzell, an engineering draftsman with the U.S. Army Corps of Engineers. The two talked about the National Ocean Survey's hydrographic project and the Corps' request to locate a submerged navigational hazard north of the bridge over the Ashley River.

"This is almost bank to bank," said Iwamoto pointing to a Corps of Engineers map on the wall. "Dredge is here. Everything looks good and clean."

"You'll run into a lot of debris near shore," said Mizzell. "We also have a shoal down there."

"No controls on the map," said Iwamoto. "Just soundings."

The two had been discussing the project for several minutes when Iwamoto asked how the Corps of Engineers was alerted to the possible underwater hazard.

"We had a notice from a construction company about an obstruction 100 feet out of the channel," said Mizzell. "When a shipping firm starts inquiring why they can't get into the dock, we start dredging."

"We'll go out tomorrow," said Iwamoto who picked up his charts from the table.

"That should be pretty interesting — bank to bank," said Mizzell walking Iwamoto to the elevator.

The next morning Iwamoto and his crew of four met at the NOAA trailer parked at the sprawling Charleston Naval Base.

"This party," he said, "is set up for unusually narrow rivers and inlets. We use an electronic-visual control, the Del Norte Ranger and a Wild T-2 — all surveyor's instruments. Our data is sent to Norfolk on field plotting sheets where it is computerized and then sent to Rockville. From the time we get the data to the time it's put on a National Ocean Survey chart, it has been checked at least 10 times."

Iwamoto joined the NOAA Corps in July 1974 after graduating from the University of Washington with a B.S. degree in Geology. While attending the University, he also obtained Patches, an intelligent dog of equal parts (more or less) of labrador and beagle.

Assigned to the Atlantic Hydrographic Party at NOAA's Atlantic Marine Center, Norfolk, Va., Iwamoto was placed in charge of Launch 1260, a 28-foot Monarch containing such survey equipment as an echo sounder and special instruments for fixing launch positions. He had previously served two years aboard the 231-foot survey ship Mt Mitchell.

A steady, quiet boat, with a top speed of about 12 knots, Launch 1260 was trailered to Charleston's Cooper River where an intensive hydrographic survey was to be conducted during most of 1977 to provide new survey data for the maintenance of existing marine charts. The crew included Lloyd C. Gilden,

Photos: John Roseborough

Robert Snow, David B. Elliott, and Thomas B. Finn. Patches was also aboard.

One of the best harbors of refuge on the South Atlantic coast, Charleston Harbor is 264 miles southwest of Cape Hatteras and 65 miles northeast of the Savannah River. It is the main waterway to South Carolina's largest city, Charleston, built at the confluence of the Cooper and Ashley Rivers. Since colonial times, the city has been a center of a rich agricultural district for which it is the distributing point. Other than the fact that Charleston is the home of an enormous U.S. Navy base, numerous manufacturing plants are also in and near the city, creating still another dimension to its seagoing commerce.

Along the west bank of the Cooper River are Union Pier, Del Monte Banana Co. Wharf, Columbus Street Terminal, Exxon Tanker Wharf and Barge Dock, Hess Chemical Wharf, British Petroleum Co. Wharf, Shell Oil Co. Wharf, Texaco Wharf, Phillips Petroleum Co. Marine Dock, Westvaco Corp. Wharf, and the North Charleston Terminal.

The survey was divided into two projects. The first, which began last March, included the Cooper River north of Charleston to a point where it forks into east and west branches known as "The Tee"; the second part started in October and covered a two mile area above the mouth of the Cooper River, Shipyard Creek, and Drum Island where Gulf Oil, and Airco Alloys and Carbide Co. maintain wharves for the import of petroleum products, ore and coke, and for the shipment of ferro-alloys.

Stressing data quality over quantity, Iwamoto said the supplemental horizontal control established to support survey operations would be to "Third-Order, Class I accuracy" meaning that the measurements would vary to the degree of about 1 foot in 2 miles. The survey also would delineate a minimum of a 4-foot curve inshore.

Inside the trailer next to the door, a piece of driftwood found by Robert Snow on the mud flats of the upper Cooper River was mounted on a plaque on which was printed "National Ocean Survey." The driftwood, polished until it gleamed a dark mahogany color, resembled a sea lion's head. It overlooked the lighted drafting table where Tom Finn, Dave Elliott, Lloyd Gilden, and Iwamoto were determining on the charts the actual parameters of the hydro survey scheduled for that day. The field plotting sheets for the previous day's work to locate a sunken wreck were being checked by Snow.

It had been futile effort. The day was clear and the river calm. Finn sped quietly away from the dock in the snubnosed Boston Whaler, the 25 hp Evinrude purring like a kitten. He turned the small boat from the channel and headed across the Cooper toward a Coast Guard range marker about 150 feet from the opposite shore where a radio transmitter had been set up. There he would climb the pilings to a platform where he would use a theodolite to turn an angle from a known object to assist in the location of the sunken wreck. By using the distance and angle data, the depth at a given position could be determined.

"It's a p.d.," said Iwamoto, meaning position doubtful. "All we can do now is to run a closely spaced scheme of lines in the vicinity of the unrecorded wreck to prove or disprove whether the wreck is still there."

Iwamoto turned in the coxswain chair and said, "Put out 30 feet of chain." This was the device used to snag underwater obstructions. Elliott and Snow moved to the storage compartment near the boat's stern and removed the chain. Slowly, it was dropped overboard.

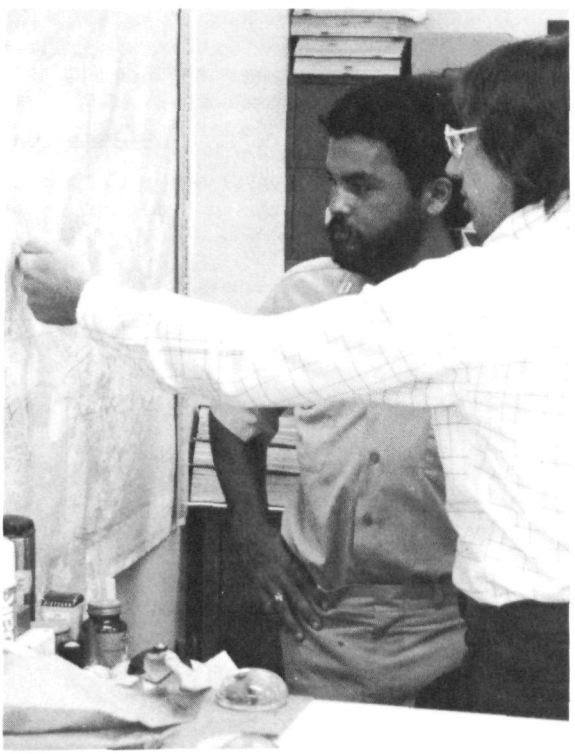
"Stand by," said Iwamoto. "Mark." The weaving, synchronized with Finn atop the pilings, began as the launch slowed from its standard hydro speed of 2000 rpms to 1500 rpms and, on a plotted course, moved like a needle over the area where the wreck had been reported.

"1317," said Snow reading the distance in meters on the Decca/ Trisponder.

"6859," came in Finn on the handi-talkie aloft on the pilings near shore.

"6859," repeated Gilden plotting the position of the boat on the chart. "Come right about. 1315, Mark."

"8227," said Finn. And the hydro talk continued with only the numbers and the time changing as the boat moved back and forth.



Willard Mizzell (above), a draftsman with the U.S. Army Corps of Engineers in Charleston, S.C., shows Lt. Stanley C. Iwamoto the approximate location of an underwater obstruction in the Ashley River. At NOAA's Atlantic Marine Center in Norfolk, Va., Cdr. Charles H. Nixon (left), Lt. Cdr. William R. Daniels and James Shay check the project's operational requirements.

Lloyd C. Gilden had been with the National Ocean Survey for 29 years, and with its field parties since 1961. For the past 4 1/2 years he and his wife had lived in a 32-foot Yellowstone, enjoying a most unique life — independent yet secure, fulfilling in knowing that his work was beneficial to thousands of persons, their safety and their jobs.

"Shorty" Gilden knew his job well. As the launch's senior survey tech, he plotted, diagrammed, and verified all obstructions on the chart. When he joined the Coast Survey in Mobile, Alabama, he was moved to Texas, and then to Lake Meade, Nevada, where he used the fathometer to run levels for the contour of the lake, a 17-month project that required three launches.

It was Shorty who said, "On a hydro launch, everyone must know the other person's job." And Shorty could do them all, and get a 'well done.'

"Let's have a bar check," said Iwamoto as he idled the boat's engine. He wanted to be certain of the accuracy of the fathometer.

Gilden and Snow moved to the stern where a long chain which looked like a ladder was dropped over the side. "Down," said Snow.

"15," said Elliott who remained at the fathometer.

"Down," "20," "Down," "25," "Down," "30."

The bar was lowered in five foot lengths until 45 feet were out, and all measurements had been verified on the fathometer.

"Bring it in," said Iwamoto. And it was brought back up in the same manner. "The last time this river was surveyed bank to bank was 1933. In those days, they used lead lines to determine the depth and sextants to fix their positions, but electronics have changed that."

Snow has logged in 12 years with National Ocean Survey, 4 years as a member of this

Survey Tech Lloyd C. Gilden (upper left) plots the boat's position while Iwamoto (above right-center) shows Elliott (right) and Tom Finn (left) how to adjust a sextant. Gilden, Elliott and Robert Snow, field party engineer, remove snagged debris aboard Launch 1260.

Tech Aid David Elliott (right) crosses the Cooper River in the Boston Whaler to set up his survey equipment (above) on a U.S. Coast Guard range marker.

field party. His wife and four-year-old son live in a mobile home close to the Charleston Naval Base where the launch is docked.

Snow began his work for the Survey in the engine room on the NOAA Ship Whiting, a 163-foot hydrographic survey vessel whose home port was the Atlantic Marine Center. He became a junior engineer, and then a field party engineer (Class V) on which has been tacked "Survey Tech."

"We were running a trackline when the storm hit," said Snow as he described one of his more exciting moments at sea. "We were off Cape Hatteras, and doing 42 degree rolls. We rode out the storm, and then headed for Norfolk."

Snow later read where the U.S. nuclear submarine Scorpion had been lost in the Atlantic near the Azores with 99 aboard during that storm on May 21, 1968. "I've seen some crazy things," he said.

The search for the sunken wreck ended with a snagged crab trap, unmarked and festooned with barnacles. The bottom of the Cooper River has been changing since the 1930s, when the new Santee-Cooper hydroelectric dam some 60 miles northwest of Charleston included the diversion of portions of the Santee River into the Cooper River. Since then, Charleston harbor has experienced increased silting. Coupled with submerged pilings, sunken wrecks, and discarded Navy equipment, the Cooper River survey for navigational hazards was important to everyone — from a carrier admiral to a weekend yachtsman. Patches sniffed at the trap in which a lone crab had found a home. Over the side; Launch 1260 would return another day.

The Charleston Naval Base provides NOAA with mooring facilities at a dock that appears more like a marina for private yachts than those used by the minesweepers, destroyers, and other large naval craft. The dock also is used by the U.S. Coast Guard which had recently brought in two British West Indies yachts, one of which was a sleek sailing vessel in the $100,000 plus range; the other, a 45-foot, deep-sea fishing boat. The two vessels were now U.S. property — seized by Federal officials while in the act of smuggling.

Gilden secures a mooring line as Launch 1260 prepares for another day on the Cooper River.

David Elliott, of Virginia Beach, Va., was the youngest member of Launch 1260. He had joined as a Tech/ Aid at Ocean City, Md., August 31 where the launch had been working on a hydro survey from Chincoteague, Va., to Cape May, N.J.

"Always liked the water," he said. "And I like moving around." He had heard about NOAA from his next door neighbor who worked at the Atlantic Marine Center. Familiar with the essentials of survey work from his previous job in land surveying, he was at Ocean City at the right time.

"One of the nicest things," said Elliott, "is that I don't have any ties."

"Whenever a new man comes on," said Snow, "we always try to teach him all the jobs."

One of the jobs Elliott readily assumed, however, was cooking for Iwamoto and Finn in a house the three bachelors had rented near the Naval Base. Although Elliott acknowledged that Iwamoto was a master of Oriental cuisine, he deferred his appraisal on the lieutenant's preparation of American food. "My favorite is roast beef," he said. "I make good gravy."

"His chicken and dumplings are good, too," said Iwamoto.

Launch 1260 headed down the Cooper River on behalf of the U.S. Corps of Engineers request to locate an underwater hazard. It was a grey November morning, and a chilly northwest wind had begun to blow, reminding Iwamoto and his crew that winter was on its way to Charleston. The lieutenant was at the controls.

"Hat overboard," was the cry from the stern. Moving his boat with the utmost skill, Iwamoto quickly brought the boat around and along side the floating hat which was hooked by Finn who gave it to Elliott. The boat continued on its way, passing Charleston's Battery Park behind which could be seen some of the most beautiful and historical homes on the American continent. The storied steeple of St. Michael's Episcopal Church disappeared soon after the launch turned up the Ashley River.

"The people in Charleston," said Snow, "believe that the waters from the Ashley and Cooper rivers form the Atlantic Ocean."

The launch passed under a bridge on which the roar of the morning traffic seemed momentarily to disturb Patches. Quietly, he moved back into the corner where Snow worked. "Visual hydro like this," said Snow, "makes it difficult to judge your distance from shore, especially if you want to run back and forth, 50 meters apart."

"Where are we?" asked Elliott who had taken control of the launch when Iwamoto went topside to verify the position of a radio tower which would be used in the survey plot scheme.

"Check fix," said Snow.

"9411," said Finn at the fathometer.

Gilden, who remained at the chart table, said, "Come off shore a little bit. You're right on the line you just ran."

"You want to split your third and fourth line," said Snow to Elliott. "You were on your second line."

"Come off shore a little more," said Iwamoto from above.

"Isn't there a radio tower down there?" asked Gilden.

"I see that," said Elliott. "It's straight ahead."

"Standby. Mark," said Snow.

"5828," said Iwamoto.

"9739," said Finn marking the fathometer.

"That's right," said Gilden.

"Have you picked up anything?" asked Iwamoto.

"Not yet."

"Let's run one where the railroad trestle goes across," said Iwamoto. "From shore to shore."

The moment had come. It was to be bank to bank.

"I just don't want to run ashore," said Elliott to no one in particular.

"It's like a regular hydro," said Snow. "Go in close."

"You all ready?" asked Elliott.

"Standby . . . Mark," said Snow.

"Watch the front of the trestle with the background trees," said Iwamoto.

"Stand by. Mark."

Slowly, Launch 1260 progressed across the Ashley River until she went aground in one foot of water. On deck, Iwamoto gave a forward signal with his hand, and Elliott threw more power into the engine. The grinding noise of the aluminum hull on the mud flat was deafening.

"Can't push the bow around," said Elliott whereupon Iwamoto ordered everybody on the bow.

"Reverse," said Iwamoto. "More, more power."

"This was an easy one," said Elliott as the launch slid back into deep water. "We got off quick."

"Hat overboard!" It was Gilden's. Patches, on deck during the excitement, barked for the first time. But nine more lines, bank-to-bank, were to be run before lunch.

Tom Finn had joined the hydro party in September. Like Elliott, he was from Virginia Beach; and he was young and looking for a challenge after graduation from college. His father was a commander in the Navy, and he grew up traveling much of the time which gave him a worldly reserve that became even more subdued when he talked about his girl friend who was attending the University of Virginia. Friendly yet quiet, Finn complemented the personality of the crew which worked as a single unit.

It was late in the afternoon, and the crew of Launch 1260 had been dragging the chain for several hours.

"We got it this time. Right on the edge of the channel."

"Stand by. Mark."

"8010."

"7214."

"You got it, hoss." □

Sea Fare

South for the Winter

For winter-weary readers, Sea Fare offers a gustatory trip to the Southland for a potpourri of delectable fish and shellfish dishes.

These delicious and nutritious recipes are from "A Seafood Heritage, From the Rappahannock to the Rio Grande," third of a three-volume set of heritage cookbooks published by the National Marine Fisheries Education Center.

Pompano En Papillote

2 pounds pompano fillets or other fish fillets, fresh or frozen
1 can (6½ or 7 ounces) crabmeat, drained, flaked and cartilage removed
¼ pound cooked, peeled, and deveined shrimp, fresh or frozen
3 cups water
1 teaspoon salt
2 lemon slices
1 bay leaf
⅛ teaspoon dried thyme leaves, crushed
Parchment or brown paper
2 tablespoons cooking oil
½ cup chopped green onion
1 clove garlic, minced
2 tablespoons margarine or butter
3 tablespoons all-purpose flour
¼ teaspoon salt
2 slightly beaten egg yolks
3 tablespoons dry white wine

Thaw fish if frozen. Chop shrimp. In 10-inch fry pan bring water, 1 teaspoon salt, lemon, bay leaf, and thyme to a boil. Add fish, cover, and simmer for about 10 minutes or until fish flakes easily when tested with a fork. Carefully remove fish. Reserve stock. Strain stock, reserving 1½ cups. Remove skin and bones from fish. Cut 6 pieces parchment or brown paper into heart shapes about 10 x 12 inches each. Brush paper with oil. Place one fillet on half of each paper heart. In saucepan melt margarine. Add onion and garlic and cook until tender. Blend in flour and ¼ teaspoon salt. Add reserved stock. Cook stirring constantly, until thickened. Gradually stir small amount of hot mixture into egg yolks, add to remaining sauce, stirring constantly. Heat just until mixture thickens. Stir in wine, crabmeat, and shrimp. Heat. Spoon about ½ cup sauce over each fillet. Fold other half of each paper heart over fillet to form individual cases. Seal, starting at top of heart, by turning edges up and folding, twisting tip of heart to hold case closed. Place cases in shallow baking pan. Bake in a hot oven, 400°F for 10 to 15 minutes To serve, cut cases open with X design on top; fold back each segment. Makes 6 servings.

Outer Banks Stuffed Spanish Mackerel

3 to 4 pounds dressed Spanish mackerel or other dressed fish, fresh or frozen
1 ½ teaspoon salt
¼ teaspoon pepper
Vegetable stuffing
2 tablespoons melted margarine or butter

Thaw fish if frozen. Clean, wash, and dry fish. Sprinkle inside and outside with salt and pepper. Place fish on a well-greased bake-and-serve platter 18 x 13 inches. Stuff fish; brush with margarine. Bake in a moderate oven, 350° F., for 30 to 45 minues or until fish flakes easily when tested with a fork. Makes 6 servings.

Vegetable Stuffing

½ cup margarine or butter
1 ½ cups chopped onion
1 cup chopped celery
1 cup chopped fresh mushrooms
½ cup chopped green pepper
1 clove garlic, minced
2 tomatoes, peeled, seeded, and chopped
3 cups soft bread crumbs
½ teaspoon salt

In saucepan, melt margarine. Add onion, celery, muchrooms, green pepper, and garlic; cover and cook until tender. Combine all ingredients and mix well. Makes 3½ cups stuffing.

Pickled Rock Shrimp

2 pounds cooked, peeled, and deveined rock shrimp or other shrimp, fresh or frozen
½ cup salad oil
½ cup lime juice
½ cup sliced onion
6 lemon slices
1 tablespoons capers with liquid
1 tablespoon chopped parsley
½ teaspoon salt
½ teaspoon dried dillweed
⅛ teaspoon liquid hot pepper sauce

Thaw shrimp if frozen. Combine remaining ingredients. Pour marinade over shrimp; toss lightly. Cover and chill several hours, stirring occasionally. Drain. Makes approximately 60 to 70 hors d'oeuvres.

Note: This may be served on salad greens as an appetizer. Makes 12 to 15 appetizer servings.

Fried Catfish, Arkansas Style

6 skinned, pan-dressed catfish or other pan-dressed fish, fresh or frozen (½ to ¾ pound each)
2 teaspoons salt
¼ teaspoon pepper
2 eggs, beaten
2 tablespoons milk
2 cups cornmeal
Fat for frying

Thaw fish if frozen. Sprinkle both sides with salt and pepper. Combine eggs and milk. Dip fish in egg mixture and roll in cornmeal. Place fish in a heavy fry pan which contains about ⅛ inch melted fat, hot but not smoking. Fry at a moderate heat. When fish is brown on one side, turn carefully and brown the other side. Cooking time is about 10 minutes, depending on thickness of the fish. Drain on absorbent paper. Serve immediately on a hot platter, plain or with a sauce. Makes 6 servings.
Note: Traditionally, Fried Catfish is served with coleslaw and hush puppies. Catfish steaks may also be used in this receipe.

Hush Puppies

1½ cups cornmeal
½ cups sifted all-purpose flour
2½ teaspoons baking powder
½ teaspoon salt
¼ cup finely chopped onion
1 egg, beaten
½ cup milk
Fat for deep frying

Sift dry ingredients together. Add remaining ingredients and stir only until blended. Drop by tablespoons into deep fat, 350° F., for 3 to 4 minutes or until brown. Drain on absorbent paper. Makes 18 hush puppies.

Oyster Loaf

1 pint oysters, standards, fresh or frozen
½ teaspoon salt
⅛ teaspoon pepper
2 eggs, beaten
¼ cup milk
¾ cup all-purpose flour
2 cups soft bread crumbs
½ cup melted margarine or butter
2 loaves French bread, 15 inches long and 3 inches wide
Fat for deep frying
½ cup tartar sauce
1½ cups shredded lettuce
18 thin tomato slices

Thaw oysters if frozen. Drain oysters; dry between absorbent paper. Sprinkle with salt and pepper. Combine eggs and milk. Roll oysters in flour, dip into egg mixture, then roll in bread crumbs to coat evenly. Refrigerate at least 30 minutes to firm coating. Slice bread loaves in half horizontally. Pull out the inside soft crumb from bottom and top halves of bread. Brush the bread shells inside with melted margarine. Place bread shells on baking sheet and bake in a moderate oven, 350° F., 3 to 5 minutes to warm and crisp. Place oysters in a single layer in a fry basket. Fry in deep fat, 350° F., for 2 to 3 minutes. Drain on abosrbent paper. Spread inside of bread shells with tartar sauce. Place shredded lettuce in the bottom halves of the loaves Arrange tomato slices on lettuce, and fried oysters on top of the tomatoes. Cover with top halves of the loaves of bread. Cut each loaf in 3 portions. Makes 6 servings.

Mullet Mobile

2 pounds mullet fish or other fish fillets, fresh or frozen
2 tablespoons melted margarine or butter
1 teaspoon salt
⅛ teaspoon pepper
Paprika
Hollandaise Sauce or Bearnaise Sauce

Thaw fish if frozen. Cut fish into 6 portions. Place fish in a single layer, skin side down, on a well-greased baking pan. 15 x 10 x 1 inches. Brush with margarine and sprinkle with salt, pepper, and paprika. Broil about 4 inches from source of heat for 10 to 15 minutes or until fish flakes easily when tested with a fork. Fish need not be turned during broiling. Serve with Hollandaise or Bearnaise Sauce. Makes 6 servings.

Blender Hollandaise Sauce

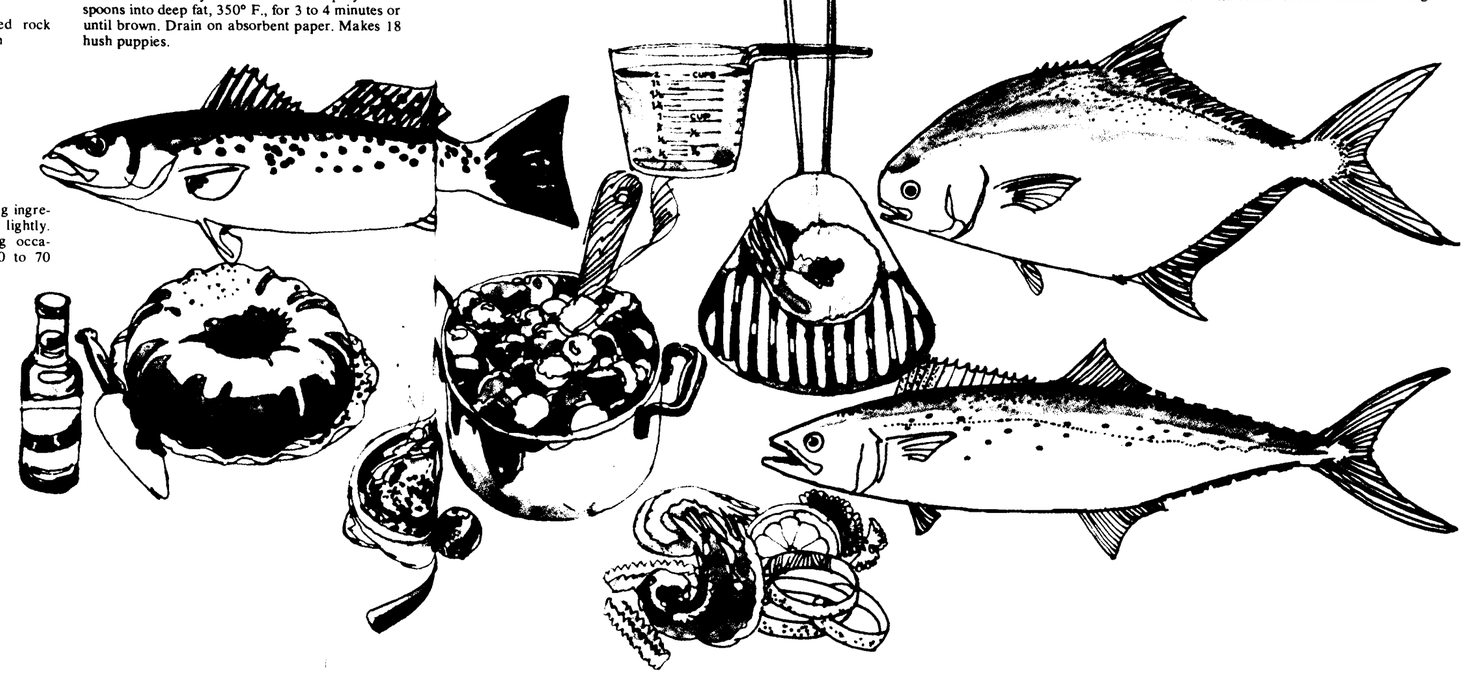
3 egg yolks
2 tablespoons lemon juice
Dash cayenne pepper
½ cup margarine or butter

Place egg yolks, lemon juice, and cayenne pepper in blender container. Cover; quickly turn blender on and off. Heat margarine until melted and almost boiling. Turn blender on high speed; slowly pour in margarine, blending until thick and fluffy, about 30 seconds. Heat over warm, not hot, water until ready to serve. Makes 1 cup sauce.

Gulf Courtbouillon

2 pounds red drum fillets or steaks, or other fish fillets or steaks, fresh or frozen
⅓ cup margarine or butter
½ cup all-purpose flour
1 ½ cups chopped onion
1 cup chopped celery
½ cup chopped green onion
½ cup chopped green pepper
2 tablespoons chopped parsley
1 clove garlic, minced
2 cans (15 ounces each) tomato sauce with tomato bits
¾ cup dry red wine
2 tablespoons lemon juice
½ teaspoon salt
½ teaspoon dried thyme leaves, crushed
¼ teaspoon dried marjoram leaves, crushed
¼ teaspoon cayenne pepper
6 whole allspice
1 bay leaf
Lemon slices

Thaw fish if frozen. Remove skin and bones from fish. Cut fish into 6 portions. In a heavy 4 to 5 quart Dutch oven, heat oil, blend in flour. Cook, stirring constantly, over medium heat until light brown in color, about 10 minutes. Add onion, celery, green onion, green pepper, parsley, and garlic. Cover and cook 5 minutes or until tender. Gradually stir in tomato sauce. Add wine, lemon juice, salt, thyme, marjoram, cayenne, allspice, and bay leaf. Bring to a boil and simmer for 30 minutes. Add fish to courtbouillon. Cover and simmer 5 to 10 minutes or until fish flakes easily when tested with a fork. To serve, place portion of fish in soup bowl and pour about one cup sauce over fish. Garnish with lemon slices. Makes 6 servings.



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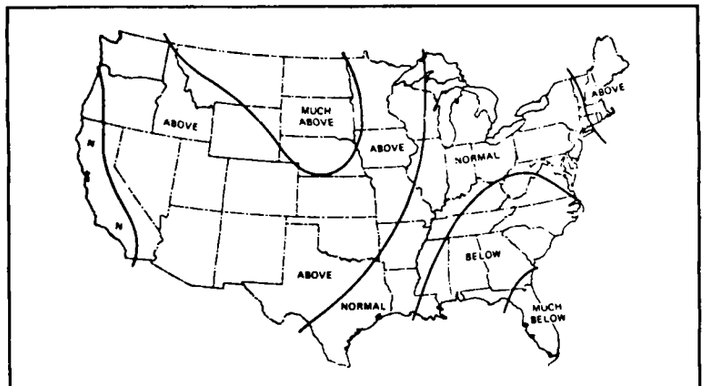
National Weather Service Issues Six Through Ten Day Outlooks

In December, the National Weather Service began issuing a new type of weather outlook for the period of six through ten days ahead.

The outlooks, first of their kind, help fill a gap between NWS's shorter-range forecasts, which extend out through five days ahead, and its long-range outlooks, which extend through 30 days for temperature and precipitation, and 90 days for temperature only.

The new outlooks were made possible in part by a computer model of the Earth's atmosphere designed by Lloyd W. Vanderman of the National Meteorological Center. Vanderman's model predicts winds and temperatures up to six miles high, as well as precipitation amounts. Because of the model's relative simplicity, it can produce sixth through tenth day outlooks in 90 minutes on one of the large, fast computers at the National Meteorological Center. James F. Andrews heads the new program as Chief of Medium Range Forecasting. The Weather Service's National Meteorological Center issues the new outlooks, in both map and narrative form, three times a week. Each issuance contains predictions of average temperature and precipitation for the five-day period beginning on the sixth day ahead and ending on the tenth.



This sample map shows how the new outlooks will be presented.

Predictions are for averages expected throughout the period, not for expected conditions on each individual day.

The new outlooks carry predictions for temperature in the following categories: much above normal, above normal, near normal, below normal, and much below normal. Predictions for precipitation are for above normal, near normal, below normal, or none.

Weather Service officials are planning to canvass a number of agencies to find a wide range of ways the new outlooks can be used. Already, a Weather Service study shows the following activities are good candidates, being especially weather-sensitive: Fishing, agriculture, air transport, forestry, construction, land and water transportation, energy use, health and safety, resources utilization, merchandising, water-supply planning, communications, recreation, and manufacturing.

CZM Grant Made For Grand Isle Water Project

A $798,618 grant to the State of Louisiana — the first construction grant to be made under the Coastal Energy Impact Program — through the Office of Coastal Zone Management, will provide a critically needed water supply facility on Grand Isle in Jefferson Parish.

"Grand Isle is both an extremely appealing recreational spot and an important base for energy production," said OCZM Director Robert W. Knecht. "The island's water supply is adequate to handle the town's permanent residents, but cannot meet the increased recreational demand because of the coastal energy activity. This situation is one that the Coastal Energy Impact Program was designed to alleviate."

Under the grant, land will be acquired, a million-gallon ground storage tank erected, and pumping, piping, and chlorinating facilities installed.

Nicaraguan Airline Uses GOES Data To Provide Smoother, Safer Flights

Passengers flying on a number of airlines between Miami, the Caribbean and South America can expect smoother flights in the days ahead because of the GOES-2 satellite and the imagination of Lineas Aeros Nicaragua — LANICA Airlines — personnel.

The satellite gives the airlines pictures of weather conditions, enabling them to avoid extreme weather, take advantage of beneficial winds, and generally provide more comfortable flights.

Already, LANICA is using the satellite imagery to, among other things, advise cabin attendants as to the best time to serve in-flight meals — when turbulence will be at a minimum.

Donald Gaby, manager of NOAA's Satellite Field Services Station in Miami, said his office is providing LANICA with two pictures from the Federal agency's GOES-2 satellite every hour.

"The combination of these two pictures every hour," Gaby said, "should add greatly to weather avoidance and passenger comfort. In addition, if needed, we can zoom in on a particular storm area to view it in greater detail or acquire a larger view of the entire western hemisphere."

Eleven Named To Fisheries Committees

Commerce Secretary Juanita M. Kreps has announced 11 appointments to the Marine Fisheries Advisory Committee.

Members of the Committee are chosen for recognized competence and proven interest in the marine fishery resources of the United States and are appointed by the Secretary for a term of three years. Approximately one-third of the Committee members are also selected to achieve both balanced geographical representation as well as a broad view of the U.S. commercial fishing industry, marine recreational fishing, the academic community, conservation interests, State governments and the consumer.

The new members are:

Henry J. Cofer, Jr., President, Rich-Sea Pak Corporation, St. Simons Island, Ga.; Dr. Charles H. W. Foster, Dean, School of Forestry and Environmental Studies, Yale University, New Haven Conn.; William C. Lunsford, Jr., Assistant Secretary, Zapata Haynie Corp., Towson, Md.; Fred Maly, Outdoor Editor, San Antonio Light, San Antonio, Tex.; Edward P. Manary, Manager, Washington State Commercial Passenger Fishing Vessel Association, Olympia, Wash.

Also, Dr. Stephen B. Mathews, Associate Professor, College of Fisheries, University of Washington, Seattle, Wash.; Ann McDuffie, Food Editor, the Tampa Tribune, Tampa, Fla.; Kathryn E. Poland, State Senator, Juneau, Alaska; Dr. Haakon Ragde, Seattle, Wash., a practicing physician; Dr. Dorothy F. Soule, Director, Harbors Environmental Project, Allan Hancock Foundation, University of Southern California, Los Angeles, Calif.; Christopher M. Weld, Sullivan & Worcester, attorneys, Boston, Mass.

20-Sided Make-It-Yourself 'Globe' Shows Quake Data for Years 1963-74

The EDS National Geophysical and Solar-Terrestrial Data Center, in Boulder, Colo., has prepared an icosahedron (20-sided) "globe" showing the distribution of earthquake epicenters of magnitude 4.5 and greater for the years 1963-74.

This four-color representation of the Earth is printed on heavy paper and can be folded to construct a useful desk device or ceiling hanging.

It has been received favorably by individual scientists and the national meetings of the Seismological Society of America and the American Geophysical Union.

Cartographers have used polyhedrons to represent the globe for hundreds of years. In the 1940's Irving Fischer designed a 20-sided globe made of equilateral triangles, and exhibited it at the Metropolitan Museum of Art in New York. In the particular projection he used, all great circles are straight lines on the facets. John Ward, a computer specialist at NGSDC programmed Fischer's construction, including also the code to plot geophysical data.

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Ocean Floor Burial Seen For Radioactive Wastes

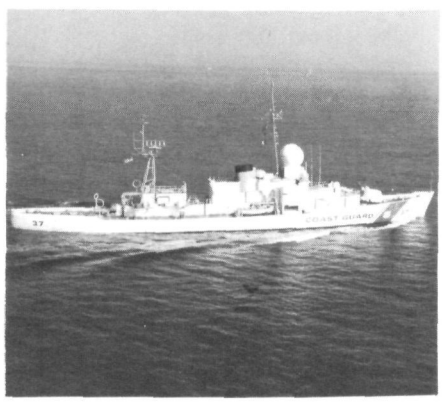
The possibility that radioactive wastes from nuclear power plants could be safely buried in cracks in the Atlantic Ocean floor should be explored further, according to Drs. Peter Rona of ERL's Atlantic Oceanographic and Meteorological Laboratory and Karl E. Turekian of Yale University.

As debate over a safe, permanent disposal site continues, radioactive wastes are accumulating in temporary repositories. The search for a safe site is difficult because a place must be found where the wastes can lie undisturbed for as long as 250,000 years. During that enormous span of time, no earthquake may jar them, living creatures cannot be exposed to them, and they must not be carried away by ocean currents or underground streams.

Plutonium sealed in canisters and dropped into fracture zones in the eastern Atlantic, suggest Turekian and Rona, might be buried by sediments. Should the canisters someday leak, the materials inside would be imprisoned by chemical processes in the deep-ocean sediments and water themselves.

Rona and Turekian believe fracture zones in the eastern Atlantic should be considered as such a place. Though more study is needed, say the two, what scientists now know of the geological, chemical, and oceanographic nature characteristics of the fractures suggests they might make a safe burial ground.

Unmanned Buoy Replaces Coast Guard Weather Ship



A huge unmanned data buoy replaced a ship at Ocean Station HOTEL on Sept. 30, and an era came to an end.

For 37 years, Coast Guard cutters carried out ocean weather patrols, providing vital links in the nation's weather network. The last of the weather ships — USCGC Taney — turned over its weather measuring and reporting to NOAA's EB-07.

Use of the big buoy will result in a savings to the taxpayer of about $3 million annually. In addition, the crew of 140 officers and enlisted men of the USCGC Taney were freed for other Coast Guard assignments. EB-07 will be on duty year round, as opposed to the nine-month coverage provided by the ships.

The buoy is a 40-foot diameter, 100-ton automated data collection platform, moored in 9,000 feet of water with a two-inch diameter nylon line. It reports wind speed and direction, barometric pressure, air and surface seawater temperatures, and wave height and periods. It is positioned about 230 miles off Cape May, N.J.

EB-07 was built by General Dynamics under contract to the NOAA Data Buoy Office, Bay St. Louis, Miss., a part of NOAA's Office of Ocean Engineering.

At least once every three hours, EB-07 will report its measurements to a shore receiving station, which will send them along to NWS for use in the next weather forecast.

In critical storm situations, when conditions are changing rapidly, NWS can command the buoy to provide hourly reports, so that hurricane and severe storm watchers can keep better track of what is happening at sea.

In 1978, the buoy will begin transmitting its data by satellite.

NOAA To Manage Bowhead Whale Stocks

NOAA has announced the formulation of an expanded NOAA research program on bowhead whales, and initiation of the development of a management and conservation regime of the bowhead whale stock.

These actions are in response to a decision by the State Department that the U.S. Government had decided not to present an objection at this time to the June action of the International Whaling Commission (IWC) removing the Alaskan Eskimo exemption for subsistence hunting for bowhead whales.

In addition, the Department of State stated that at a special meeting of the IWC in December the United States would work for Commission approval of a subsistence hunt by the Eskimos.

Such approval was obtained.

The major objective now is rapid development of a sound management and conservation regime in cooperation with the Eskimo communities involved in hunting for bowheads.

NOAA Administrator Richard A. Frank has voiced deep concern for the welfare and culture of the Eskimos. He added that the development of an adequate management and conservation regime would require the cooperation and efforts of other interested and affected parties — the Eskimos, the environmental community, and state governments.

Highest and Lowest Temperatures Given In Updated Booklet

The highest temperature ever officially observed in the United States was 134 degrees Fahrenheit at Greenland Ranch, Calif. The lowest, -79.8 degrees F., was observed at Prospect Creek Camp in the mountains of northern Alaska. These highest and lowest temperature statistics and those for the remaining 49 states are listed in the recently revised publication, *Temperature Extremes in the United States.*

Published by EDS' National Climatic Center, the booklet contains updated tables, listing by State the extreme temperature, date they occurred, and station name and elevation. The recorded temperature extremes depend on several factors: elevation, latitude, condition of the earth's surface, local effects of terrain, density of observational network, and length of observational record.

Greenland Ranch station is 178 feet below sea level and recorded the 134 degrees F. on July 10, 1913. The station is located in Death Valley which has the hottest summers in the Western Hemisphere, and is the only known place in the U.S. where nighttime temperatures sometimes remain above 100 degrees F.

Prospect Creek station is at 1,100 feet and recorded the -79.8 degrees F. on Jan 23, 1971. The lowest temperature ever recorded in the conterminous 48 States, -69.7 degrees F., was observed at Rogers Pass in Lewis and Clark County, Mont., on Jan. 20, 1954.

The booklet also lists some rapid temperature changes associated with hot downslope winds. For example, the temperature rose 49 degrees F. in 2 minutes at Spearfish, S. Dak., on Jan. 22, 1943. The change was from -4 degrees F. at 7:30 a.m. to 45 degrees F. at 7:32 a.m.

Two maps show the highest and lowest temperature and location for each State.

Copies of the booklet are available from National Climatic Center, Federal Building, Asheville, NC 28801.

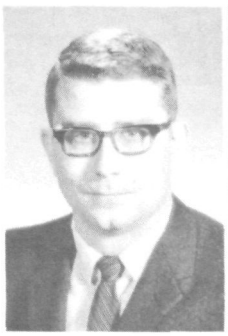
Computer-Produced Weather Mod List Prepared by EDS

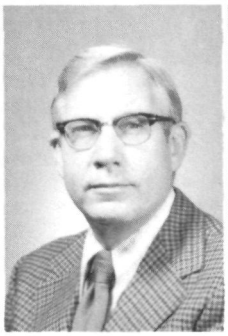
A new computer-produced bibliography, Weather Modification - Packaged Literature Search 77-1, has been published by the Library and Information Services Division of EDS' Environmental Science Information Center. The fourth in a series of packaged searches on high-interest topics, it contains almost 1,000 references to technical literature on topics such as cloud seeding, fog dissipation, lightning suppression, snow augmentation, and other aspects of weather modification and control.

Available free, the bibliography may be ordered from: the Library and Information Services Division, User Services Branch, Attn: R.R. Walter, D822, WSC-4, 6009 Executive Blvd., Rockville, Md., 20852 or by calling (301) 443-8330.

Weather Modification includes abstracts for many citations. It was produced from the Meteorological and Geoastrophysical Abstracts data base, which is automated with EDS support.

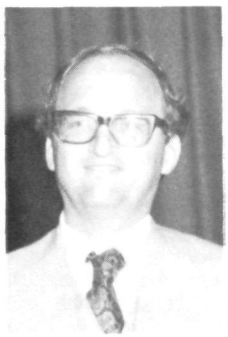
29 WIN GOLD, SILVER MEDAL AWARDS


Dr. Daniel L. Albritton


Bryon B. Phillips

Dr. Robert L. Edwards

Richard C. Hennemuth


Dr. John B. Hovermale

Richard L. McNeely

Jack H. Puerner

NOAA employees from a wide cross-section of NOAA agencies were winners this year of Department of Commerce Gold and Silver Medals, presented October 26 in a ceremony in Washington, D.C. Seven were Gold Medal winners and 22 won Silver Medals.

Department of Commerce Gold Medals — the highest award given by the Department — are for contributions for major significance to the Department, the Nation, or the world. Department of Commerce Silver Medals — Commerce's second highest award — are given for contributions of unusual value, including unusual courage or competence in an emergency.

This year's Gold Medal winners from NOAA are:

Dr. Daniel L. Albritton, physicist with ERL's Aeronomy Laboratory in Boulder, Colo., for his pioneering contribution to theoretical techniques and unique measurements of ion-molecule reaction rates in the ionosphere, 50 to 650 miles above the earth's surface. His work led to the first successful analysis of a quartet molecular band system and an experimental capability for measuring ion-molecule reaction rate constants over the ionospheric temperature range, the only such technique presently available.

Byron K. Phillips, chief of ERL's Instrumentation Task Force, Weather Modification Program Office, Boulder, Colo., for his work in advancing the technology needed for studying atmospheric and oceanographic phenomena. Through his efforts, NOAA's two P-3 Orions and one C-130 large, long-range aircraft were equipped to study hurricanes and severe convective storms, enabling ERL's Research Facilities Center in Miami Fla., to have the most advanced atmospheric research aircraft capability in the world.

Dr. Robert L. Edwards, National Marine Fisheries Service Director of the Northeast Fisheries Center, Woods Hole, Mass., for his part in a successful management/scientific team that contributed to the shaping of national and international policies and programs in fisheries research and management. Together with Richard C. Hennemuth, also a Gold Medal winner, he was responsible for promoting an understanding of the marine ecosystems, including joint, cooperative research with foreign countries.

Richard C, Hennemuth, National Marine Fisheries Service Director of the Woods Hole Laboratory, Northeast Fisheries Center, Woods Hole, Mass., was honored along with Dr. Edwards for work in marine ecosystems. The citation calls the research "... the finest examples of joint and useful studies in the world."

Dr. John B. Hovermale, chief of the Atmospheric Modeling Branch of NWS's National Meteorological Center, Camp Springs, Md., for spearheading development of a numerical (computer) model of hurricanes, making earlier protective response possible when U.S. coastlines are threatened by the massive storms.

Richard L. McNeely, supervisory research electronic engineer at NMFS's Northwest and Alaska Fisheries Center, Seattle, Wash., for leadership and contributions to fishing gear technology, sampling system development, and conservation engineering. One of his contributions is conservation of porpoises by introduction of new technology into the U.S. tropical tuna fishery.

Jack H. Puerner, chief of National Environmental Satellite Service's Special Projects Group, Camp Springs, Md., for his leadership in the creation of a system for collecting and relaying environmental data via satellite. Puerner is credited with the concept of using the GOES satellite to collect information sensed in remote areas by buoys, ships, river gauges, aircraft and other observing platforms and to relay the data to ground stations, a system which not only collects measurements but also gives early warning of conditions leading to natural disasters such as severe storms or flash floods.

Silver Medals were awarded to the following:

Ellis B. Burton, Meteorologist-in-Charge of WSFO Denver, Colo.

Robert K. DeLawder, manager of NOS's Chart Planning and Technology Group, Rockville, Md.,

Roland A. Finch, of NOAA's Office of Living Resources in Rockville, Md.

Frank V. Garcia, chief of NOS's Radio Facility Chart Branch, Rockville, Md.

Richard Haas, a computer expert at NWS's National Meteorological Center, Camp Springs, Md.

Dr. Harry F. Hawkins, Jr., a meterologist with ERL's National Hurricane and Experimental Meterology Laboratory, Coral Gables, Fla.

Steacy D. Hicks, physical oceanographer with NOS's Office of Marine Maps and Surveys, Rockville, Md.

David W. Holmes and **Robert W. Miller,** of National Weather Service Headquarters, Silver Spring, Md.

Jean T. Lee, ERL's National Severe Storms Laboratory Norman, Okla.

Barbara McLaughlin, chief of NOAA's Procurement, Grant and Loan Branch, Rockville, Md.

Maxwell M. Rogers, chief of NOS's Nautical Chart Branch, Rockville, Md.

Robert B. Rollins, NOS's Associate Director of Program Development and Management, Rockville, Md.

Howard S. Sears, a fishery research biologist of the NMFS's Northwest and Alaska Fisheries Center Auke Bay Fisheries Laboratory, Auke Bay, Alaska.

Dale Sirmans, a scientist with ERL's National Severe Storms Laboratory, Norman, Okla.,

Thomas J. Sokolowski, a geophysicist at NWS's Pacific Tsunami Warning Center.

Kendall L. Svendsen, EDS's National Geophysical and Solar Terrestrial Data Center, Boulder, Colo.

Raymond R. Waldman, Meteorologist-in-Charge of NWS's Chicago Weather Service Forecast Office, Chicago, Ill.,

Harold M. Woolf, NESS's Meteorological Satellite Laboratory, Camp Springs, Md.

Three Weather Service meteorologists — **Ronald E. Drummond,** WSO Beckley, W. Va., **Russell L. Durham,** WSFO Lousiville, Ky., and **Philip C. Zinn.** WSFO Charleston, W. Va.

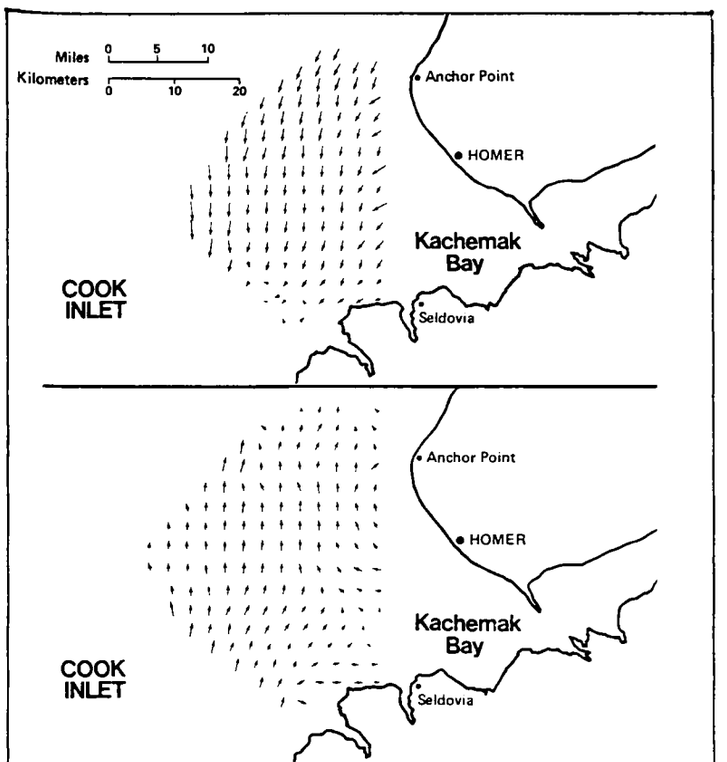
20-Year Veteran

Poor Is Oceanographer's CO

Capt George M. Poor has been appointed commanding officer of the NOAA Ship Oceanographer.

Poor has been with the Pacific Marine Environmental Laboratory since January 1974, working with the Puget Sound MESA (Marine EcoSystem Analysis) program. His sixth ship assignment since he joined the NOAA Corps in 1958, he commanded the USC & GS Ship Marmer in 1964-65 and the McArthur in 1972-74. Poor also served for three years at the Pacific Marine Center.

The 303-foot, 3800-ton Oceanographer is one of the world's best-equipped floating laboratories, commissioned in 1966. The NOS ship combines a full marine environmental research capability with automated engine room control and data acquisition systems; radio, radar and satellite navigation equipment; and a research-oriented arrangement of living quarters, laboratories and oceanographic work areas.



A novel radar system developed by NOAA scientists, which deduces ocean current velocity by sensing the scattering of radar echoes by ocean waves, produced these maps of water movements at two different times on one day last summer. The radar may become a major tool for monitoring sea pollutants and setting environmental baselines where petroleum and other exploration are planned.

EDS Develops New Map Locating U.S. Geothermal Energy Sources

The first detailed map of geothermal energy sources in the western United States — including Alaska and Hawaii — has been prepared to help demonstrate the importance of heat from the earth's interior in meeting the future energy needs of the United States, according to Paul J. Grimm, of EDS's National Geophysical and Solar-Terrestrial Data Center in Boulder, Colo.

The map shows geothermal areas now producing, or with known potential to produce, electrical power from steam-driven turbines. Also shown are areas where hot water from the earth is being used for such purposes as heating buildings, agriculture, and various manufacturing activities, or where there is known potential for such uses.

There are more than 100 locales in the western U.S. — from the Rocky Mountains to the Pacific — classified as "Known Geothermal Resources Areas," several of which already supply usable energy.

Some experts believe that by the year 2000, geothermal energy could account for up to several percent of the total power needs of the United States, if properly developed.

In addition to the known and potential geothermal areas, the 46 x 35 inch map also shows other types of geological and geophysical data closely associated with geothermal resources, such as heat flow, earthquake epicenters, major faults, and volcanoes and volcanic cones.

National Geophysical and Solar-Terrestrial Data Center produced the map in cooperation with the Energy Research and Development Administration — now part of the Department of Energy — and the United States Geological Survey. Copies are available, folded or rolled in a mailing tube, for $2.50 from NOAA, National Ocean Survey, Distribution Division C44, Riverdale, Md. 20840.

Administrator Fills Three Top Positions

Three appointments to top-level positions at the National Oceanic and Atmospheric Administration were announced in December.

William C. Brewer, Jr., who had served since 1974 as NOAA General Counsel, became Special Representative of the Secretary of Commerce to the Law of the Sea Conference and Special Representative of the NOAA Administrator on Law of the Sea and International Law.

Eldon Van Cleef Greenberg, presently Deputy General Counsel of the Agency for International Development, was named General Counsel of NOAA.

Samuel A. Bleicher, who had been acting as Special Assistant to Mr. Frank for reorganization and policy planning, became Director of the newly-created Office of Ocean Management of the Commerce Department agency.

Brewer was a partner in the Boston law firm of Hill and Barlow before his appointment as General Counsel of NOAA in 1974.

He was graduated from Phillips Academy in 1939, Williams College in 1943, and from Harvard Law School in 1949 when he became General Counsel of the Mutual Boiler and Machinery Insurance Company. In 1953 he became a partner in the law firm of Peabody, Koufman and Brewer, which was succeeded by the firm of Hill and Barlow in 1965.

Brewer has served as adjunct professor at Boston College Law School, teaching coastal zone management and international business law. He has been a director of several companies, and has written numerous articles for legal journals.

Greenberg was graduated Magna Cum Laude from Harvard College in 1965 with a Bachelor of Arts degree. After postgraduate studies at the Institute d'Etudes Politiques de Paris in France from 1965 to 1966, he took his J.D. degree Cum Laude from Harvard Law School in 1969.

From 1969 to 1970 he was law clerk to Edward C. McLean, U.S. District Judge for the Southern District of New York, and for the next two years was associate attorney at Debevoise, Plimpton, Lyons and Gates of New York. He was staff attorney at the Center for Law and Social Policy in Washington, D.C. from 1972 to 1977 when he became Deputy General Counsel at the Agency for International Development.

The author of several articles appearing in legal journals, Greenberg has served as adjunct professor in administrative law at Georgetown University Law Center. He was Advisor to the United States Delegation to the Law of the Sea Conference from 1975 to 1977.

Bleicher was graduated from Northwestern University in 1963, Phi Beta Kappa, with Honors in Economics, and received his J.D. degree from Harvard Law School in 1966. He is a law professor at the University of Toledo College of Law, with emphasis on environmental, constitutional, and international law. On leave from the University from 1972 to 1975, Bleicher served with the Ohio Environmental Protection Agency, first as Deputy Director for Regulation and then as Deputy Director for Regulation and Enforcement. He joined NOAA as Special Assistant to the Administrator with responsibilities for reorganization, policy planning, and executive recruitment in February 1977.

He is the author of articles in several law journals as well as college course materials on pollution and political boundaries.

Two Contractors Are Developing Weather Buoys

Research organizations in the East and in California are independently developing meteorological drifting buoys to be used in the Global Weather Experiment in 1979.

NOAA's Office of Ocean Engineering has awarded a $275,000 contract to American Electronic Laboratories, Inc., of Lansdale, Pa., and one for $237,189 to Polar Research Laboratory of Santa Barbara, Calif.

Each contractor will provide six buoys capable of measuring barometric pressure and ocean sea surface temperature, and transmitting that data via NOAA satellites to communications stations ashore.

The Global Weather Experiment in 1979 will be the most comprehensive global observational program of tropospheric, stratospheric, and sea surface conditions ever attempted. NOAA has major responsibility for the United States' participation in the program.

The contracts were awarded by the NOAA Data Buoy Office in Bay St. Louis, Miss.

Awards Honor Administration's Best

Five NOAA employees received NOAA Awards and two received NOAA EEO Awards on October 7, at the annual NOAA Awards Luncheon, held in Washington, D.C.

In addition, 28 NOAA units received Unit Citations as they continued the NOAA tradition of people helping people.

The top awards ranged from public service through scientific research and achievement, engineering and applications development, to program administration. Cited were:

Dr. Donald L. Gilman, National Weather Service Long Range Prediction Group, who received a Public Service Award for accurately predicting the severe winter of 1976-77. Gilman, who heads the LRPG, warned Congress as early as November of 1976 that the eastern half of the Nation would be colder than normal from December through February.

As last winter's cold weather crisis deepened, heavy demands were placed on Gilman's group by the media, the general public, agricultural and industrial interests, and high levels of Government. Gilman appeared on national television about 15 times to explain his predictions.

Dr. C. Gordon Little, who heads Environmental Research Laboratories' Wave Propagation Laboratory, received NOAA's Scientific Research and Achievement Award for his leadership in organizing the Laboratory in 1967 *because he was convinced that advances in atmospheric science and improvements in weather service depend upon improving methods of observation.*

Since that time, a variety of remote sensors have been developed to solve these problems, either as a result of Little's or his laboratory's work, or WPL-inspired research done at the Boulder Laboratory. Today, WPL is the only one of its kind in the world in the breadth of its remote sensor development — forerunners to the application of remote and on-site sensors to the problem of accurate short-term weather forecasting.

Dr. George H. Ludwig, Director of Operations for the National Environmental Satellite Service, received the NOAA Program Administration Award for his managerial and technical leadership in planning, organizing, and directing the NESS Office of Systems Integration, a unit he helped to set up in 1972.

Working closely with NASA and system contractors, Dr. Ludwig's group follows the system they will one day manage — for example, the TIROS N, planned for the late 1970's — through design, development, testing, and production. After the satellite is launched, its operation is the responsibility of the Satellite Service.

Frank R. Niedermair, a computer specialist for National Ocean Survey's Aeronautical Charting and Cartography Division, received an Engineering and Applications Development Award for *his work in the design and implementation* of two major systems that have improved the FAA's Air Traffic Control System.

One system he designed — the Computational Oriented National Data Optimum Retrieval System (CONDOR) — is now the Government standard for computing geodetic positional information for aeronautical chart compilers using remote computer terminals. The second — the Radar Video Map System — aids the automated production of chart overlays for Air Traffic Control radar displays.

Dr. John B. Pearce, head of the National Marine Fisheries Service Sandy Hook Laboratory, received the NOAA Scientific Research and Achievement Award for leading a group of Federal experts in developing an effective, environmentally oriented, oversight of dredging and spoiling operations. Pearce, as Chairman of the *Interagency Advisory Subcommittee* on Ocean Dredging and Spoiling, monitors such operations to assure no environmental damage.

A recognized authority in marine ecosystems science, Pearce has published a nine-volume study on the biological effects of ocean dumping. He is the principal investigator for all biological aspects of NOAA's multiagency environmental study of the New York Bight.

Samuel S. Ross, an Equal Employment Opportunities Specialist, received the NOAA EEO Award for his outstanding work as an EEO Counselor. From 1972 to 1976, Ross served as a volunteer EEO Counselor for National Environment Satellite Service while he worked as a physical science technician.

In 1976, he was selected as a fulltime EEO Counselor for NOAA. During this time, he was able to settle more than 90 percent of the informal complaints on EEO matters brought to him. Only one of the 54 informal complaints he processed went on to become a formal complaint.

Landry Williams, a scientist with National Ocean Survey, received the NOAA EEO Award for his voluntary work, carried out in addition to his regular work, and his dedication to eliminating discriminatory practices in NOAA. From June 1976 to June 1977, Williams was Chairperson of the NOAA Equal Employment Opportunity Committee.

During this period, the committee, under William's leadership, successfully advanced EEO objectives in the establishment of NOAA's High School Cooperative Education Program; production of an in-depth assessment of NOAA's Upward Mobility and Cooperative Education Program, which uncovered several deficiencies; establishment of a formal written quarterly review of NOAA Affirmative Action Plans to promote EEO accountability; and establishment of NOAA's first agency-wide EEO Newsletter.

The Unit Citations recognize groups of employees who, through their individual and collective efforts, have made substantial contributions to NOAA programs or objectives. The 1977 NOAA Unit Citation for Special Achievement has been presented to:

National Ocean Survey:

— Area Team 2, Nautical Chart Branch
— Base Line Team G-10
— Nautical Chart Section
— NOAA Ship Rainier
— AMC Electronic Engineering Division
— PMC Electronic Engineering Division
— PMC Processing Division
— Electronic Systems Branch

National Weather Service:

— WSMO Guam
— Weather Service Meteorological Observatory, San Diego
— Forecast Staff, WSO, Meridian Miss.
— Forceast Staff, WSO, Fort Smith, Ark.
— WSO Atlantic City N.J.
— NWS Technical Training Center, Kansas City, Mo.
— WSFO Albany
— WSFO Buffalo Forecast Unit
— WSFO Buffalo Observing Unit
— WSO Tampa Bay Area
— WSFO Pittsburgh
— Sacramento Federal-State River Forecast Center

National Environmental Satellite Service:

— Satellite Winds Section

Environmental Research Laboratories:

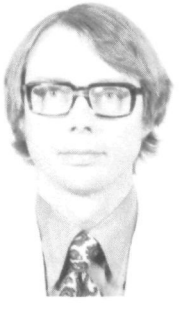
— Research Facility Center Crew N6541C
— Argo Merchant Oil Spill

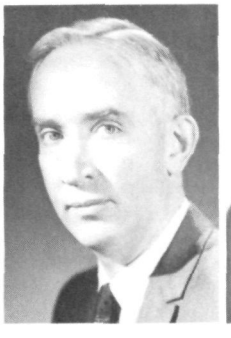
National Marine Fisheries Service:

— Marketing Services Division Field Staff
— Investigations of Satellite Applications of Fishery Problems
— First International Saturation Study of Herring and Hydroacoustics

Environmental Data Service:

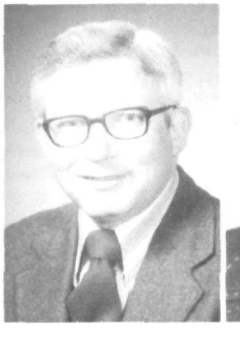
— Model Operations Division, CCEA
— Library and Information Services Division.


Dr. Donald L. Gilman

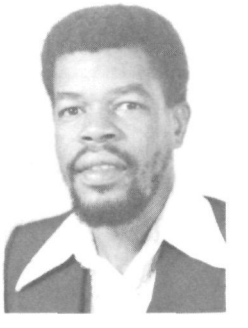

Dr. C. Gordon Little

Dr. George H. Ludwig

Frank R. Niedermair


Dr. John B. Pearce

Samuel S. Ross


Landry Williams

noaa/update

U.S./France

Joint Ocean Study Set

Joint scientific and technical cooperation in four areas of oceanography will be carried on by French and U.S. scientists over the next two years as a result of planning meetings in Bandol, France held late last year.

Major projects approved at the meeting include a two-year study of seafloor spreading in the Pacific, exchange of information on means of controlling oil pollution, marine environmental research, and research in diving medicine.

Head of the U.S. delegation was David H. Wallace, now Acting Assistant Administrator for Fisheries. The French delegation was led by Yves La Prairie, General Director of CNEXO (Centre National pour l'Exploitation des Oceans).

The East Pacific Rise at 21 degrees north latitude off the coast of Mexico will be the site of a major seafloor spreading study, to be carried out with the participation of Mexican scientists. The East Pacific Rise in that area is a rapidly spreading undersea ridge connected with the extensive geologic fault system along the U.S. west coast. Scientists from France, Mexico, and the U.S. hope to learn more about the mechanism of seafloor spreading, formation of the earth's crust, and possible formation of metals.

The French and U.S. delegations agreed to hold demonstrations of oil pollution equipment each nation has developed, and made plans for a French expert to obtain training at the U.S. National Strike Force and, possibly, the Marine Environmental Protection School. France will sponsor a workshop in September, 1978, looking toward multilateral exchange of information on oil spill cleanup information and techniques.

Flash Flood Dangers Prompt New NWS Focus

The Disaster Preparedness Staff is now the focal point for the National Weather Service's renewed effort to solve the problem of the serious threat to human life posed by killer flash floods, Weather Service Director Dr. George P. Cressman announced in December.

Dr. Cressman said, "I've decided to center the responsibility in my office, but instead of creating a new staff office or a special assistant for flash floods, I'm asking the office of Disaster Preparedness to serve as my focus for this effort."

The Disaster Preparedness Staff is headed by Herbert S. Lieb, former Deputy Director of NOAA Public Affairs. The staff also includes Herbert S. Groper, a physical scientist, formerly the NWS Flash Flood Program Leader, and H. Michael Mogil, a meteorologist, formerly with the NWS Public Services Branch at Weather Service headquarters.

"I have asked the Disaster Preparedness Staff to undertake a complete review of all existing directives and guidance impinging on the flash flood program," Dr. Cressman said.

Operational aspects of flash flood programs in NWS's Office of Hydrology, Office of Meteorology & Oceanography, and Office of Technical Services will remain unchanged.

Former NWS Eastern Region Director Silvio Simplicio has been asked to work with NWS offices to develop a flash flood training course.

The action was taken following recommendations made by attendees at the Flash Flood Workshop, held in Boulder, Colo., September 26-30, 1977. The workshop included representatives from various NOAA components.

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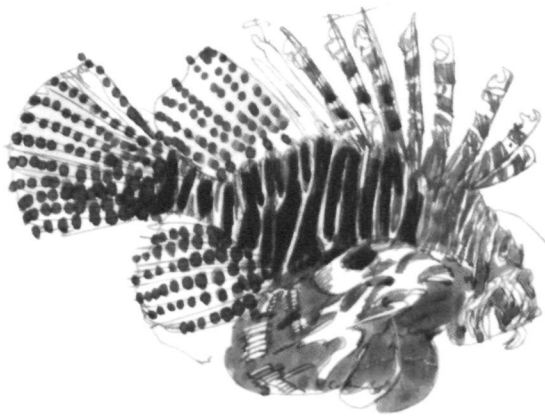
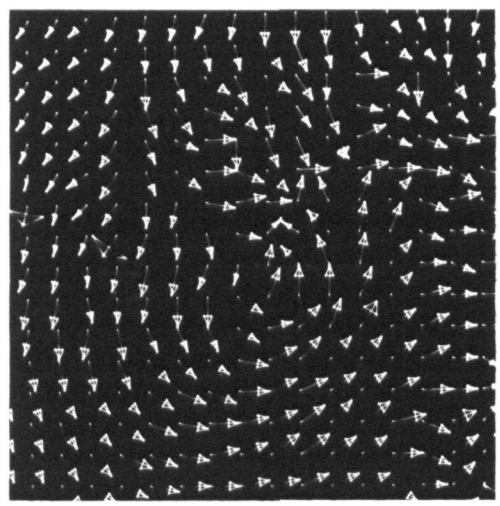


The Not-So-Friendly Denizens of the Deep (page 26)

Assignment: Boulder (page 12)

Turning Landlubbers Into Sea Lovers (page 23)



Tornado Warnings of the Future (page 4)

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