VOLUME 7 NUMBER 4 OCTOBER 1977

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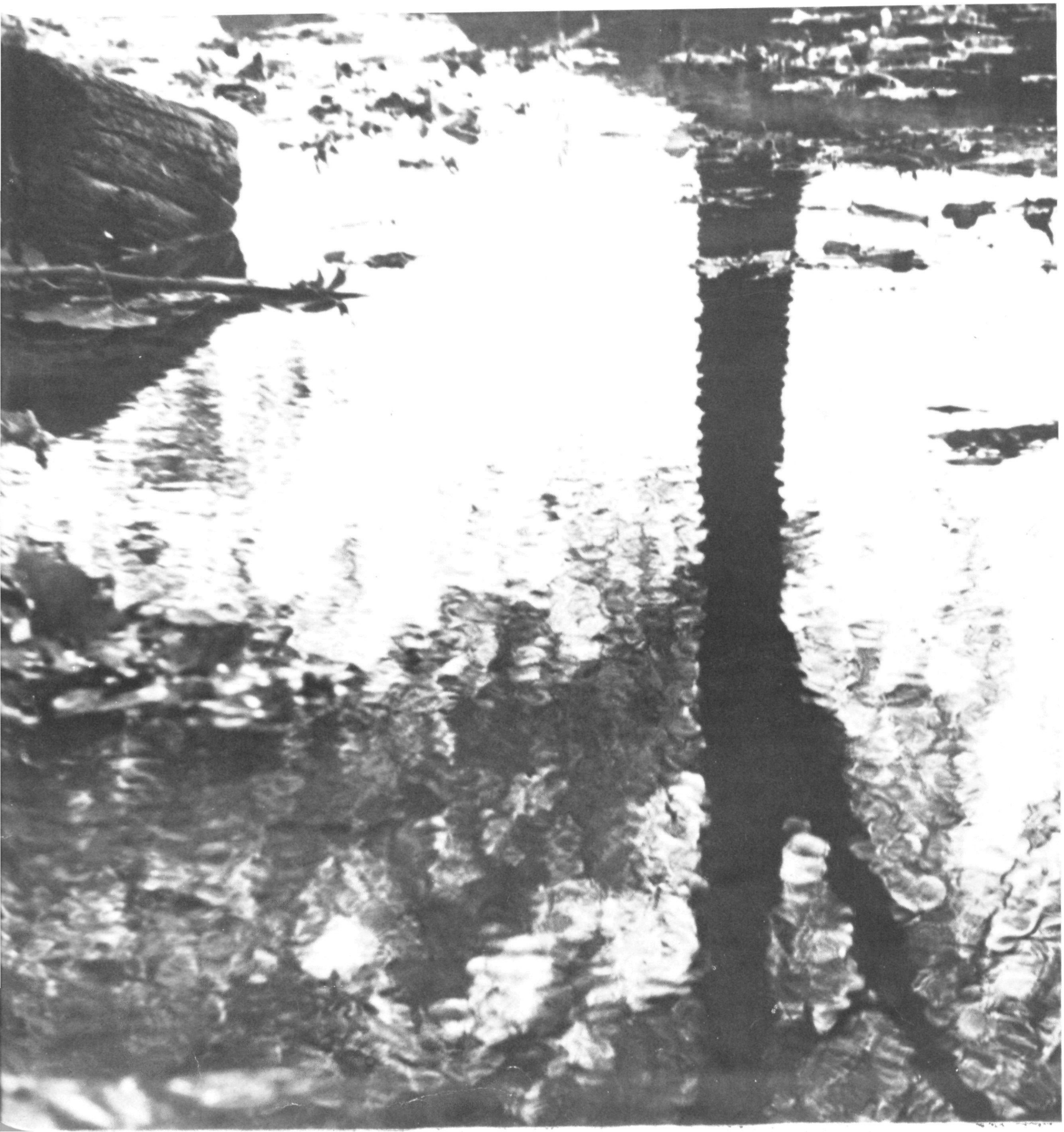

National Oceanic and Atmospheric Administration

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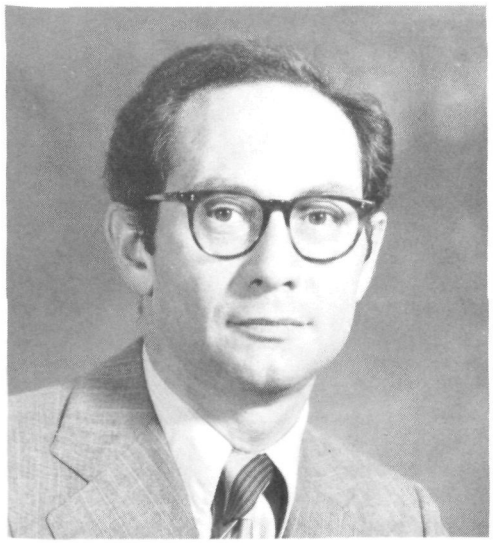
Reorganization: The First Step Toward A Stronger NOAA



As many of you know, reorganization has been a major focus of NOAA activity over the past three months. Secretary Kreps has recently approved the NOAA reorganization plan.

I believe this reorganization marks a significant turning point in NOAA's development. Over the past five years, NOAA's mandate has been transformed by Congress from a scientific service organization into a major instrument of oceanic and atmospheric policy in the Federal government. The Coastal Zone Management program, the Weather Modification study, the Marine Mammal Protection Act, and the Fisheries Conservation and Management Act all call upon NOAA to provide new national policy direction while continuing to provide the highest quality of scientific research and services to the American people. The future promises an even greater leadership role for NOAA—if we can handle our present responsibilities effectively and continue to win the respect of the President, the Congress, and our constituents.

The primary objective in reorganizing the top echelons of NOAA is to expand our capacity to provide vigorous and effective national leadership on a timely basis. To this end the new structure consolidates the elements dealing with fisheries, creates a new Office of Policy and Planning, and establishes a Washington focal point for NOAA research and development.

Some assert that reorganizations are futile—that capable, industrious and dedicated people can make any organization work and, reorganization cannot help in the absence of such people. NOAA has some of the finest talent to be found anywhere in the world, and that is one reason Congress and the public keep expanding NOAA's responsibilities. With the new structure, NOAA can concentrate that talent more effectively on the issues it is now called upon to resolve.

No doubt some of the organizational changes will prove more successful than others, and further changes may be necessary to accomplish our objectives. Each of us should keep these objectives in mind in evaluating how well the new arrangements are working and how they might be further improved.

Richard A. Frank
Administrator.

CO_2: Key to Tomorrow's Climate

By CARL A. POSEY

The pale sun returns to Point Barrow, touching the dormant plants of the tundra like a sorcerer. Then, for the intense, abbreviated span of an Arctic summer, life awakens in the thick carpet of mosses and lichens and tiny flowers, the botanical microcosm that does the work of forests north of the planet's timberline.

At the base of the narrow gravel hook of Point Barrow, beyond the large white dome of the DEW-line station there, a small cluster of ochre Arctic prefabs sit on pilings driven into the permafrost. This is Barrow Observatory, one of four "clean-air" facilities in NOAA's Geophysical Monitoring for Climatic Change (GMCC) program. And here, the instruments that monitor the subtle physical and chemical signals the atmosphere gives of global climatic change also record the springtime revival of the tundra: atmospheric carbon dioxide drops sharply.

The carbon dioxide measurements at Barrow are a seasonal reproduction, on a very fine scale, of events that span millions of years, and occur on a global scale. It is a miniature of what happens to carbon dioxide in what is called the biosphere—plants "inhale" carbon dioxide, remove (or fix) the carbon in the form of carbohydrates, and "exhale" oxygen.

But in their fixing of enormous quantities of carbon, plants create a reservoir of carbon, locked in time. As dead plants rot this carbon is liberated in the form of carbon dioxide; and this delayed return of carbon is the principal source of the "natural" carbon dioxide recycled to the atmosphere.

Time is the critical dimension here, for understanding the global carbon dioxide cycle requires the work of generations of scientists. Comprehension must be built like the city of Paris, an era, a century, at a time. But it is work that must be done, for the amount of carbon dioxide in the atmosphere may do much to shape the climate of twenty-first century earth, and the lives of people whose great grandfathers have only just been born.

The problem is that carbon dioxide, a stable gas that exists only in trace amounts in the atmosphere—about three hundredths of one percent by volume—has properties that give it a significant role in regulating the planet's heat budget. Because carbon dioxide is quite transparent to most incoming solar radiation, it lets the radiation pass through the atmosphere. Absorbed by the earth, this energy is re-radiated at the longer infrared wavelengths of heat. But carbon dioxide strongly absorbs much of the emitted earth's radiation, and holds the heat in. This property of selective transmission can invigorate a cold planet—and heat up a temperate one. Because this process resembles what seems to happen in a greenhouse, it is called the "greenhouse" effect.*

Thus, minuscule increases in the amount of carbon dioxide in the atmosphere can have major effects on the average temperature at the surface and in the lower atmosphere. How such changes will affect the planet and its life is uncertain. Scientists have theorized that at some point a warmer atmosphere could cause melting of polar ice caps, and higher sea level. There is also the compensating possibility that a warmer atmosphere would warm the oceans, increasing cloudiness; and the increased cloud cover would block incoming solar radiation and cancel out the warming caused by increased carbon dioxide. The only sure thing in any assessment of carbon dioxide increases is that they will produce extremely complicated, interacting sets of effects, occurring over long intervals of time.

There is also agreement among scientists that predicting the climatic effects of increased atmospheric carbon dioxide—which is only one force working to change global climate—depends entirely upon understanding the observed increases in atmospheric carbon dioxide, and their peculiar fluctuations. It also rests on acquiring better knowledge of how the effectiveness of the oceans and biosphere in taking up carbon may be modified as atmospheric levels of carbon dioxide grow higher and higher.

The need for such predictions is an urgent one. The United States must now determine whether it will rely more and more heavily on its vast coal reserves to meet its energy requirements, or begin the difficult transition to alternative energy sources. Coal produces about 15 percent more carbon dioxide than natural gas to generate the same amount of energy. The decision must come in the next few years or decades; but its greatest impact will not be felt for a century or more. Predicted values—and the predicted climatic effects—of increased carbon dioxide are critically linked to the fossil-fuel decision. The closer these predictions are to future reality, the greater the benefit this generation's energy decisions will have for coming generations.

Knowledge that atmospheric carbon dioxide is increasing comes from measurements made by NOAA and Scripps Institution of Oceanography over the past two decades. Taken at NOAA's Mauna Loa Observatory in Hawaii, the oldest of the GMCC stations, the 18-year-long series of measurements is the longest, most nearly continuous record of measured atmospheric carbon dioxide in existence.

The NOAA-Scripps record from Mauna Loa indicates that carbon dioxide has increased from about 314 parts per million in 1958 to about 330 parts per million in 1976—an increase of about five percent, averaged over the period of record.

It also suggests that the annual rate of increase is growing. From 1960 to 1965, for example, measured carbon dioxide at Mauna Loa increased from about 315 to about 318 parts per million, an increase of just under one percent. But between 1965 and 1970, Mauna Loa measured an increase of just over one percent, and the increase was 1.16 percent between 1970 and 1975.

The Mauna Loa record is essentially duplicated by the less continuous record covering the same period at South Pole Station, and by the shorter carbon dioxide records at NOAA's recently established climate-monitoring stations at Point Barrow and at Cape Matatula, American Samoa.

Because virtually all carbon dioxide added to the atmosphere comes from the combustion of fossil fuels like coal, petroleum, and natural gas, and possibly from the destruction of forests, scientists begin their retrospective carbon dioxide "watch" in 1860, when the industrial revolutions had begun in earnest. For it was in this transformation from agrarian to industrial society that humankind began the massive liberation of carbon that nature had stored hundreds of millions of years before. So, a century ago, the pin was pulled on the carbon dioxide time bomb.

Recent, typical estimates of what atmospheric carbon dioxide values were in 1860 range from 285 to 305 parts per million. Another estimate indicates the pre-industrial value may have been as low as 265 parts per million. If those typical estimates are correct, the NOAA-Scripps measurements at Mauna

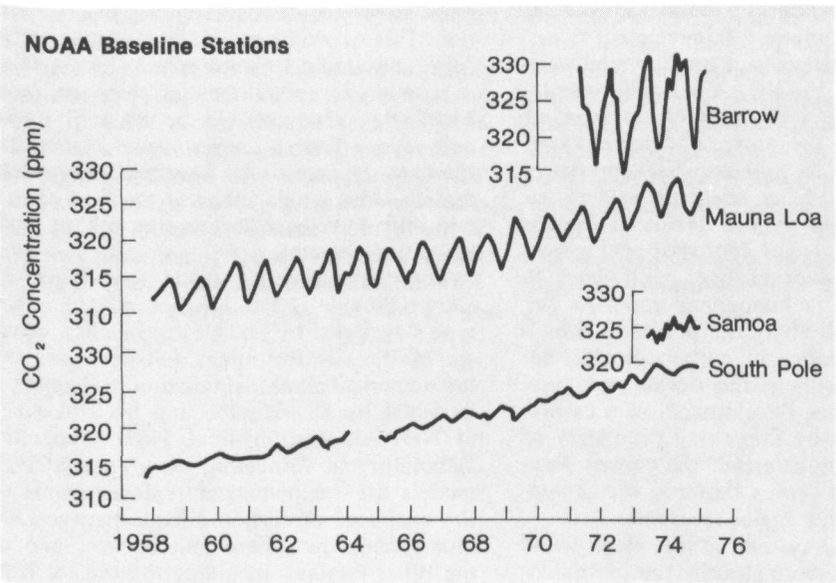
Loa show that atmospheric carbon dioxide has increased from 8.2 to 13.8 percent since 1860. That is one source of uncertainty to begin with.

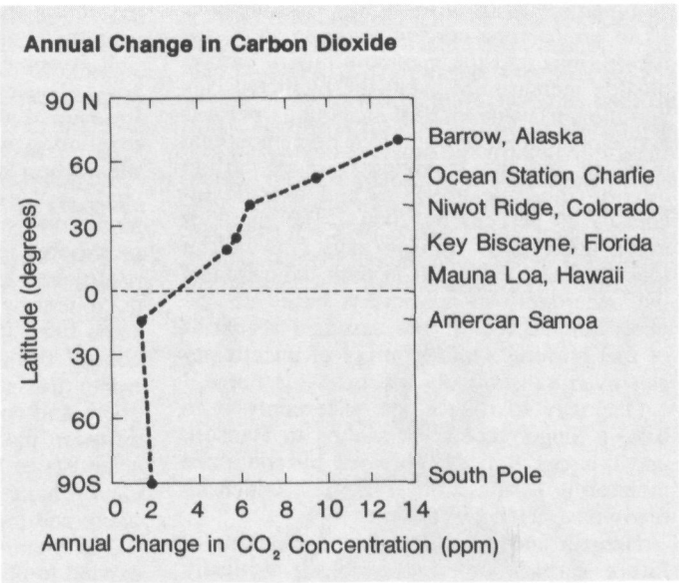
Such uncertainty is only part of the problem with present knowledge of the atmospheric carbon dioxide cycle. According to Dr. Kirby Hanson, who directs the GMCC program for NOAA's Air Resources Laboratories, minuscule, hard-to-explain fluctuations in the rate of the observed carbon-dioxide increase show that the job of assessing the future build-up of carbon dioxide in the atmosphere is, indeed, a difficult one.

"The carbon dioxide record from Mauna Loa does not show the constant year-to-year increase in carbon dioxide you might expect if the rather steadily increasing fossil fuel burning was the only factor affecting the rise," he says.

"Studies have shown that the departures from this hypothetical steady increase are correlated with the sea-surface temperature anomalies of tropical oceans. Apparently we are observing the fact that when the ocean warms it releases carbon dioxide into the atmosphere. It takes about five months for the tropical ocean-induced carbon dioxide anomalies to reach Mauna Loa Observatory. The same anomalies are propagated southward by the general circulation of the atmosphere and reach the South Pole after about eleven months. These are direct observations that carbon dioxide, regardless of its source, is mixed throughout the global atmosphere with a time lag of, at most, a year or two."

At the present time, he notes, a number of studies are using the 18-year observational record to try to determine what portion of the carbon dioxide released from fossil fuel burning over that period has remained in the atmosphere. The potential problem with this is that natural fluctuations in carbon dioxide associated with ocean temperature changes are combined in the observational record with the rise in carbon dioxide from fossil fuel burning. "If one attempts to interpret the observation record, directly, as a measure of the increase in carbon dioxide due to fossil fuel burning, without removing from the record the carbon dioxide variations from natural sources, then these natural variations provide an added uncertainty in the interpretation," Hanson says.





Graphs from four NOAA baseline stations (left) show upward trend of carbon dioxide in atmosphere, from the South Pole to Alaska. The annual increase at seven stations is shown at right, ranging from less than two percent at the two southern hemisphere stations to an almost 14 percent annual increase in Alaska.

This uncertainty has a significant effect on assessing the implications of the observed increase in atmospheric carbon dioxide.

"If the beginning and present end points of the Mauna Loa observational record are used directly, to estimate the increase in atmospheric carbon dioxide from anthropogenic sources, the increase is 5.3 percent over the past 18 years. However, if the uncertainty from natural sources is included, the increase over that period of time is more likely somewhere in the range from 4.5 to 6.1 percent."

If this recent observational record is used as a baseline for prediction, Hanson explains, these uncertainties are carried into the predictions. For example, it is possible to specify a "best case" (that is, the least carbon dioxide increase in the future) and a "worst case" based on this range of uncertainties and on assumed scenarios of fossil fuel consumption. If an annual two-percent increase in fossil-fuel burning and the minimum rate of carbon dioxide increase are used, the predicted carbon dioxide value in 2000 is about 11 percent above present values. If a four-percent annual increase and the maximum rate of carbon dioxide increase used, carbon dioxide increases 20 percent by 2000. "The merit of these numbers," Hanson says, "is not in their absolute value but in their indication of the uncertainty in predictions based on the observational record and assumed scenarios of fuel burning. Other sources of uncertainty can even substantially increase this range."

One way to reduce the uncertainty is to have a longer record, according to Hanson, and this can only be obtained by continued monitoring at these observatories, which already have a lengthy record.

Hanson adds that accurate predictions of future carbon dioxide levels are critically linked to a better understanding of the role played in the global carbon cycle by these natural sources and sinks. "Our estimates are that between 47 and 64 percent of the carbon dioxide released by the burning of fossil fuels between 1960 and 1974 remains in the atmosphere. This means that the remaining added carbon dioxide—from 53 to 36 percent of it—has found its way into the ocean and biosphere. While we understand how this biospheric uptake occurs on a laboratory scale, we do not have a good idea of how it occurs in global terms.

"How do we monitor such quantities? Do we have to count every plant in the world or can we generalize? Do we have to sample the ocean every day or every year, at how many locations? We have to know about what to measure, and how often, and where, to detect changes that have climatic significance."

These questions persist as time begins to run out on scientists attempting to work on the carbon dioxide problem. Decisions on fossil-fuel usage wait for long-term predictions of the effects and consequences of increasing carbon dioxide. But predicting the increase caused by fossil fuels must wait for the observed natural and anthropogenic fluctuations of atmospheric carbon dioxide to be resolved.

One of the first things that must be done, Hanson believes, is to broaden the way the carbon dioxide record is kept. The measurements made by NOAA's GMCC stations began in 1957, when Dr. C. David Keeling of Scripps Institution of Oceanography in La Jolla, California, began analyzing flask samples collected at South Pole Station.

This monitoring of global carbon dioxide levels continues, with weekly pairs of flask air samples collected at the four GMCC stations at Niwot Ridge, Colo., Key Biscayne, Fla., and Cape Kumukahi, Hawaii. The flasks are shipped to GMCC headquarters in Boulder, Colo., and compared with a reference gas (nitrogen containing known amounts of carbon dioxide) to determine their carbon dioxide content.

In addition, NOAA operates automatic carbon-dioxide monitoring systems. These continuously sample and analyze ambient air, measuring the carbon dioxide in sampled air against the amount in a reference gas.

It is not enough, and a major initiative is being developed by NOAA's Environmental Research Laboratories to match the level of monitoring with the extreme complexity of the carbon dioxide problem. This proposed study will establish an adequate system for monitoring carbon dioxide levels in the atmosphere, in air over biomass, and ocean reservoirs, and their changes with time, to document what is happening *now*. At the same time, it will study the processes which control the exchange of carbon dioxide between the atmosphere the ocean and biosphere and continue development of a carbon diffusion model—by improving the ability of scientists to "parameterize" the carbon dioxide exchange processes between the atmosphere and the other major reservoirs.

The monitoring system, in this plan, would expand to obtain more globally representative information. At present, the GMCC and other sampling sites provide data that is representative of background carbon dioxide; but measurements made in such remote locations do not tell scientists much about the specific roles of natural and human sources and sinks for carbon dioxide. Thus, the plan calls for the number of sampling stations to be more than doubled, to provide a broader view of carbon dioxide trends.

Meanwhile, the proposed monitoring program would attempt to determine carbon dioxide quantities in the ocean, sampling from the surface mixed layer to depth at selected intervals. This would help determine the efficiency—and the limits—of the ocean as a sink for carbon dioxide, and tell scientists something about the rate of uptake and release of carbon dioxide by this huge reservoir.

Most important in the proposed monitoring system would be an effort to learn how the earth's vegetation acts to modify atmospheric carbon dioxide and how increasing atmospheric carbon dioxide would change the earth's vegetation.

The uptake of carbon dioxide by vegetation, and how it varies with time, requires further study. The proposed program would establish continuous carbon dioxide monitoring stations in representative areas of the tropical rainforest, the boreal spruce-larch-pine-fir taiga, and the mid-western agricultural lands of the United States. These measurements would provide baseline carbon dioxide values for the present stage of development of those vegetated areas. At the same time, short-term expedition-type measurements would be used to specify the net carbon uptake and release in these three representative areas.

An effort would be made to evaluate the exchange rate of carbon dioxide between the atmosphere and the biosphere, by measuring vertical carbon dioxide flux in tropical and temperate forests, at various stages of regrowth, and for boreal taiga.

A parallel attempt would assess the phytoplankton biomass of the sea, and how it varies seasonally in its uptake and release of carbon dioxide. To make the measurements globally representative, the monitoring program must include a survey of global vegetation. This would be based, in part, on satellite data, and would be used initially to establish a baseline for conditions as they are now. Then the survey would be brought up to date every five to seven years, to reveal biomass changes—for example, destroyed forests—that would increase the rate of carbon dioxide release to the atmosphere, and, so, global climate.

These assessments would feed improved carbon-dioxide global diffusion models of the type developed by Dr. Lester Machta, director of the Air Resources Laboratories, and the numerical climate-prediction models being designed by Dr. Marabe and his colleagues at NOAA's Geophysical Fluid Dynamics Laboratory at Princeton, New Jersey. Such models are mathematical representations of the exchange of carbon dioxide between the atmosphere, biosphere and oceans, and of the other factors—including the rate of consumption of fossil fuels—which affect the rate of carbon dioxide increase. At present, small differences between the quantities used to represent fossil fuel consumption, for example, can produce large differences in the level of atmospheric carbon dioxide predicted for the coming century or two. A more comprehensive monitoring effort and a longer observational record would provide more realistic data base for such models, and lead to more accurate predictions. But in the view of most scientists trying to solve the great equations of climate, none of this will do much good without unprecedented continuity of effort.

"Twenty years is barely a tick on the climatic clock," Hanson says. "We need to maintain continuity of measurements across generations of scientists, or we'll never be able to tell where we are, where we've been, or where we're going in terms of global climate and the factors that cause it to change." □

**The effect of carbon dioxide in the atmosphere is to trap heat in the lower layers of the atmosphere, and so it appears to function like a greenhouse. But carbon dioxide traps heat through selective transmission of energy; greenhouse glass merely limits vertical mixing with cooler outside air circulation.*

At four minutes before noon, the first submarine slipped beneath the waves. It only took five minutes to descend the 210 feet to the bottom. Gordon Watts, a marine archeologist from North Carolina, was in the forward sphere of the submarine. Four years ago he had been aboard the R/V Eastward on the expedition that first located the remains of the USS Monitor 16 miles off Cape Hatteras. Now he and the three other men in the submarine would be touring the wreck first hand, the wreck that no one had seen, except in photographs and TV pictures, since it sank on New Year's Eve in 1862.

Tim Askew, the pilot of the sub, was using the sonar to navigate to the wreck when suddenly twenty yards from the Monitor, Watts spotted what appeared to be a tin can lying half covered in the sand. Askew slowed the sub to a hover and switched on the head lights. "We've come across a brass lantern with a red glass lens," he reported to the dive controller. The event was logged and he was instructed to proceed to the wreck.

At 1347, a second submarine was launched at the Monitor Marine Sanctuary. Together they spent four and one half hours measuring currents on the bottom, testing the camera system, and looking at what remains of the vessel that changed the course of naval history.

Early in the Civil War, the Confederacy started building armor-plated ships as a challenge to the North's wooden fleet. Disturbing news reached President Lincoln in 1861. The South had raised the scuttled Union steam frigate Merrimack, and rebuilt her into an ironclad fort called the Virginia. To meet this threat, the Federal Navy Department established the Ironclad Board and advertised for plans of ironclads.

The design selected by the Board with the approval of President Lincoln was the brainchild of Capt. John Ericsson, a brilliant engineer who had immigrated from Sweden. The Ericsson design was as unique as it was controversial. A revolving turret with only two 11-inch guns, a massive belt of armor five feet high ringing the entire vessel below the water line, forced air ventilation, and the first marine heads, were some of the unique design features. What caused the most skepticism among high Navy officials was the fact that the Monitor had only 18 inches of freeboard. Her decks would be awash in the slightest of seas.

Ericsson's eloquent arguments prevailed, however, and construction began at the Continental Iron Works in Brooklyn, New York. Built in less than 100 days, the ship was launched on January 30, 1862. Unable to transit under her own power, the Monitor was towed to Hampton Roads, Virginia. Her famous engagement with the Merrimack (C.S.S. Virginia) took place on March 9, 1862, the day after her arrival at Hampton Roads.

The USS Monitor was on her way to Beaufort, North Carolina to join in a land and sea attack against Wilmington when she was lost. The vessel that proved an equal match to the feared Southern ironclad became just another victim in the "graveyard of the Atlantic." As the USS Rhode Island stood by, the red distress lantern—and 11 men—vanished beneath the waves, 11 months to the day after she was launched.

And one hundred and thirteen years to the day after she was launched—January 30, 1975—NOAA designated the site of the wreck a Marine Sanctuary, for the purpose of protecting it from would-be treasure hunters or salvors. Persons or groups with legitimate research plans must receive a permit from NOAA's Office of Coastal Zone Management (OCZM) before conducting any scientific studies in the area. Since designation of the site as a marine sanctuary, two scien-

THE LANTERN

By LT. CDR. FLOYD CHILDRESS*

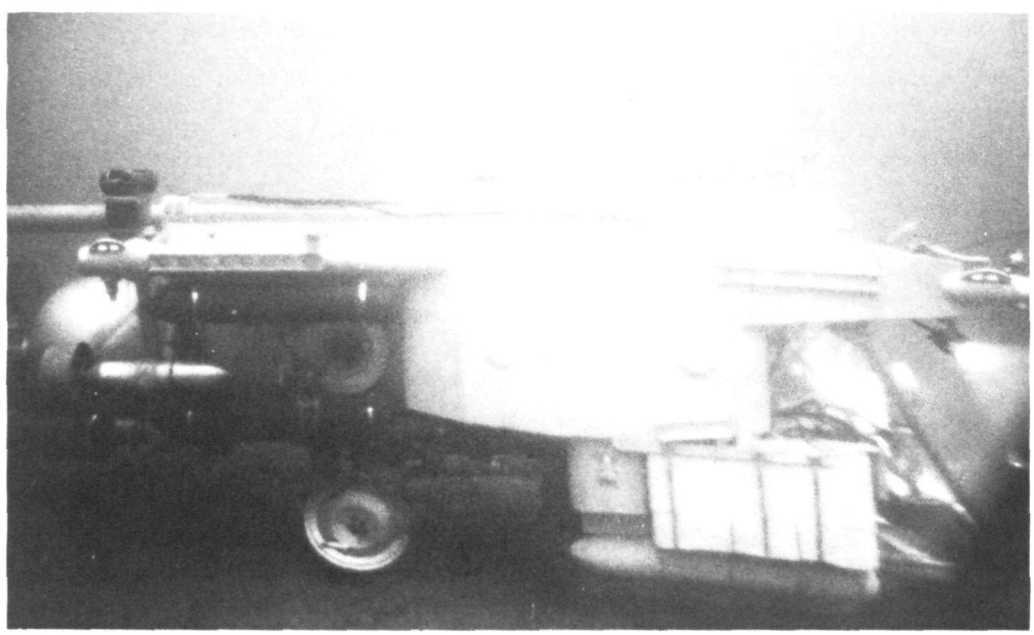
**Lt. Cdr. Childress is Deputy Officer-in-Charge, Marine Sanctuaries Program, Office of Coastal Zone Management.*

Photos: Lt. Cdr. Floyd Childress

tific expeditions have been authorized, the most ambitious being the joint NOAA—Harbor Branch Foundation, Inc., project conducted this past July and August.

Cdr. Phillip Johnson, NOAA, who is the Officer-in-Charge of the Marine Sanctuaries Program, initiated plans for the expedition after meeting with J. S. Johnson, President, and Edwin A. Link, Vice President of Harbor Branch Foundation, Inc. A NOAA team was quickly assembled consisting of Chester Slama from NOS, Sue Froeschle from OCZM, and myself. We spent most of May and June working with Roger Cook, Operations Director of HBF, writing the operations plan for a photogrammetric survey of the Monitor.

The plan was ambitious. It required two oceanographic ships, the R/V Johnson and R/V Sea Diver, two submarines, Johnson-Sea-Link I and II, and a sophisiticated remote controlled vehicle named CORD (for Cabled Observation & Rescue Device). Harbor Branch Foundation had been generous with an offer of up to three weeks of project time. All we needed was cooperation from the weather.



Harbor Branch Foundation's R/V Sea Diver, with Johnson-Sea Link I on the stern, anchored on quiet evening off Cape Hatteras (above). Below, Johnson-Sea-Link II on bottom, with diver locked out (note open hatch at left under sub) to retrieve lantern.

Meanwhile Slama, Chief of Photogrammetric Research for NOS, was busy designing the camera system for the submarines and the method for calibrating the system at 210 feet. The concept is the same as making a photogrammetric survey from an airplane, which NOS does routinely; designing the system to take the photographs is an altogether different challenge. Slama designed a system of stereo cameras and dual strobe lights mounted to a frame on the front of the submarine. Calibration of the system was to be done on the bottom at the wreck using a five by eight foot aluminum grid. Watts had his hands full, too. In addition to photography, we planned to retrieve a half-inch, 200 pound bottom plate and a camera system snagged in the wreck in 1973. He was responsible for designing a method of keeping the bottom plate stabilized until engineering testing and analysis could be conducted by experts. The plan and the equipment were ready to go. Hurricane season had begun but no disturbances were yet reported in the Caribbean.

Disturbances were reported in the office, however. The list of people who wanted to join the project was growing at an incredible rate. Once the word gets around that a project is planned at the wreck of the Monitor, the phone doesn't stop ringing. Civil War buffs, Monitor enthusiasts, scientists and the press are all suddenly interested. A team was selected to work with NOAA and Harbor Branch. In addition to Watts and Slama, it included Harold Edgerton from MIT, an expert in underwater photography, and Donald Rosencrantz from the Navy, with experience in marine archeology. Dr. Edgerton was aboard the R/V Eastward in 1973 when the camera system of his design was snagged in the wreck. Lost with the camera were the first pictures ever taken of the

Diver's eye view of the Monitor (above). Resting bottom up on the sand, about one-third of the underhull is visible in this photo; broad diagonal band is five-foot high armor belt that encircled hull; ship's keel is at top of the wreck. At right, Cdr. Phillip Johnson, NOAA, examines the lantern.

Monitor. We planned to recover the camera system, and Dr. Edgerton was going to be there. If the film was still good, he would try to salvage it.

The expedition began on July 17. The first week was spent locating the wreck with LORAN C and Del Norte navigation equipment, and using side scan sonar to look at the wreck and to search within one half mile on either side for other obstacles or artifacts. The wreck lies on a sand plateau with no major rock outcrops or other objects in the vicinity. The wreck acts as an artificial reef attracting schools of fish of all sizes.

On Friday, July 22, the CORD system gave us our first TV pictures of the Monitor. What pictures! The visibility was well over 100 feet as the TV camera scanned the wreck from bow to stern with the turret clearly visible as it protrudes from beneath. And fish everywhere! The reaction of the scientists and archeologists was predictable. "Astounding." "Remarkable." "Overwhelming."

Little did they know that the best was yet to come.

The R/V Johnson with the submersible Johnson-Sea-Link II arrived at the site on July 24, and submersible operations began the next day. For most of the next nine days one and sometimes two submarines worked on the bottom. Bottom conditions, currents and low visibility, and surface conditions, wind and sea state, hampered the operation two days and cut a mission short on a third. The weather is notoriously unpredictable at Cape Hatteras and bottom conditions were found to be equally variable.

The baseline to guide the sub pilots for the photography was laid without a hitch in one day. Passes for the horizontal and oblique stereo photography were conducted three separate times, twice in black and white and once in color. Each photo mission obtained more than 1200 individual photographs. Vast amounts of new information was being accumulated but the work was sometimes tedious and routine, and there was always the weather. We always thought about the weather.

During the second week of operations, several people had the opportunity to view the wreck from the submarines. Watts' reaction was typical. He described the wreck as larger, more massive and in better condition than expected. "You don't get the full impact of what it will take to recover the Monitor until you are sitting next to it on the bottom," he said. Cdr. Johnson noted in his dive log that "the Monitor has a dark green cast to it and the armor belt and turret look to be in very good condition—the ship appears austere and solitary and very much like a shipwreck." He closed with the comment that "I wish this opportunity was available to more people."

Then suddenly it was Monday, August 1. The plan for the day was to finish a run of oblique color photography, to recover the camera system and bottom plate from the wreck, and to bring up the lantern with the red lens. Johnson-Sea-Link II (JSL-II) was on the bottom finishing the photography and Johnson-Sea-Link I (JSL-I) was preparing to launch when Cook passed the word that the wind and sea state exceeded operating limits.

Twenty-four hours of tension, of expectation, of renewed planning.

On Tuesday, all systems were GO. The sky was partly cloudy with small thunderstorms moving through the area. Winds were 10 mph and the seas were calm. On the bottom the visibility was about 50 feet but the light level was low due to the clouds above. Everything was cast in an eerie greenish color. Richard Roesch, an HBF diver, was to recover the artifacts. He was diving on mixed gas, and was tethered to JSL-I for life support and communications.

In JSL-II Watts and I watched, 10 feet from the lantern, as Roesch swam over from the other sub with a plastic bucket. He gingerly scooped up the lantern, placed it in the bucket and swam back toward the dark hulk of the wreck. Our submarine moved back over to the wreck as Roesch transferred the bucket into the pressurized diving chamber in JSL-I. Then, taking two lifting bags, he swam up over the edge of the Monitor's armor belt and down into the wreck to recover, first, the bottom plate, and then the camera system. The two inflated lifting bags, looking like two huge yellow balloons, floated slowly to the surface with their cargo.

The plate was recovered at the surface routinely but the camera system "burped" at the surface and sank immediately to the bottom. But Roesch's job was finished and he and JSL-I returned to the surface for decompression. JSL-II began a search down current of the wreck and came upon the camera system and lift bag about 200 yards distant. The manipulator on JSL-II was used to grasp the camera system and return it to the surface.

Much is yet to be learned from the photographs and from the plate and its analysis. NOAA will be working with many Federal, state, and private groups to better understand the Monitor and its environment. The question most often asked is, can the Monitor be raised? It is a question worthy of an answer considering the significance the USS Monitor has in the history of our country and in its role in advancing naval technology. But it is a very complex question requiring the thought and study of many scientists, archeologists, and engineers. Perhaps Cdr. Johnson's wish will come true. Perhaps more Americans will eventually be able to see the remains of a most unique vessel—the "impregnable steam battery of light draught"—the USS Monitor. □

Scrimshaw & Scrimshanders, Whalebone & Whalers

By BRIAN E. GORMAN

"Long exile from Christendom and civilization inevitably restores a man to that condition in which God placed him, i.e., what is called savagery. Your true whale hunter is as much a savage as an Iroquois. I myself am a savage. . . . Now, one of the peculiar characteristics of the savage in his domestic hours is his wonderful patience of industry. . . .

"As with the Hawaiian savage, so with the white sailor-savage. With the same marvelous patience and with the same single shark's tooth, or his one poor jack-knife, he will carve you a bit of bone sculpture, not quite as workmanlike, but as closely packed in its maziness of design as the Greek savage, Achilles' shield; and as full of barbaric spirit and suggestiveness as the prints of that fine old Dutch savage, Albrecht Dürer."

Herman Melville in Moby Dick, or the Whale

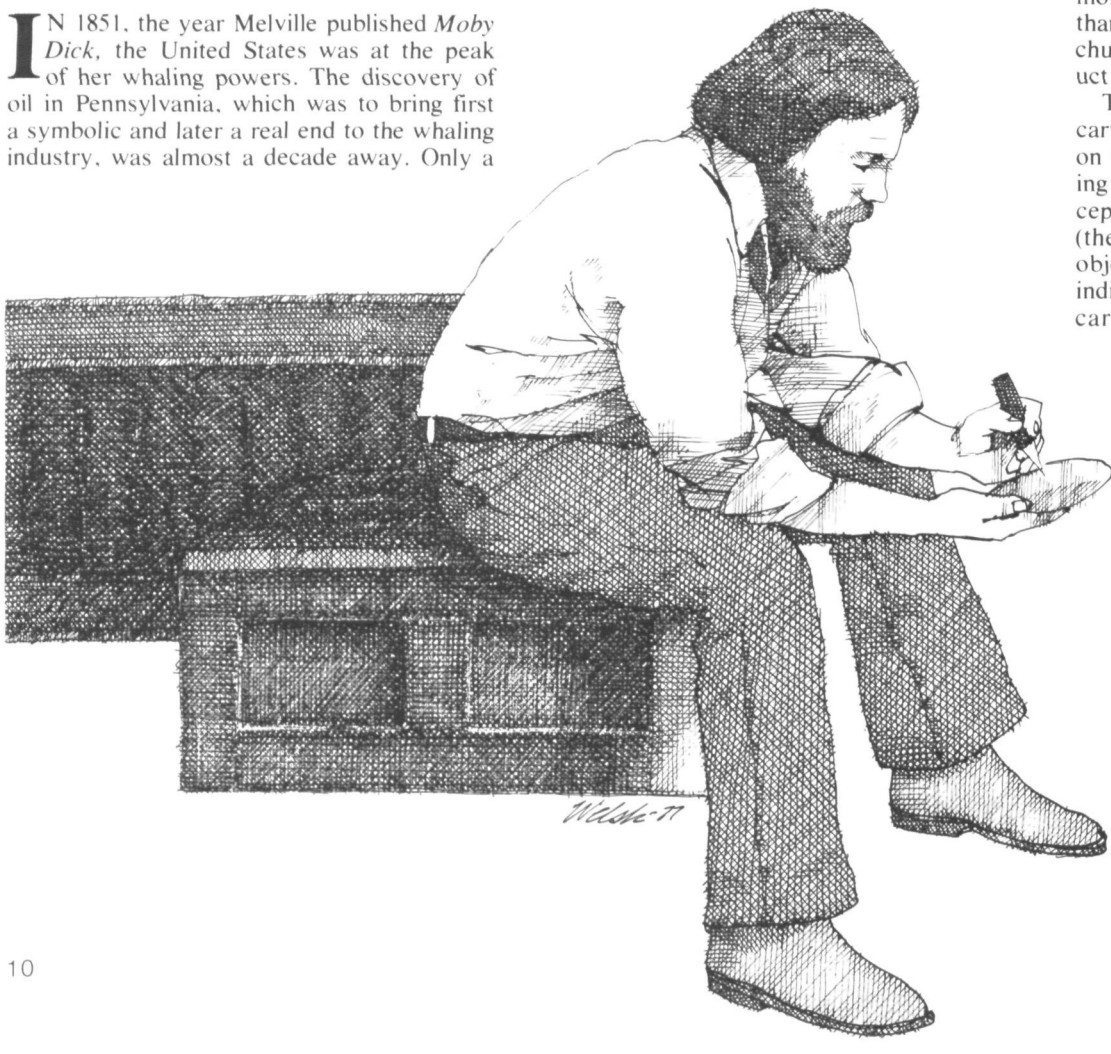
IN 1851, the year Melville published *Moby Dick*, the United States was at the peak of her whaling powers. The discovery of oil in Pennsylvania, which was to bring first a symbolic and later a real end to the whaling industry, was almost a decade away. Only a few years before, in 1846, the U.S. had a record 729 registered whaling vessels totalling more than 230,000 gross tons. The demand for whale oil, both for lubrication and illumination, continued to climb and was making masters and the owners of their vessels—if not their crews—fabulously rich. The success of some cities, such as New Bedford, Mass., was so intertwined with whaling that even now, more than a century later, it is difficult to walk their streets and see their houses without thinking of the industry that made their existence possible.

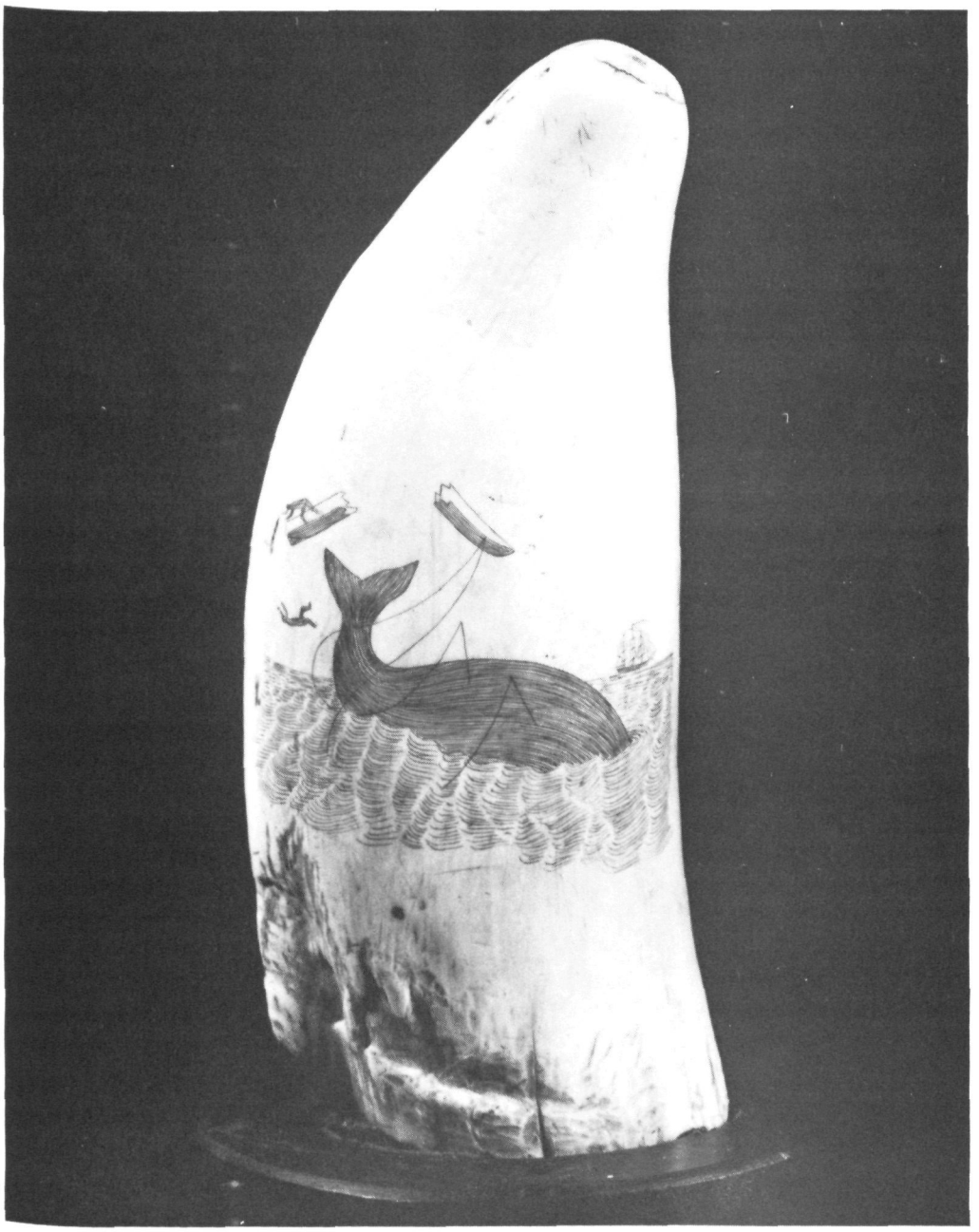
Little more than memory of those times now remains, however. The oil, rendered in sooty, stinking iron tryworks on the decks of whalers and sold for $1.15 a barrel at the end of a voyage that might last three or four years, is gone forever. Gone, too, is the "whalebone," more properly baleen, the long, horny, bone-like plates, taken from the mouths of right whales and their relatives, commanding prices upwards of $6.00 a pound on the London market in the late 1870s, and used to provide stiffness to corsets and breathless beauty, literally, to their wearers.

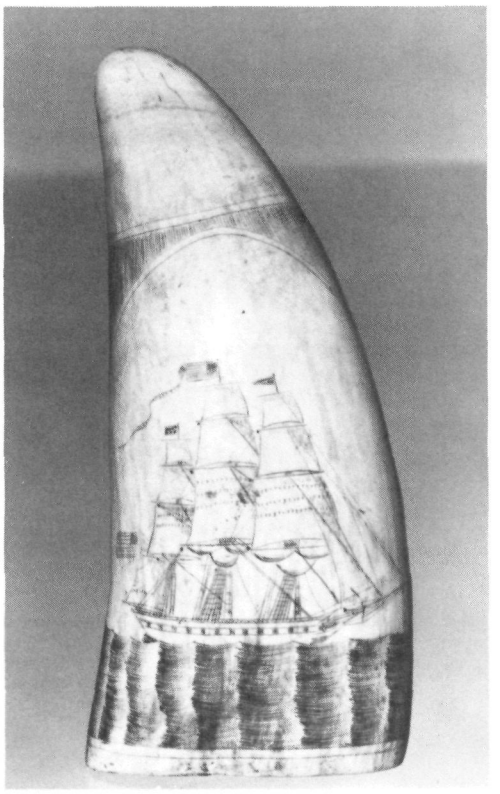
There is no longer a market for such items. Whale oil has been replaced by gas, petroleum ("rock oil" rather than "whale oil"), and electricity. And the uses to which baleen was put have given way to other notions of the female form.

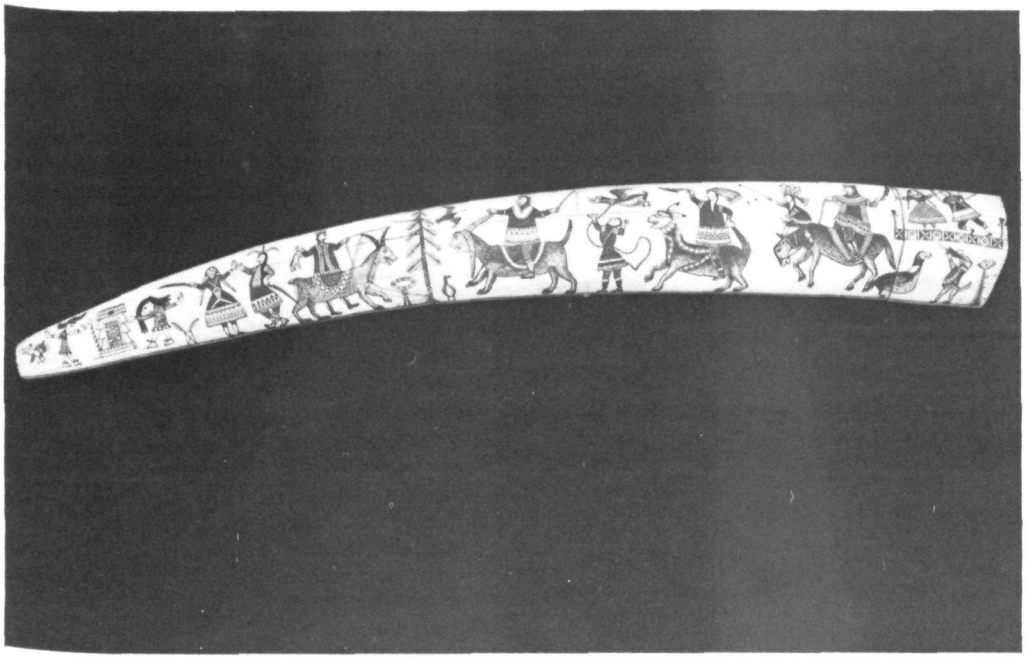
Ironically, the product of whaling that was of no economic importance at the time, that was the result of nothing more than a fortuitous combination of Yankee utilitarianism and simple boredom, almost certainly has more meaning to contemporary Americans than all the oil and baleen landed in Massachusetts in the nineteenth century. That product is scrimshaw.

The history of scrimshaw, the decorative carving of objects both useful and aesthetic on whalebone and whale teeth, is as fascinating as the objects themselves. With the exception of American Indian art, scrimshaw (the name properly can describe both the object and the process) is the only truly indigenous American folk art form. It was carved almost exclusively by sailors on









The classic scrimshaw medium was the sperm whale's tooth. Whaling scenes such as those above and left were repeated countless times by scrimshanders. The engraved walrus tusk (below, left), carved by a 19th century Eskimo rather than a whaler, displays the versatility of marine ivory. (Photos courtesy the Smithsonian Institution)

American vessels, although the sailors themselves were not always American natives. In fact, a study of the New Bedford fleet in 1880 revealed that of the 3896 "whalemen" cited, about one-third were American born, one-third Portuguese, and the remainder "Negroes, Kanaka [South Seas Islanders, generally Hawaiian], and American Indian." Moreover, like any other folk art form, scrimshaw really had no patrons. It was created for the pure pleasure of carving (although part of that pleasure was motivated by the intolerable boredom of whaling voyages). During its heyday at least (from about 1840–1870), it seldom seems to have fallen prey to a formal commercialism. Part of its modern charm, in fact, lies in the knowledge that thoughts of profit usually didn't enter the mind of the carver, or scrimshander.

Also, like other genuine folk art, scrimshaw embodied what is called "found art." In the same way that nineteenth century women gathered together scraps of cloth to make quilts, so too did the whalemen gather scraps of whales—teeth, baleen, bones—and occasionally other "found objects"—tortoise and sea shells, coconuts—to work on, although these latter are usually not considered genuine scrimshaw. Its "market" was for the most part limited to wives, cousins, and sweethearts back home. However, it was not unheard of for a whaleman in a foreign port

to barter his carvings for clothing, drink, or other needs.

Finally, scrimshaw has the quality of being inseparable from the medium from which it grew. Scrimshaw *is* carved whalebone and carved whalebone *is* scrimshaw. The result is an art that has unique characteristics: created by a people while at their work on the discarded products of their industry with design motifs that are predominantly about that industry.

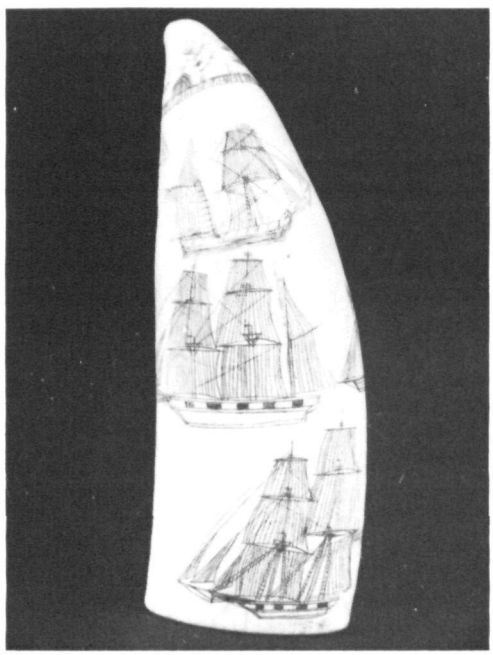
Who were these scrimshanders? What kinds of things did they make and why? To answer these questions, it is necessary to understand not so much the whaling industry itself as the ordinary men who served as crew aboard American whalers in the nineteenth century. They were, for the most part, quite unexceptional. They were uneducated; most could neither read nor write. They were young; it was not at all uncommon for a mother to send her downy 16-year-old son away on his first whaling trip and have him return, a quarter of his lifetime later, a very different 20-year-old. Finally, and most importantly, while they were whaling, they were bored.

In spite of the popular view of whaling as an exciting, challenging, romantic life—Nantucket sleigh rides, crazed whales, nubile island girls—it was in fact an extraordinarily tedious existence. On a voyage that might last four years (not at all uncommon in the 1850s and 1860s), perhaps only 75 whales would be taken. They would be hunted, killed, blubber rendered, and their oil stored away in barrels in a total of 50 or 60 days. That left the crew more than 1300 days of sailing, stopping for stores, more sailing, maintaining the vessel, and still more sailing. And all the while confined to an inhospitable, unnatural space no more than 200 feet long and 40 feet wide, eating ghastly food, and sleeping in a forecastle with little headroom, less ventilation, and no light at all. By comparison, the inmates in most prisons live in regal splendor. Out of this nettle, boredom, whalemen plucked a flower of remarkable beauty.

The first known reference to the practice of scrimshaw occurs in an entry for May 20, 1826 from the log of the brig *By Chance* out of Dartmouth, Mass.: "All these 24 hours of small breezes and thick foggy weather, made no sale. So ends this day, all hands employed Scrimshonting." Variants of the word—*squimshon, scrimshone, scrimshorn,* and *scrimshand*—which appear in logs and in print throughout the period, suggest to some authorities that a commonly supposed Dutch origin for the word (scrimshander = idle fellow, time waster) may be fanciful.

But no matter what the etymology of the word, scrimshanders were hardly idle. Between 1825 and 1865, some 200,000 sailors carved what must have been several million pieces of scrimshaw, although fewer than 8000 pieces are extant. Their materials came from three parts of the whale: bone, hard, available in great size and quantity, and wrought into items of primarily utilitarian purpose; baleen, long, flexible, useful not so much for carving (it was too thin for much intricate work) as a fascinating construction material for such items as swifts (collapsible umbrella-like devices for wrapping yarn) and

Although scrimshaw was generally simple and nautical, like the crudely inscribed whalers, below, left, some carvings, like this grande dame of the 1870s, were beautifully executed. The bone object, above, left, is a seam smoother, used by the sailmaker to finish off his repairs. (Photos courtesy the Smithsonian Institution)



Victory for whale protection

REPORT FROM CANBERRA

"A victory for conscientious protection of the world's whales, based on sound science."

Dr. William Aron, NOAA's Director of the Office of Ecology and Conservation, thus described the results of the 29th Annual Meeting of the International Whaling Commission in Canberra, Australia, in June. Aron was the U.S. Commissioner to the IWC at the meeting, and had long been associated with it as a member of the Scientific Committee.

Results of the IWC meetings have not always been so positive. The Commission is about thirty years old, having been established under the 1946 International Convention for the Regulation of Whaling. Its initial purpose was to increase the yield of whales, rather than to reduce whaling activities. However, prohibitions were adopted early on against commercial taking of a number of species, including gray whales and all species of right whales.

There are, incidentally, no "left" whales. Right whales, including bowhead whales, are species particularly desired by the whalers of the last century for the large yield of whale oil and baleen, and because they are slow swimmers and their carcasses ordinarily float. When one was sighted, the lookout would identify it as one that was "right" to kill, as opposed to animals that were too fast to catch and that sank when killed.

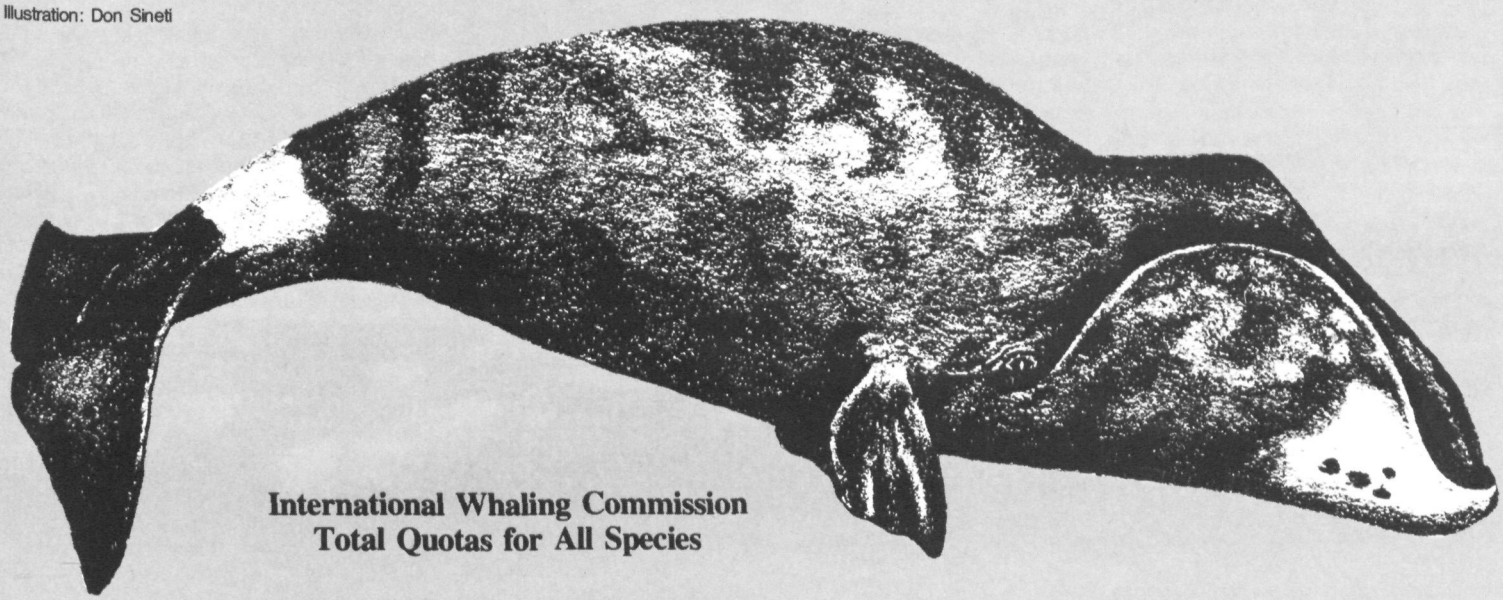
Yankee whalers, joined by men of many other nations, consequently wrought havoc upon them.

But despite the fact that the United States was once one of the great whaling nations of the world, Americans have long had a feeling for the great animals that encompasses more than simple consumptive use. For many, they have cultural and esthetic value, too, value expressed in literature, art, and—today—in study and recreation. The hundreds of people who go to California to watch the gray whales migrate provide economic evidence of the esthetic value of whales, a value that to many of them far exceeds the value of consumption of whale oil and baleen products. The U.S. has therefore been a leader in the IWC for a number of years in promoting a conservation, rather than a consumptive, emphasis to whaling activities.

In the past six years the IWC has greatly increased its effectiveness in conservation activities, and other actions in the international arena have also served to help the great mammals. In the U.S., the Secretary of Commerce abolished commercial whaling in 1971, and shortly thereafter the last U.S. whaling station was closed. A system of international observers was finally agreed to by the IWC that same year, after repeated efforts had been made over the years to establish such a system. In 1972, the United Nations Conference on the Human Environment, at Stockholm, passed a resolution calling for a 10-year moratorium on all commercial whaling. The United States supported the resolution and attempted to have it considered by the IWC, but was rebuffed; the U.S. has continued to support it. However, at the 1974 IWC meeting a system of "selective" moratoria was established, and the following year it went into effect. In addition, the IWC members have agreed that all whale stocks must now be classified, including those not fished, so that necessary research can be performed and management instituted when necessary.

During the 1975 meeting the IWC adopted a New Management Procedure that encompassed the requirement of classifying all stocks, and provided that both the classifica-

Illustration: Don Sineti



International Whaling Commission Total Quotas for All Species

1973	*1974*	*1975*	*1976*	*1977*
45,673	42,473	33,936	28,050	17,839

tions and the catch limits must be "according to the advice of the Scientific Committee." For classification purposes, stocks were defined as follows:

—"Protected Stocks" are those under 10 percent below the population level that will give a maximum sustainable yield (MSY) or optimum population, as that may be determined; no commercial whaling is permitted on Protected Stocks.

—"Sustained Management Stocks" are those between 10 percent below and 20 percent above the MSY or optimum population level; limited whaling is permitted.

—"Initial Management Stocks" are those over 20 percent above the MSY or optimum population level; whaling is permitted except on species about which there is insufficient data to assess the consequences.

As a result of this major step forward, many of the selective moratoria will be in effect for much longer than the 10 year complete moratorium would have provided, because the stocks will not have been renewed to levels where whaling can begin again.

Limitations placed on commercial whaling by the Commission in 1975 were more stringent than ever before. The Commission listened more closely to its Scientific Committee, which had developed new statistical tools and modeling techniques for estimating the populations of stocks of whales. As a result, the southern ocean sperm whale quota was decreased from almost 12,000 in 1975 to 4791 in 1976—a reduction that hit the Soviet and Japanese, the chief whaling nations today, particularly hard. Neither nation filed an objection to the Commission action, however. Filing an objection would have indicated that they would not go along with the IWC ruling. Instead, both nations reduced the size of their whaling fleets by about one-third, and laid off substantial numbers of workers.

With the recent history of change in direction of the IWC and the commitment to adhere to the advice of the Scientific Committee, signs were auspicious for the meeting held last June in Canberra. At the opening of the session, the U.S. Commissioner read a message to the delegates from President Jimmy Carter, reaffirming the U.S. interest in conservation and its continued strong support for the 10-year moratorium. It did not go unnoticed that this was the first time that an American President had sent a special message to the Commission, and the delegates were impressed with the seriousness with which the U.S. viewed the deliberations.

Meetings of the IWC itself are preceded by meetings of the Scientific Committee. The committee had applied its statistical modeling techniques to North Pacific sperm whales, and on the basis of the results recommended a zero quota on males (as compared to 4,320 the previous year) and a reduction in the female quota from 2,880 to 763. This was another serious blow to the Japanese and Soviet whaling interests. Adhering to its new guidelines, however, the IWC voted to adopt those quotas.

Numerous other quota changes were also adopted, in most cases calling for a reduction in catch over the previous year. Catches of sei whales, for example, are totally forbidden in four of the six areas of the Southern Hemisphere protection stocks, and in the remaining two cannot exceed 771, a reduction of 58.5 percent from the previous season's limit.

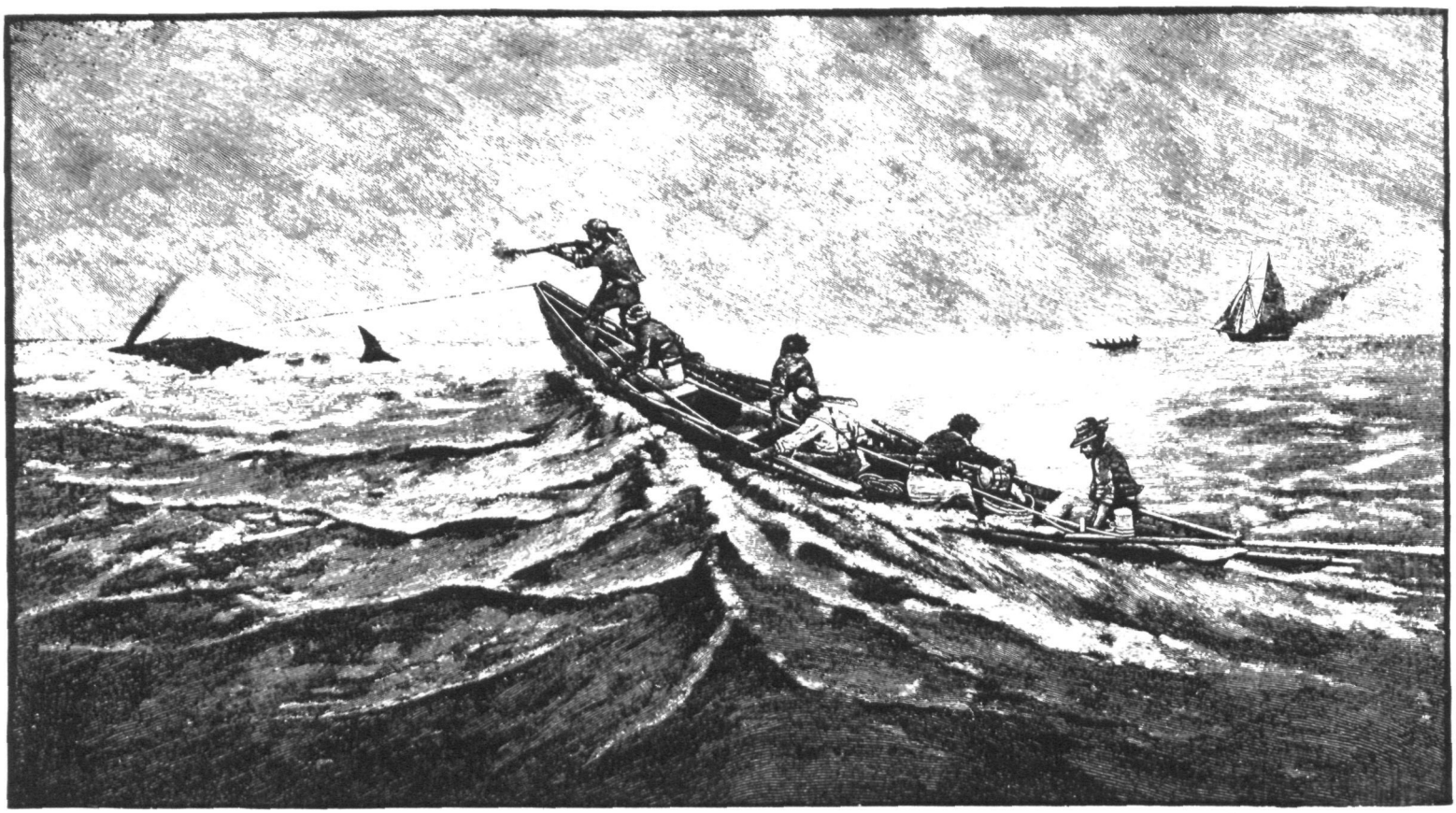
Other quota reductions include minke whales in the Southern Hemisphere, down from 8900 to 5690; Bryde's whales in the North Pacific, down from 1,000 to 524; and sei whales in the North Atlantic, down from 132 to 84.

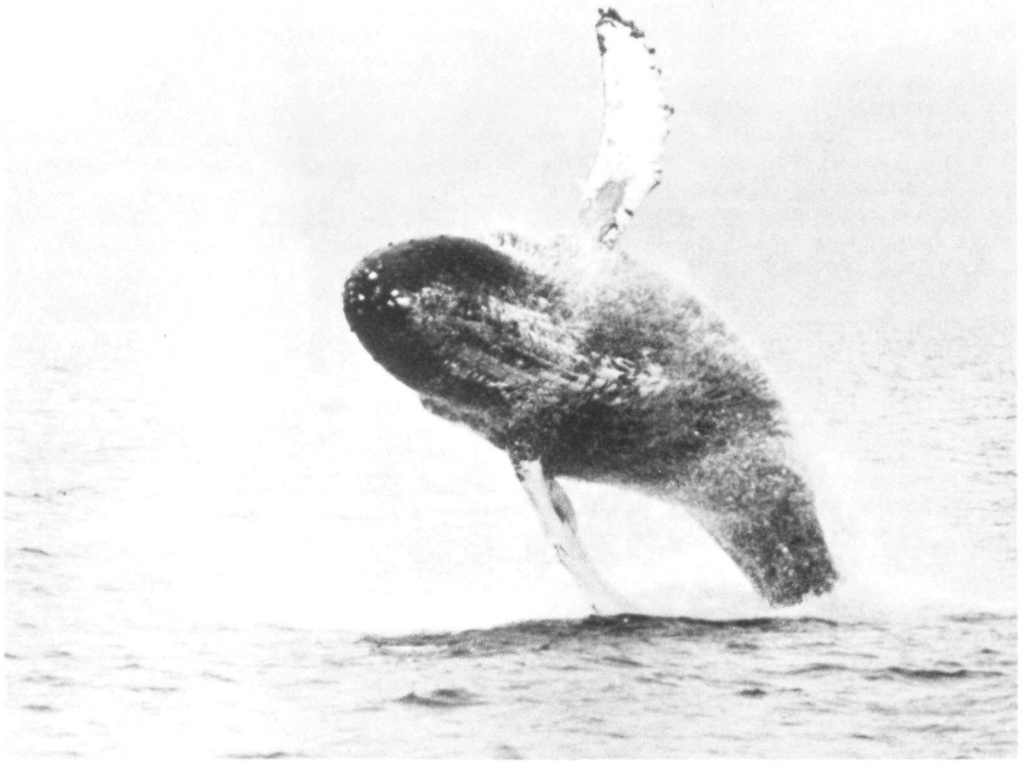
The total quota for all species was reduced from 28,591 to 17,839.

There had been concern that as whaling fleets among IWC member nations were reduced, much of the equipment, vessels, and expertise would be transferred to non-member countries that also engage in whaling. With respect to ships, Japanese law forbids the resale abroad of its whaling vessels, and both the Russians and the South Africans scrapped their ships. Whaling equipment and expertise were different matters. The United States proposed an amendment to the IWC schedule to forbid such transfers, but was again unsuccessful in obtaining Commission agreement. However, this year for the first time the Commission passed a strongly worded resolution requesting member nations to take all practicable steps to prevent such transfers.

To further discourage whaling by non-IWC nations, the Commission also adopted a resolution asking members not to buy whale products from non-member nations; Peru, for example, is not an IWC member and has sold whale products to member nations for the past several years.

The Commission again adopted resolutions addressed to non-member nations, calling on them to join the Commission and to cooperate in the conservation of individual stocks of whales. Four such resolutions were passed:





—to the People's Republic of China, the Democratic People's Republic of Korea, and the Republic of Korea concerning the Sea of Japan stock of minke whales;

—to Spain concerning the Spain, Portugal, and British Isles stock of fin whales;

—to Portugal concerning protection of right and other endangered species of whales in waters under Portuguese fisheries jurisdiction;

—to Spain and Portugal concerning sperm whales in the North Atlantic.

The Commission also came to a decision that was the occasion of considerable embarrassment to the American delegation, and that confronted the United States with a very difficult decision. This was the decision that the Schedule be amended to remove the aboriginal right to take bowhead whales.

Bowhead whales of course were among the species first banned from commercial whaling by the Commission. A small aboriginal catch has been permitted through the years, as these whales are part of the subsistence of Eskimo and other peoples in North America and the Soviet Union. A large part of their native culture as well as diet is founded upon their whale fishing.

It is known that Eskimos began hunting bowheads in Northwestern Alaska in about 800 A.D., and there is archaeological evidence to suggest that the practice may have started on St. Lawrence Island about 1,000 years earlier than that. The great amounts of food that came from whaling during the eight-week spring hunt, when bowheads were migrating, gave the Eskimos leisure time to develop a rich artistic culture.

With the discovery of bowheads by Yankee whalers—it occurred in 1848, when Capt. Thomas Roys of Sag Harbor, Long Island, sailed north after a poor season off the Chilean coast—came the near-destruction of the bowheads. Within a few years more than 200 ships operated in the Bering Strait, seeking the bowheads for their oil and baleen.

Baleen was the best material for corset stays, and 19th century fashions increasingly called for narrow waists. By the beginning of the 20th century the price of baleen was more than $5 per pound, and each adult bowhead was worth more than $10,000. The collapse of the industry came in 1908, when spring steel was introduced as a cheaper substitute, but it was almost too late for the bowheads.

In the years since then the Eskimo kill has been as little as ten each year in all of Alaska, climbing up to about 15 in the 1960's—a rise that has been interpreted by some as evidence that the bowhead population was slowly beginning to rise from its severely depleted 1910 level.

Beginning in about 1970 Eskimo whaling entered a new and controversial phase. With the ready availability of jobs on the Alaska pipeline, young Eskimos were for the first time able to lay by the large amounts of money required to invest in whaling equipment—boat, shoulder gun, darting guns, tent, sleds, rifles, bombs, cooking gear. No longer confined to the seasoned older whalers, the hunt was now also conducted by numerous groups of younger Eskimos. In addition, hunting began to take place during the fall reverse migration, as well as the traditional spring hunt.

The number of whales killed by the native peoples thus began to rise dramatically, up to 56 in 1976 and 28 during the spring hunt of 1977. Moreover, there is apparently an increasing number of animals that are struck and then lost, either because they dive under the ice and cannot be retrieved, or because they do not die immediately and escape their pursuers. An additional 77 bowheads were reportedly struck and lost in the 1977 spring hunt.

These kills were of great concern to the Scientific Committee because they were further reducing an already severely depleted population. The native take of whales is estimated to be removing whales from the stock at a minimum rate of 6.7 percent, while the "recruitment" rate—the rate at which young whales are born and brought into the stock—is only between three and four percent.

The seriousness of the problem is accentuated by the fact that best estimates of the bowhead population place it at no more than 10 percent of its original stock size. The removal rate caused by the native hunters is greater than the rate permitted by the IWC for stocks that are at least 88 percent of their original stock size.

During the previous meeting, in 1976, the IWC passed a resolution to which the United States agreed, asking that the U.S. take all possible action to reduce the bowhead whale kill by aboriginal populations in Alaska, both to reduce the fishing effort and to reduce the loss rate.

During the 1977 meeting the U.S. Commissioner had to report failure in both these areas. The level of hunting had increased, and the loss rate had increased.

Because the loss rate exceeded that permitted for healthy whale stocks, the IWC therefore removed the aboriginal right to take bowhead whales.

And this action placed the U.S. in the dilemma of seeing two of its national commitments in collision—the commitment to preserve whales, and the commitment to preserve native cultures. Two courses of action were open. One was to file an objection to the IWC action, which would mean that the U.S. would continue to permit native subsistence whaling, with consequent loss of U.S. credibility in the IWC and continued erosion of the bowhead stock. The other was not to file an objection, with consequent impairment of the Eskimo means of subsistence and of their unique and valuable culture. NOAA prepared a draft environmental impact statement that analyzed the consequences of both courses of action—consequences for the whales, consequences for the native populations, consequences for the U.S. position in the IWC. Hearings were held during September in Washington, D.C., and Barrow and Kotzebue, Alaska, on the document, with testimony by Federal, State, and local officials, by Eskimos, and by representatives of environmental groups on both sides of the issue.

In the end, it was decided that the U.S. would not file an objection. It was pointed out that this year's ban on hunting bowheads may save the very source of sustenance that the native peoples have depended upon, and that limited hunting may once again be permitted in the future. Although the Eskimo population will be faced with grave problems, it is felt that these are not insurmountable. In addition, Federal and State officials have pledged themselves to assist in every way.

Hams and CB'ers

Allies to Disaster Fighters

By EDWIN P. WEIGEL

The scene: a lone man standing on a hilltop next to a parked car, microphone in hand. He stares intently at a large black cloud approaching rapidly from the west. Suddenly, the cloud develops an ominous circular motion. Part of it descends and takes on the shape of a whirling black funnel, the tip of which touches the ground and stirs a cloud of dust.

Tornado!

The man speaks into his microphone: "Civil Defense Net Control, this is W5VOW in Sector Location Charlie. Tornado sighted. Appears to be heading toward Jefferson High School."

Civil Defense Net Control, in a local Weather Service office, responds: "Roger Skywarn Charlie One. All Skywarn units in southwest quadrant: Tornado sighted near Jefferson High School. Any Skywarn units in Sectors Charlie Two or Dog Three, report to Net Control."

Dog Two reports: "Funnel in sight. Moving fast. Heading almost due east. Looks like tornado will pass about six blocks south of me."

Civil Defense Net Control: "All Skywarn units please copy. Weather Service now has hook echo on radar. Appears to be the tornado reported. Radar shows movement east-northeast at 30 miles per hour. Weather Service has issued tornado warning for Okaloosa and Sumter Counties. Continue your surveillance."

The tornado warning spreads swiftly throughout the area via teletypewriter, commercial radio and television, hot-line telephone calls to public-safety agencies, and NOAA Weather Radio. Sirens wail. People run for cover to basements of homes, interior corridors of large buildings, inside closets, and even into ditches or beneath roadside culverts.

The tornado strikes the community with devastating force, leveling homes, unroofing schools, tumbling automobiles like toys, uprooting trees, and sending telephone poles flying through the air. Yet not a single life is lost.

This scenario is fiction, yet it is typical of a type of coordinated effort which has saved many lives in the United States. It could have taken place in Texas, Nebraska, Oklahoma, Mississippi, Missouri, or many other states.

It represents a kind of disaster preparedness that other areas could well emulate when fast-paced threats such as severe thunderstorms, tornadoes and flash floods are bearing down.

The key is an alliance between the Weather Service and a growing number of volunteer two-way radio operators—namely, amateur radio operators or "hams," and citizens-band or CB radio operators.

The two groups are quite different. First, the hams: There are more than 250,000 of these skilled amateurs in the United States, more than 700,000 worldwide. To become a U.S. amateur radio operator, an applicant must pass exams administered by the Federal Communications Commission, including a written test on radio theory, communications procedures, and FCC regulations, and a test of ability to send and receive International Morse Code at no less than five words a minute.

Carl Reber, executive officer of the National Weather Service's Southern Region, headquartered in Fort Worth, Texas, is a dedicated ham. His *Amateur Radio and the National Weather Service* is an excellent guide to the utility of hams in a storm-spotting and reporting system, as these excerpts show:

Hams have been radio experimenters and developers since before 1912, only a few years after Marconi's first demonstration of communication by radio. They have made significant contributions to long-range communication by radio. They pioneered in development of high-frequency communication after commercial interests had abandoned these bands as useless. They explored practical applications of very high frequency (VHF), ultra high frequency (UHF), and microwave frequencies.

Amateur organizations have built and operated satellite-borne communications stations. These were "piggy-backed" on regular space shots at no cost to the taxpayer. Although only a few hams possess skills and resources to accomplish such feats, all have the ability to provide reliable communications during emergencies. They realize that continuation of their hobby depends on the value of their service to the nation. So they have given freely of their personal time and made their equipment available to meet almost every imaginable emergency communications need.

Brian Peters, amateur radio operator and National Weather Service meteorologist, transmits severe weather information to other amateur radio spotters watching the skies from mobile units throughout the area.

Two such activities are recognized nationally: *R*adio *A*mateur *C*ivil *E*mergency *S*ervice (RACES), and *A*mateur *R*adio *E*mergency *C*orps (AREC).

RACES is intended to provide emergency communications during civil emergencies as an aid to Civil Defense or in wartime. RACES shares frequencies with the regular amateur radio service.

AREC consists of emergency communica-

tions groups throughout the country—membership all told, about 30,000. AREC is sponsored by a national organization, the American Radio Relay League.

In addition, there are many amateur groups organized on a local or an area basis ready to provide emergency communications and storm-spotting services for the Weather Service.

Reber offers tips to Weather Service personnel on how to get such a group started:

First, the Weather Service and radio hams must get together to decide what the amateurs can handle. Weather Service personnel not familiar with amateur radio can learn about local groups by asking engineers of local commercial or government broadcast stations; by consulting radio supply houses catering to amateurs (see the yellow pages of the telephone directory), or by asking the section emergency coordinator of the American Radio Relay League. Reber says the Southern Region can supply a list of coordinators; typically there are one or two per state.

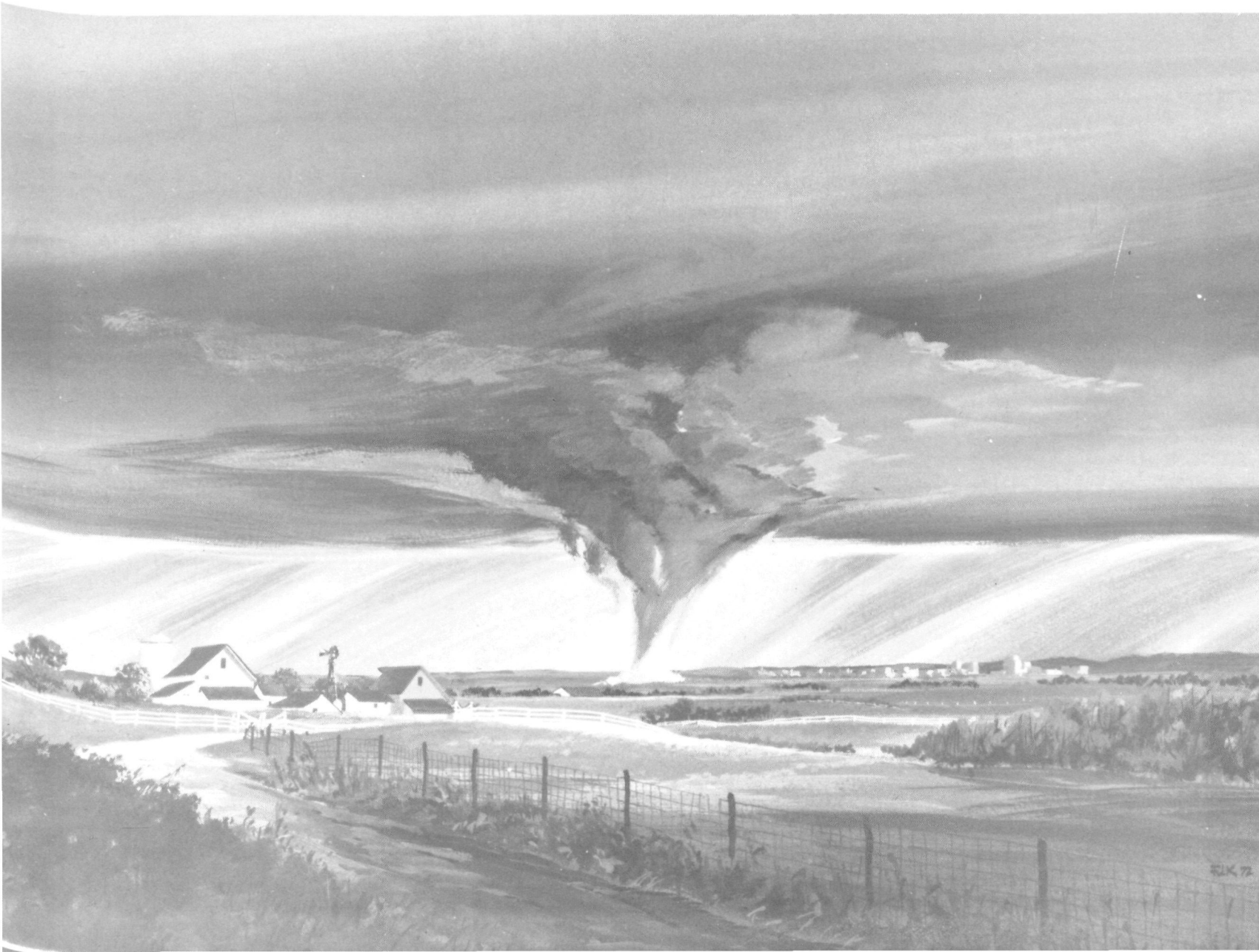
Once contact is made, both the Weather Service and the hams must speak frankly. There's no point in overselling and then having to pull back later. The Weather Service should spell out in which counties and approximate locations storm spotters will be needed. Officials should say they will provide the necessary training; that hams must provide the equipment. People with casual or fleeting interest should not be recruited.

Hams should designate one person or a small committee to represent them in producing an operating plan. Attention should be given to such questions as: Should storm-spotter training be a requirement for membership? What communications system involving what frequencies and locations should be used? How will the system be activated? (Preferably, one call from the Weather Service to a key individual or designated alternate.) How will reports get to the Weather Service? Will Weather Service personnel have time to monitor the emergency radio channel, or will the amateurs' network control do this? How does the proposed plan fit in with other spotter networks, such as those operated by Civil Defense, and will they be complementary or divisive?

Reber offers the Tulsa, Oklahoma, ham network—the Tulsa Repeater Organization—as a good example. It has been providing storm -spotting services for at least 15 years. The Tulsa Weather Service Office often warns of severe thunderstorms, tornadoes, and flash floods. Although the office has a new radar to cover its entire 21-county area, radar alone cannot assure positive identification of a tornado. Trained observers near the tornado must provide on-the-scene information to correlate with the radar image. More than 150 radio amateurs participate; some have served for many years. Proficiency is maintained by self-initiated drills and twice yearly training and refresher lectures by the Weather Service.

The Tulsa network is activated by a Weather Service request to a Civil Defense Warning Officer. He designates one ham, occasionally two, to man the Net Control Station, located at the Weather Service Office, where the hams keep a transceiver permanently.

The Net Control Station monitors reports and screens out information not needed by Weather Service personnel. The station also relays Weather Service requests to hams about areas judged to hold a potential for severe weather. Spotter reports are identified by call letters and supplemented by geo-



graphic information when the spotter is mobile.

The effectiveness of the Tulsa ham network has been demonstrated time and time again.

Reber points to the network in the Dallas and Fort Worth, Texas area as another good example, with many hundreds of dedicated amateurs assisting the Weather Service in storm spotting. They are organized under the RACES system and sponsored by Civil Defense. Participation involves completion of a formal course in storm identification, communications procedures, and operations of the Weather Service. Provided by Civil Defense and the Weather Service, the course significantly enhances the hams' ability to distinguish between tornadoes and "look alikes."

Each trainee is given a spotter network map, gridded in 3-mile squares, covering Dallas and Tarrant Counties, to which he refers when reporting a tornado.

Decision to activate the network is usually made by Civil Defense, based on Weather Service advice, but in the case of unexpected emergencies may also be made by any one of several designated hams. In such a case, the ham operator serves as net controller until normal lines of authority are re-established in the sponsoring Civil Defense office.

When the decision is made to activate the network, the Weather Service notifies selected hams that they are needed in the weather office. Here, as in the Tulsa network, they serve as the link between the Weather Service and the spotters. Criteria for activating the RACES network are Weather Service issuance of a severe-thunderstorm warning, a tornado warning, or a tornado watch.

An outstanding example of the effectiveness of the RACES network in the Dallas-Fort Worth area was the response to the Dallas tornado of May 26, 1976. Spotters, alerted to a dangerous thunderstorm, detected and reported the stage-by-stage development and movement of the twister throughout its lifespan.

The Tulsa and Dallas-Fort Worth networks have much in common with other networks, such as the one that serves Waco, Texas. The Waco network has an added feature. In Waco, TV and radio stations have learned to keep receivers tuned to amateur frequencies during severe storms, so there is the possibility of a tornado report being aired before the Weather Service can verify it and send out a warning on the weather wire. To guard against misleading information, Waco spotters have agreed never to use the word "tornado" in a report unless the tornado has been positively identified.

The other major source of volunteer two-way radio communicators as storm spotters is citizens-band radio or CB. Relative newcomers on the scene in an organized mode, CB'ers are already proving their worth, especially where ham-radio operators are few and far-between.

Some spotters are uncertain whether CB'ers can impose the proper discipline on CB'ers in general to guarantee effective communication in all emergencies, because no training or tests are required to operate a CB radio— only a readily obtained license— and there is no requirement for proper identification so that appropriate action can be taken against undisciplined operators.

Nevertheless, there are success stories. Carl Reber agrees that CB can fill an important gap in areas where there are insufficient hams to provide an adequate network.

Herbert S. Lieb, chief of Disaster Preparedness for the National Weather Service, has been a key link with CB operators, particularly a group known as REACT—for *R*adio *E*mergency *A*ssociated *C*itizens *T*eams. According to its national headquarters in Chicago, REACT has grown since 1962 to an organization of nearly 1,000 teams and 40,000 participants, operating in all 50 states and seven Canadian provinces.

REACT teams agree to operate a 24-hour monitoring system on Channel 9, the emergency channel of CB.

The lifesaving role of REACT during weather emergencies was demonstrated dramatically in the Omaha, Nebraska, tornado of May 6, 1975, which left three dead, about 200 injured, and more than 2,000 homes or apartments damaged or destroyed. The Omaha *World Herald* headlined afterward, "It Could Have Been Worse, But Tornado Alert Worked." Estimates of the potential death toll ranged to 500.

The alert was triggered by the Omaha REACT unit, which has a base station at the Omaha Weather Service Forecast Office. On May 6, Omaha REACT had 15 spotters at eight locations. Colonel John Tracy, assistant operations officer of the network, was parked on a hilltop about 10 miles southwest of the city limits. His sighting of a funnel cloud weighed most heavily in the issuance of a tornado warning by the Weather Service Forecast Office, the relays of that warning by commercial radio and TV, and the sounding of sirens in the city.

Still, because CB is of limited range, and more subject to interference from electrical storms than ham radio, expert communicators regard it as second choice for storm-spotter networks—when there is a choice. CB's great advantage lies in the greater number of operators it can draw upon, especially in sparsely populated areas.

It would appear that, nationwide, there is need for both. □

Some Notes on Use of CB and Amateur Radio in the Storm Spotter Function

	CB	Amateur Radio
Purpose (As authorized by FCC)	Citizen Communication Service	International good will; radio experimentation; pool of experienced radio operators for national emergency, other emergency needs
Band allocated[1] Typically 144–148 mHz; also 220–224 mHz.		27 mHz
Mode of Emmission	Amplitude Modulation (AM) Single Sideband (SSB) is also authorized	Nearly all Frequency Modulation, but AM, SSB, and CW also authorized.
Maximum power permissible	4 Watts	Up to 1000 Watts but 5–20 Watts is typical level of use in 144–148 mHz band.
Typical Range	5–10 miles	20–40 miles
Atmospheric noise (relative)	None to heavy	None to occasionally light
Repeater station use authorized	No	Yes (Occasionally 1 or more repeater stations in all large cities.) Repeaters extend range 50–100 miles.
Operator Technical Exam Required	No	Yes
International Morse Code Capability Required	No	Yes (Tested)
Knowledge of communication procedures required	No	Yes (Tested)
Participant Density	Very heavy in cities. Light in rural areas. Used extensively in farm and ranch country.	In the hundreds or more in large cities; few in smaller towns; rare in villages, on farms and ranches.
National Units in Use	Tens of millions	300,000 total, of which perhaps half have equipment for VHF bands.

[1] *Amateurs are allocated 5 bands in High Frequency range—3 in the VHF (including 144–148 mHz) and frequencies in the UHF and Super High Frequency bands.*

National Weather Service and Great Lakes Shippers Join In

CALMING TROUBLED WATERS

By JOAN B. DENT

CLEVELAND'S Port O'Call Motel has a nautical decor—ships' wheels, portholes, and a cocktail lounge as dark as the hold of a ship. On March 22, the motel was socked in by a fog so heavy and thick that you couldn't see the busy highways outside. The Port O'Call seemed to float in the mist, like a ship on the lakes.

It was the perfect place for a Marine Weather Seminar, a precedent-setting meeting among eighty Great Lakes Mariners and about a dozen National Weather Service and Coast Guard officials.

The Seminar was co-sponsored by NWS and the Lake Carriers Association, a group representing Great Lakes ship owners. It showcased all the weather services for the Great Lakes: radio services, ice information services, weather warning systems, radar and satellite information and the use of meteorology. It was the first time so many weather service policy-makers formally met with so many policy-users. Their relationship has sometimes been overcast with storm clouds, but by the end of the seminar, not only was the sun shining outside, but the mariners and forecasters were smiling at each other.

The seminar also provided a chance for Coast Guard officials to discuss loading and safety and to express some of their current worries about the shipping industry. It also settled some issues and promoted dialogue on others. For example, mariners confronted the Weather Service on a government proposal to use latitude and longitude references for positions. The mariners wanted position references given in relation to known geographical points, as is done now. In response to the seminar, NWS will program its computer to accept weather observations positioned by range and bearing coordinates relative to geographical points commonly used by Great Lakes navigators.

Captain Gustave Goransson, Grand President of the International Ship Masters Association of the Great Lakes, said, "The policy makers are away from the realities we face everyday. I think this seminar was a good step in getting to know the people who work for and with us."

Getting to know each other's problems and demands has been especially important in the past year. In November of 1975, one of the biggest and newest of the Great Lakes ships, the Edmund Fitzgerald, sank in a storm. There were no survivors. There have been lots of questions, however. Did Captain McSorley know enough about weather conditions? Was there a problem with the way the ship was loaded? Was there a structural weakness in the vessel? Why did it pass so close to a shoal area? What happened to the light on Whitefish Point?

The sinking of the Fitzgerald focussed attention on the Great Lakes shipping industry. Gordon Lightfoot, popular singer-composer, even wrote a song about the loss of the Fitzgerald. The song's haunting melody kept it on the charts and in the public's mind for months. But shippers, mariners and forecasters didn't need a popular song to keep it in their minds. It touched too close.

A wild storm raged the night the Fitzgerald plunged like a rock to the bottom of Lake Superior. The winds drove the water into mountainous swells and pounding, twisting waves and snow whirled tight around the ship. Since the tragedy, the age-old question put to Great Lakes mariners, "Are you afraid of the weather?" stings with renewed force.

Great Lakes weather is special. The Lakes, large areas of relatively constant temperature, actually create unique weather conditions.

According to William Kennedy, Port Meteorological Officer (PMO) Cleveland, "Great Lakes weather is much more violent than ocean weather. Rapidly deepening low pressure systems often move very fast across the Lakes. A ship can't go in one direction too long. On the Great Lakes, ships have to keep adjusting, switching directions, responding to the weather, trying to remain on the lee shore where wind velocities are lower, wind fetch is shortest and waves are smaller."

"There are lots of things to consider in making decisions about your vessel's course," says Captain Wayne Bratton, Operations Manager for Marine Fueling, Inc., "The master has to consider his ship's characteristics, the load, his own personal experiences, his time frame and his destination."

Being a master of a Great Lakes ship is

still as much art as science—and decisions ultimately belong to the captain. His decisions often control the fate of crew members and tons of valuable cargo. Last year Great Lakes' ships carried about 15 million tons of iron ore, 8 million tons of coal, and 5 million tons of grain from home ports alone.

Thus, each captain shoulders a heavy responsibility, and he knows it. He wants and needs information—about the weather, the lake conditions and what's happening along his intended route.

To help these mariners, planners of the Marine Weather Seminar set out to answer several questions about weather services. What kinds of services and transmissions are currently in use on the Great Lakes? How do they operate? What are the problems? And what is being done about them?

On the first day of the seminar, Dr. William Bonner, Director, Eastern Region NWS, noted that the NOAA weather service is not specifically marine, that it is designed for all users. This fact bothers some mariners.

There are, however, two marine weather services unique to the Great Lakes. The LAWEB (Lakes Weather Broadcast) gives actual weather conditions based on land observations and information from ships. Bonner urged shippers to report the weather conditions that they experience for the LAWEB broadcasts. MAFOR (Marine Forecast) gives predicted weather conditions based on satellite and radar information. Both MAFOR and LAWEB are numerical codes, although LAWEB does contain a plain language summary of conditions. Great Lakes shippers receive both services several times each day. Mariners must be able to restructure this numerical data into a full weather picture.

To train the mariners to get the most from the data, Dr. Alan Cole, a meteorologist from Northern Illinois University, highlighted the seminar with a second-day workshop on the use and interpretation of meteorological data.

Cole said, "We have a long way to go before we can analyze and predict Great Lakes weather with 100% accuracy, but by plotting isobars, you can get a pretty good picture of weather conditions."

With this introduction, NWS officials passed out maps and pencils to the mariners. Then the mariners cleared away the white table cloths, moved the red water pitchers and settled at the tables to plot isobars (lines of equal barometric pressure). Even Marvin Miller, Meteorologist in Charge at Cleveland, and originator of the seminar, drew his isobars. Then he circulated around the room helping other participants.

Cole emphasized and explained the four major forces that influence wind: pressure gradient force, Corriolis Force, friction force and centripetal force. He also discussed geostrophic wind, a mathematical calculation of wind velocity.

Wayne Donaldson, a ship captain for the Amoco Oil Co., said, "Cole's session was great, practical stuff. This is what we came for."

Miller was pleased. "It is so important for the mariners to be able to interpret meteorological data."

The Lake Carriers Association, apparently agrees with this need for interpretive skills. The organization has commissioned Cole to write a deck officer's handbook ("cookbook," according to Cole) on marine weather forecasting on the Great Lakes.

After lunch on the second day of the seminar, Captain J. A. Wilson, Chief of the Marine Safety Division, U.S. Coast Guard, spoke about marine safety. Wilson headed up the committee which investigated the Fitzgerald tragedy.

He discussed the three major factors which affect marine safety: poorly trained or disinterested sailors ("that old love of the Lakes isn't as evident as it used to be."), deeper loading, and longitudinal stability. Wilson said that the weather-tight integrity of vessels is greatly affected by recent trends for deeper loading. One mariner pointed out that load lines are now set at 28 feet and many channels are only 27 feet deep. Wilson said, "Yes . . . well," and threw up his hands in resignation. "You've got to be careful."

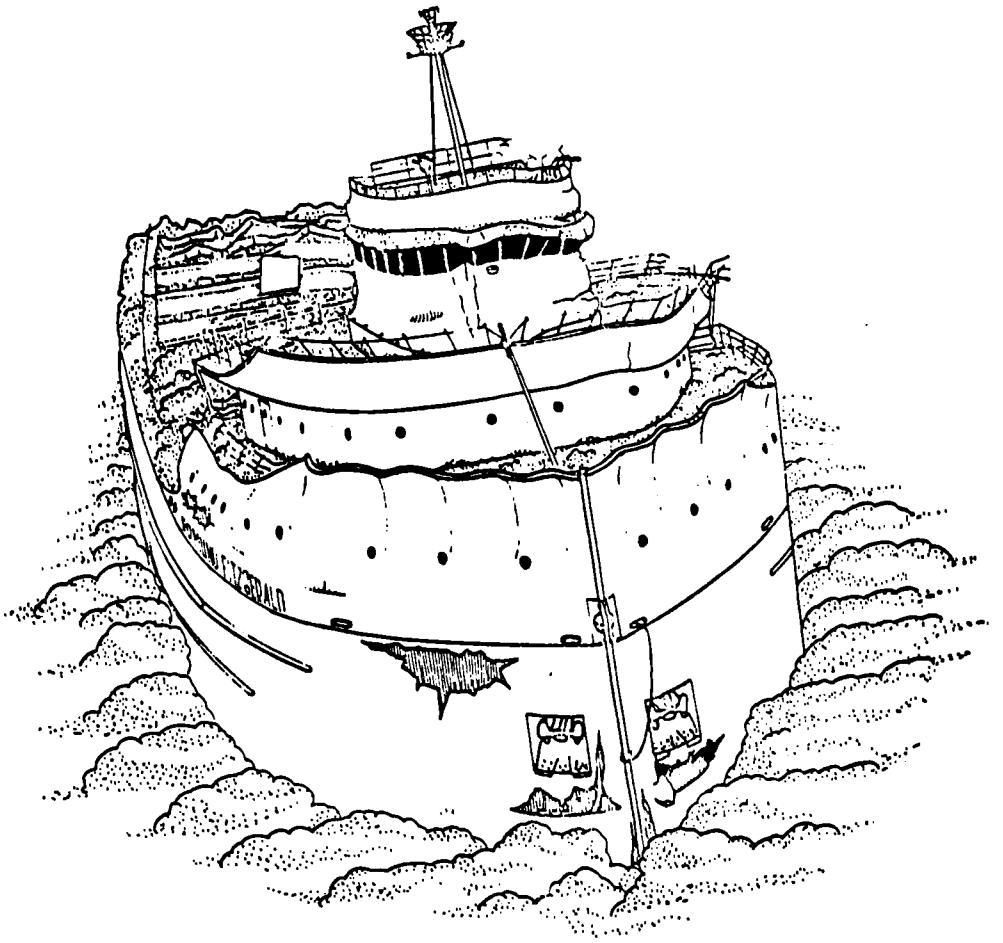
He said that with deeper loading, the vessel rides lower in the water, hatch covers and doors are closer to the water and "there is a

Marvin Miller, Meteorologist-in-Charge, Cleveland NWS, originator of the seminar, plots his isobars.

Even dispatchers drew isobars: William Crippen is flanked by Captains F. M. Saarinen and H. Krasowski.

The Chamberlains: son David, a Third Mate for U.S. Steel, draws the lines while his father, Captain Victor, checks the figures.

Capt. Gustave Tatar and K. W. Lowrie vigorously exchange ideas with Capt. J. A. Wilson between sessions.



potential of 6,000 tons of water per hour through a hatch cover open 1/16 of an inch."

The type of cargo also influences the effects of taking in water. The Fitzgerald was loaded with taconite, which, according to Wilson, "absorbs water like a sponge. You can't get it out." Wilson told the mariners to be sure that all hatch covers and doors were shut tight.

Another safety problem is that heavily-loaded ships ride lower in the water and "present a harder platform for water to break over." This heaviness eliminates many of the shock-absorbent rolling motions of the vessel.

Longitudinal stability sometimes present problems too. Excessive heaviness in the front of the vessel could lead to a "plunging situation or bending, twisting flexing or breaking." Thus Wilson emphasized that the way the ship is loaded is crucial.

However, Captain Goransson feels the "ships have been allowed to load too deep so they lose their reserve buoyancy. Now there is a lot of discussion about loading manuals, but loading is really a lot of trial and error. No two ships load the same, not even sister ships. You have to keep shifting cargo and come up with a formula where the ship will ride sturdy." Goransson says he wants to "meet part way, so we can load a ship according to a manual but also according to the characteristics of a particular ship."

In addition to loading regulation, the Coast Guard is showing concern over other aspects of marine safety. Wilson noted that several new navigation and safety regulations are being proposed: required cold-water survival suits, on-deck boarding of enclosed life-boats, reporting of inoperative equipment, and required depth finders. According to Wilson, Coast Guard officials feel, "We are pushing our limits, load limits, depth limits, human limits."

Another major area of concern for the Great Lakes' shipping industry is the transmission of weather information which travels primarily through the facilities of Lorain Electronics (WMI Radio) headquartered in Cleveland. At the seminar, Paul Romoser, the company's Research and Development Manager, acknowledged the problems of static, crowded airways and limited availability of services for many parts of the Great Lakes.

There was grumbling from the floor. "I was 20 miles from a transmitter . . . and I couldn't get a thing."

Rumbles of agreement.

Apparently radio transmissions for the Great Lakes are in a transitional phase. There is a new Federal Communications Commission ruling which requires changing marine broadcast frequencies from AM to FM. The change was instigated to eliminate the static and overcrowding of airways often due to recreational boaters. As one captain put it, "It is pretty difficult to raise Lorain when all you can hear is two recreational boaters discussing where to dock for cocktails."

However, the limitation of FM transmissions is that they have a radius of only 30-40 miles. Because of this, Lorain is building more transmission towers around the Lakes, to a total of 14.

Weather Service official Dr. Glenn Flittner, Chief, Ocean Services Division, NWS, points out that there are three other weather information services for Great Lakes' shippers: the Coast Guard Stations, NOAA's Weather Radio System and U.S. Steel's station (WLC) in Rogers City. "However," says Flittner, "there is a real need for redundancy in broadcast and reception of weather information for the Great Lakes. The seminar clarified the need to look for additional broadcast services."

Another kind of broadcast service is Radio Facsimile which sends a weather picture to ships, much like Cole's weather maps. Currently, several ships that sail the Lakes year-round receive Facsimile services, according to John Smith, NWS Regional Special Service Meteorologist. Flittner emphasized, however, that Radio Facsimile transmission of charts must be accompanied by explanatory information. "Mariners must still be able to interpret the data."

Great Lakes' shipping is becoming a year-round business. Kennedy recalls, "It used to be that ships were berthed from November to April. Now there is increasing activity on the Lakes all winter." Ice information has become important.

Bob Snider, Meteorologist in Charge, Detroit, and Derron Boyce, Great Lakes Ice Forecaster, Cleveland, illustrated the ways they compile information about ice conditions; remote sensing, satellite and radar readings, aerial surveillance, and monitoring water temperature.

They analyze the total storage of summer heat in the water, the expected temperature and precipitation, and the probable rate of heat extraction from the water. The end products of these studies are freeze-up and break-up predictions for the St. Lawrence Seaway each year.

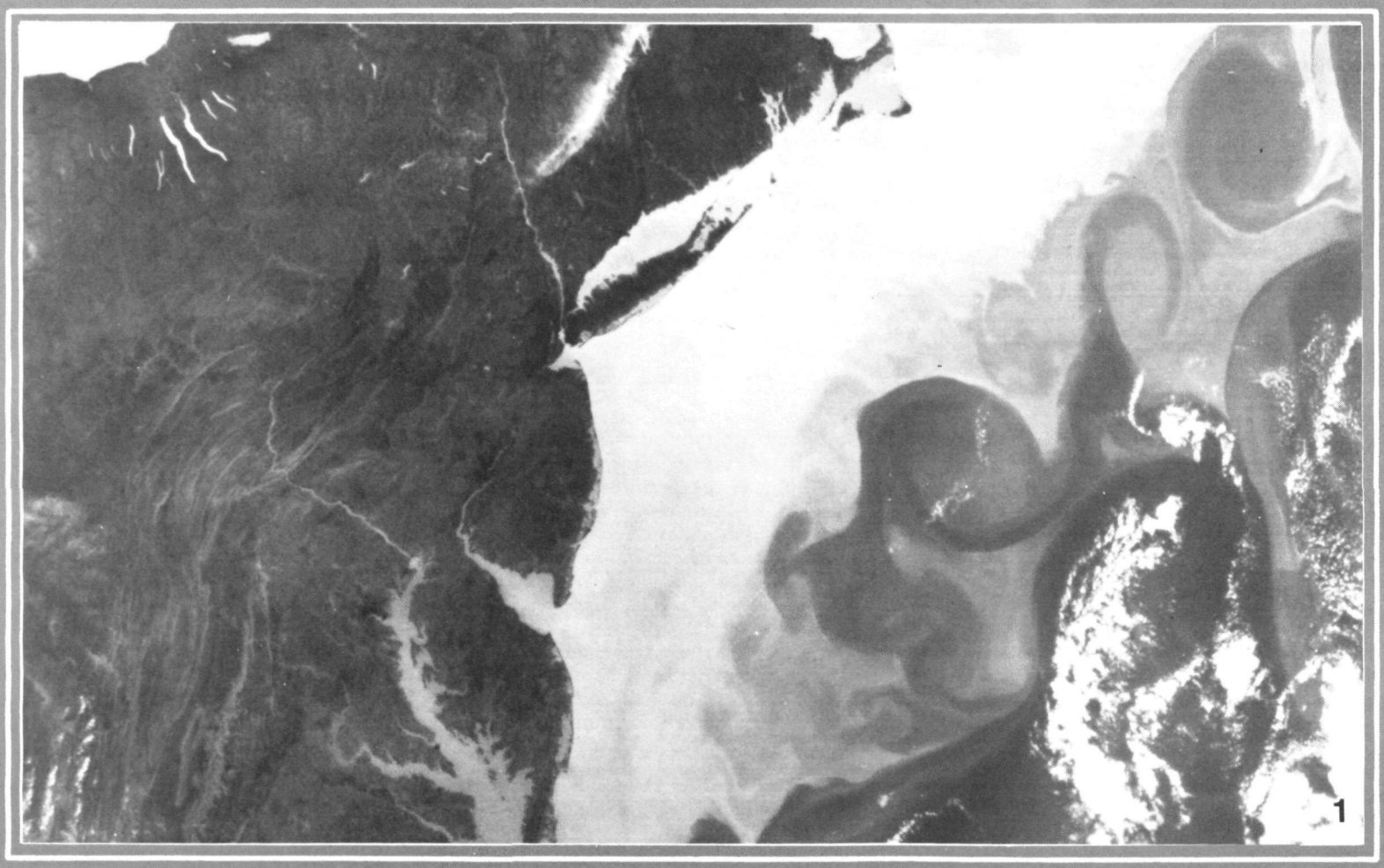
Last winter was a record for ice on the Great Lakes. Snider notes that the Daily Ice Outlook (DIO) usually begins Dec. 10. Last year, he had to begin the DIO Nov. 24. Not only did the ice start earlier and stay longer, but it covered more of the Lakes both in area and depth.

Another speaker at the seminar was Geoff Meek, Port Meteorological Officer, Toronto, the only international representative at the seminar. He discussed the positioning of anemometers. Ray Waldman, OIC, Chicago, gave a historical perspective to Great Lakes weather services. The first great lakes storm warning was on Nov. 8, 1870, according to Waldman. It said, "Very high winds yesterday, barometer falling, thermometer rising, high winds probable near the Great Lakes."

Great Lakes Weather Services have come a long way since then, but so have ships and the shipping industry.

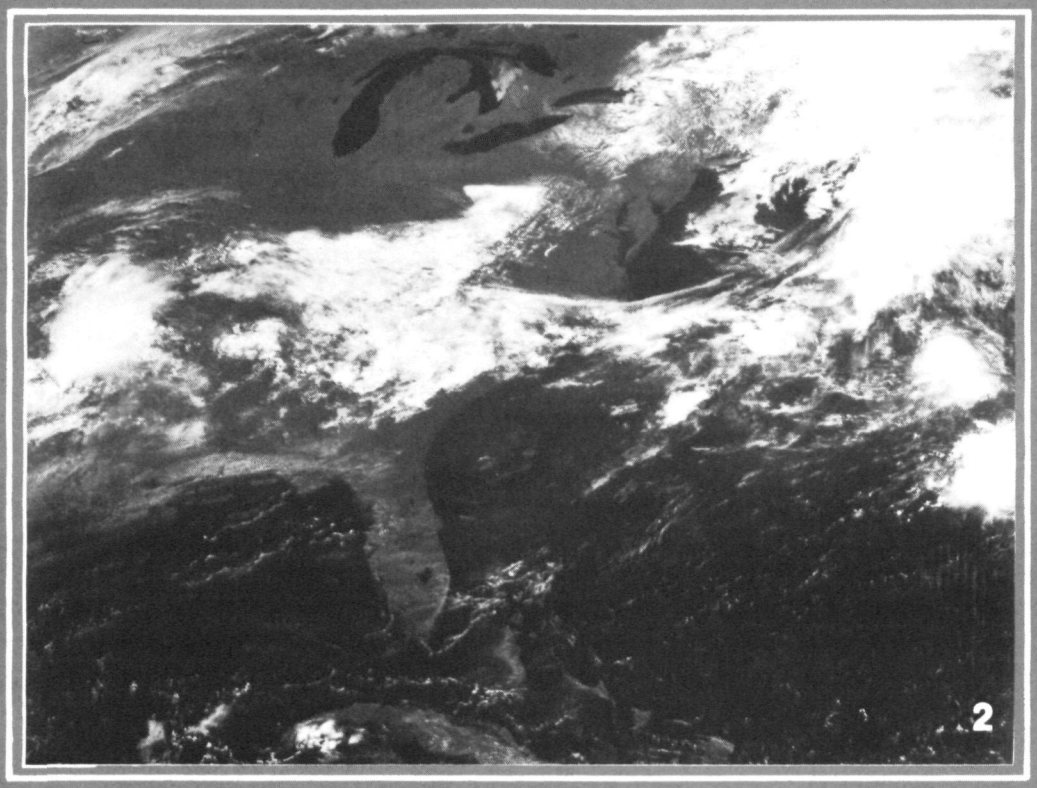
But all three have not advanced at the same rate. The Marine Weather Seminar was an attempt to clear away some of the clouds and plot a straighter course for the Great Lakes shipping industry.

Flittner summed it all up when he said, "The Fitzgerald sinking heightened the interest of all marine operators in our weather services. This seminar was an effort to show and tell—about our people, our methods and our service products. We also wanted to hear shippers' problems and their viewpoints. And certainly we did." □



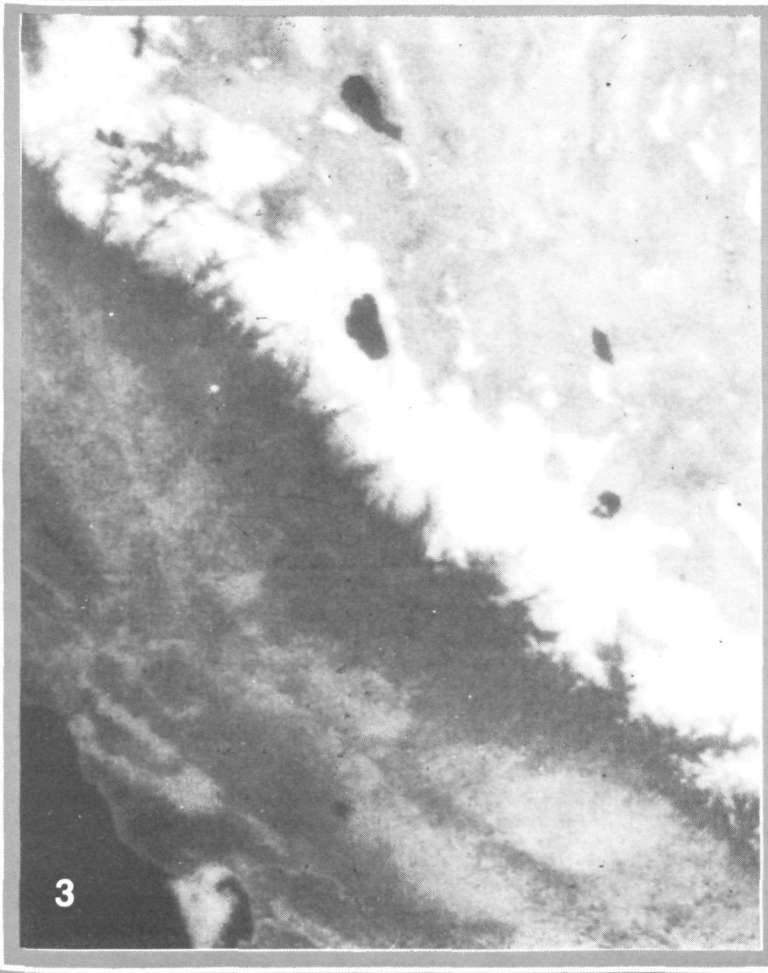
1

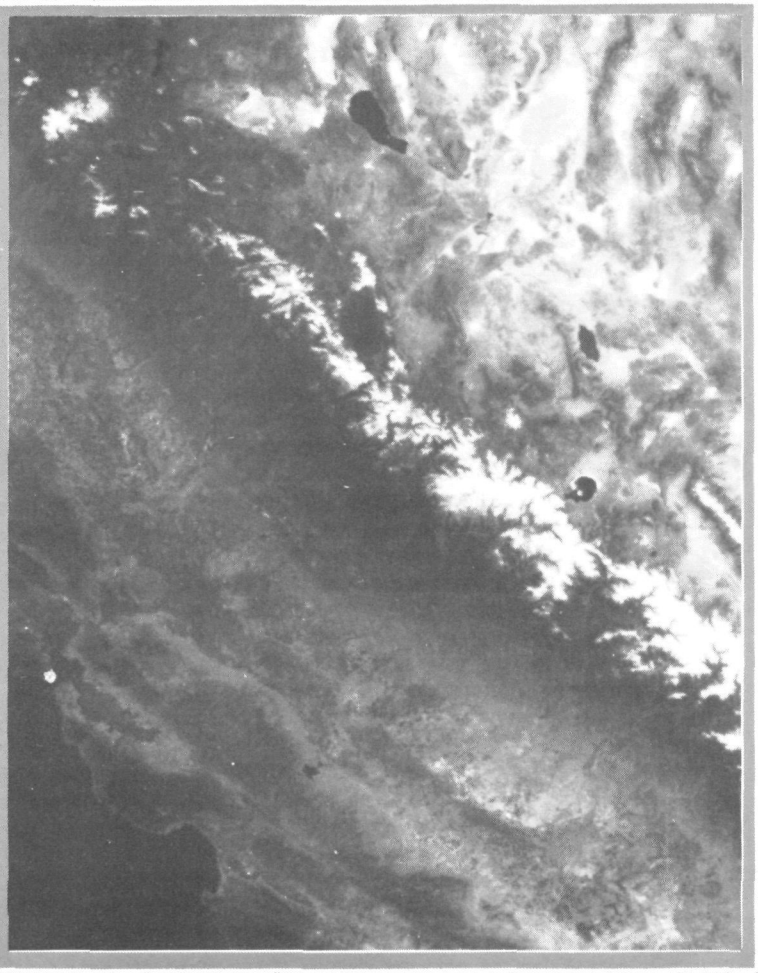
THE VIEW FROM SPACE

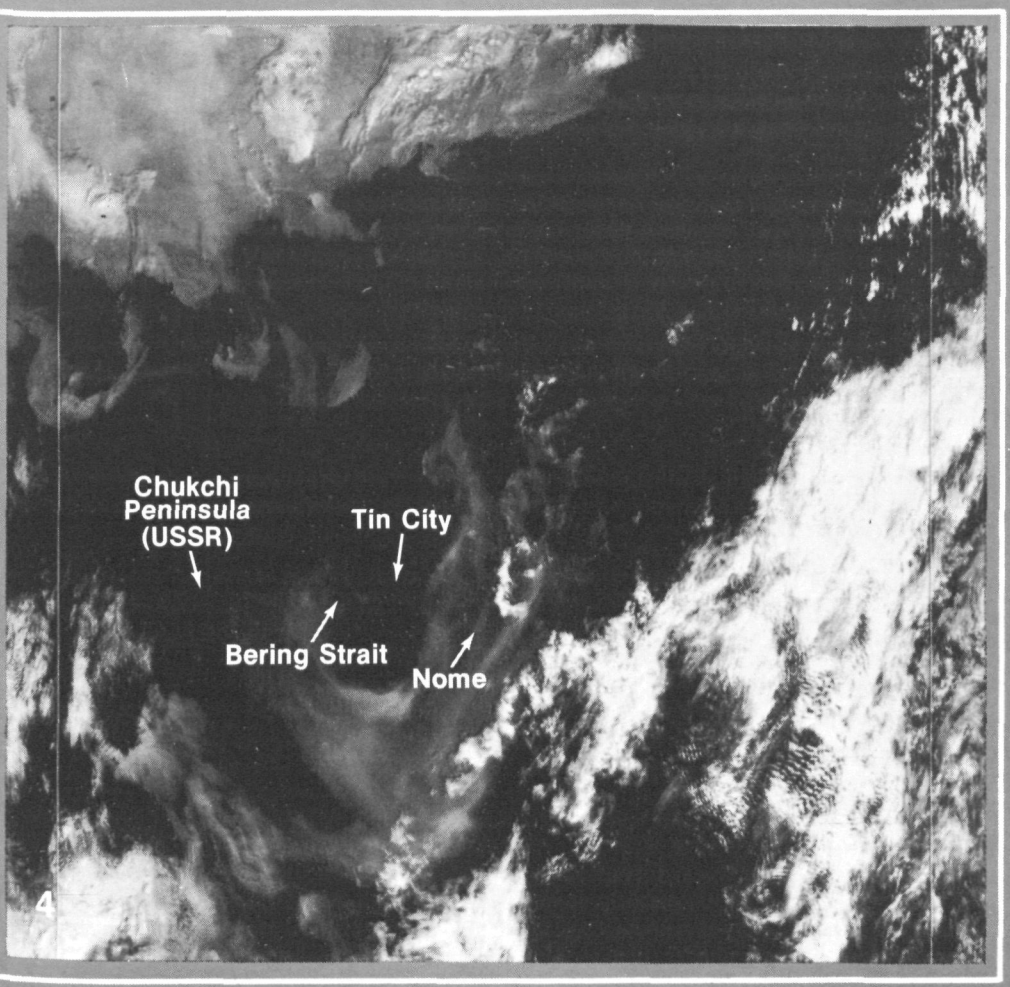


2

NOAA's dual satellite system—the geostationary and the polar-orbiting—miss little of an environmental nature that is happening on the earth beneath them, including two major environmental happenings of the year—the California drought and the Alaska forest fires. Satellite imagery relating to these are included in this issue's View from Space. So, too, is one of the first pictures from the newest spacecraft in NOAA's satellite fleet, GOES-2. Additionally, solely because it is such a pretty picture, an enlargement of part of a NOAA-5 infrared image of much of the East Coast is included on these pages.







1 Polar-orbiting NOAA-5 captured this infrared image on May 1 as it passed over the East Coast; a crystal clear portrait of the U.S. from the Great Lakes (upper left corner) to the Atlantic, Cape Hatteras to Cape Cod. Offshore, the warm Gulf Stream appears as a dark, meandering band, with several large warm eddies between it and the Northeast. New York's Finger Lakes, the Hudson and Susquehanna Rivers, and the Appalachian Mountains stand out in bold relief.

2 Three days after launch, NOAA's newest satellite, GOES-2, returned this picture to earth. The new spacecraft replaces GOES-1 as the East Coast satellite in the geostationary system. GOES-1 joines SMS-1—the first in the system—in standby mode, while SMS-2 continues as the West Coast satellite.

3 These two polar-orbiting spacecraft pictures graphically show why much of California is drought stricken—the severe shortage of snow in the Sierra Nevada mountains. Picture at left shows snowcover there in late April two years ago, while picture at right —taken in late April of this year —shows less than one-third the normal amount of snow. Scientists Stanley Schneider and Michael Matson at NOAA's National Environmental Satellite Service point out California is tremendously dependent upon snowmelt for its water.

4 With nearly one million acres of Alaska tundra and timber aflame late in July, clouds of smoke drifted out into the Bering Strait and the Chukchi Sea. The largest fire was near Nome, where 320,000 acres were ablaze. The smoke was so thick that on August 2, Tin City reported visibility of 0.12 miles. As this NOAA-5 picture shows, smoke drifted across the Bering Strait and obscured the tip of Russia's Chukchi Peninsula.

THEY'VE GOT YOU COVERED

Weather pictures from space, only 17 years ago viewed with amazement by meteorologists and the general public alike, have found a permanent place among forecasters' tools. Seen daily by millions on television weather programs and in many of the nation's more than 1,700 daily newspapers, satellite weather pictures provide professional and neophyte a new dimension in seeing what the weather is all about.

It began on April 1, 1960, when TIROS-1, the first meteorological satellite to provide photographs of the earth and clouds, was launched. And it has continued through 31 operational environmental satellites; three generations of spacecraft orbiting the earth from pole to pole, and one generation of geostationary spacecraft, in orbits which keep them positioned over the same relative place on the earth's surface.

The concept has been the same since the beginning; launch a spacecraft carrying viewing or sensing instruments into space, and design a method to return the images to earth for analysis and use. The approach hasn't changed, but the spacecraft, the instruments they carry, the quality of the data received, and the uses of the data all are vastly different.

Today, NOAA satellites—in addition to giving meteorologists weather data available in no other way—are providing fishermen, sailers, farmers, water resource managers, and many others with information of importance. The scope of NOAA's satellites has broadened beyond all expectation, even while their potential has barely been explored.

The accompanying information provides a concise reference to the two satellite systems operated by NOAA, their products, and some of the applications of the products.

NOAA's geostationary satellites are in earth-synchronous orbit at the appropriate altitude and speed to keep them apparently stationary above a given spot on the Earth's surface, over the Equator. The objectives of the Geostationary Operational Environmental Satellite (GOES) system* are: to provide high resolution visual and infrared imaging over large areas of North and South America and the surrounding oceans every 30 minutes, or more frequently when required; to provide data collection from remote observing platforms; to measure energetic particle flux and X-rays from the Sun, and the strength of the Earth's magnetic field; and to broadcast centrally prepared weather and satellite information via the WEFAX system.

Two satellites are maintained in operational status; one at about 135 degrees West Longitude, observing North America and the Pacific Ocean to west of Hawaii; the other at about 75 degrees West, observing both North and South America and the Atlantic Ocean and parts of the African west coast.

Manufactured by Ford Aerospace & Communications Corporation and launched by NASA, the GOES/SMS spacecraft are cylindrical—6.2 feet (1.9 meters) in diameter and 8.5 feet (2.6 meters) in length—and at launch weigh 1,385 pounds (628 kilograms). They are in circular orbit at about 22,200 statute miles (35,800 kilometers), traveling at about 6,830 miles per hour (11,000 kilometers per hour).

The spacecraft capabilities include:

- Visible and Infrared Spin Scan Radiometer (VISSR) providing visible and infrared imagery;
- Space Environment Monitor (SEM) subsystem, including a magnetometer, a solar X-ray telescope, and an energetic particle monitor, all for solar observations;
- Data Collection System (DCS) providing communications relay from data collection platforms on land, at sea, and airborne to the Command and Data Aquisition (CDA) station in Virginia, and interrogating platforms from the CDA station via the satellites.
- Wideband Communication subsystem for transmission of wideband video data, "stretched" VISSR data, and weather facsimile (WEFAX) data; and,
- Telemetry, Tracking and Command subsystem for commanding the spacecraft and transmitting SEM data.

**The first two prototype spacecraft of this series, were developed by NASA and designated Synchronous Meteorological Satellites, SMS-1 and SMS-2.*

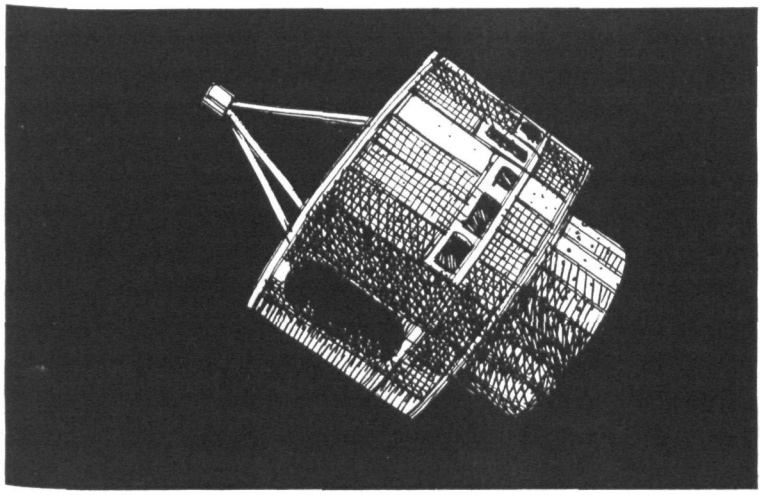
NOAA'S polar orbiting satellites circle the globe from pole to pole while the Earth spins on its axis beneath them. The objectives of the polar orbiting system are to obtain temperature and humidity profile measurements of the atmosphere, and global sea surface temperatures; to provide frequent high resolution visual and infrared observations of the entire Earth's surface (including ice and snow) and cloud cover, especially in the polar regions which are unobserved by the GOES system; to detect and count the proton and electron fluxes from the sun encountered during orbit; and, to provide data collection and platform location from remote observing platforms.

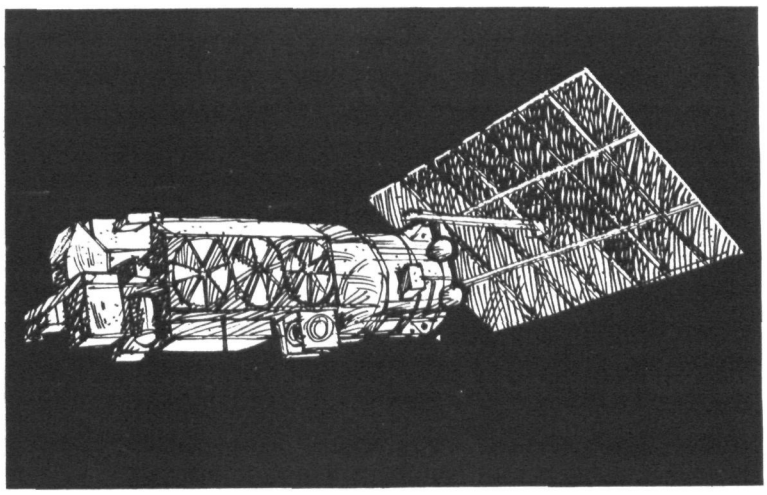
TIROS-N series spacecraft are third generation operational environmental satellites in polar orbit. The first satellite of this new series is NASA's prototype, called TIROS-N. Subsequent operational spacecraft of the series will be named NOAA-6, NOAA-7, etc., after launch. Earlier NOAA polar orbiting series were the TIROS Operational Satellites (TOS), named ESSA 1 through 9 in orbit, and the Improved TOS, or ITOS series, which were designated ITOS 1 and NOAA 1 through 5 after launch.

In the new polar orbit system, two spacecraft will be maintained in orbit at all times. Initially, TIROS-N will be at 540 statute miles (870 kilometers) and NOAA-6 at 516 miles (830 kilometers) altitude. Manufactured by RCA Astro-Electronics and launched by NASA, the spacecraft are 22 feet long and weigh 1615 pounds (732 kg).

Instruments integrated into the TIROS-N Series spacecraft include:

- Advanced Very High Resolution Radiometer (AVHRR) providing visible and infrared measurements and imagery in a variety of channels for cloud, snow and ice detection, for Earth surface temperature readings, etc; continuous broadcasting to High Resolution Picture Transmission (HRPT) and Automatic Picture Transmission (APT) receivers is included.
- TIROS Operational Vertical Sounder (TOVS) subsystem consisting of three instruments: a modified High Resolution Infrared Sounder (HIRS/2) unit producing tropospheric temperature and moisture profiles, a Stratospheric Sounding Unit (SSU) provided by Great Britain to produce temperature profiles of the stratosphere, and a Microwave Sounding Unit (MSU) used to produce temperature profiles of the atmosphere in clouds.
- Space Environment Monitor (SEM) for measuring Solar X-rays and energetic particles over essentially the full range of energies, and magnetic field variations in the earth's near-space environment; and,
- Data Collection and Platform Location System (ARGOS)—supplied by Centre National d'Etudes Spatiales of France for collection and transmission of meteorological, oceanographic, hydrologic, and other environmental information from remote land, sea, and airborne platforms, and determination of geographic location of platforms. □





Geostationary (GOES) Series

SMS–1 launched 5/17/74; now on stand-by status
SMS–2 launched 2/6/75; now on stand-by status
GOES–1 launched 10/16/75
GOES–2 lauched 6/16/77

Function	**Typical Applications*
Earth Scanning	
Visual imagery in 4 mile (8 km, full disk), 2 mile (4 km), 1 mile (2 km) and 1/2 mile (1 km) resolution.	Cloud cover analysis Wind analysis from cloud motion Fog distribution analysis Storm circulation determination Ocean current analysis Severe storm warning Hurricane tracking Snow melt and area determination for water resource management Freeze forecasting for agriculture
Infrared imagery in 5 mile (9 km) resolution with 12 enhancement curves.	Inland waters ice evaluation Ship routing Upwelling location for fisherman
Collection of Observations	
Capacity of more than 10,000 observations each six hours from Data Collection Platforms by each of two operational satellites, collected and distributed to users.	River/reservoir level determination Tsunami warnings Rainfall/snowfall measurements Ocean wave heights Ocean currents, temperatures *Forest combustibility* In-flight weather data for aviation
Wind Analysis	
Imagery and digital readouts providing wind speeds/direction at various heights.	Weather analysis and forecast Cloud height determination for aviation
Data Dissemination	
Transmission of weather charts and satellite information via WEFAX system to weather offices throughout Western Hemisphere	Preparation of local and area weather forecasts and warnings
Space Monitoring	
Quantitative measurements of solar activity; detection of solar flares; solar wind intensity; strength and direction of Earth's magnetic field	Solar forecasting and research Prediction of ionospheric communications Solar effect upon terrestrial wire communications Electric power grid management Radiation warning for manned space flights, high altitude aircraft

Polar Orbiting TIROS–N Series

TIROS–N to be launched mid '78
NOAA–6 to be launched late '78
NOAA–4 launched 11/15/74; (ITOS Series). now on stand-by status
NOAA–5 launched 7/29/76, (ITOS Series).

Function	**Typical Applications*
Earth Scanning	
Imagery from visible, infrared and other channels in a useable strip about 1,800 statute miles (2,800 km) wide from pole to pole in two different resolutions; 1/2 mile (1 km), and 2 to 4 miles (4 to 8 km)	Cloud cover analysis Fog distribution analysis Storm circulation determination Ocean surface temperature Tropical storm warning Hurricane tracking Arctic, Antarctic ice observation Computation of soundings and sea surface temperatures Snowmelt determination Ship routing, upwelling location
Collection of Observations	
Readings each day up to 16,000 Data Collection Platforms for a two-spacecraft system; or up to 4,000 platforms for collection and location	Geographic location and velocity of moving platforms (not available through GOES system) Collection from platforms in polar regions Other applications as with GOES system
Space Environment Measurement	
Measurement of solar energetic particles over almost full range of energies from about 500 to 1 billion electron volts.	Solar research Prediction of ionospheric conditions in support of longrange communications and power distribution Solar storm warning Radiation warning for manned space flights, high altitude aircraft
Atmospheric Sounding	
Measurement of vertical temperature, moisture distribution in atmosphere.	Global numerical weather analysis and forecasting
Data Dissemination	
Broadcast of unprocessed vertical temperature and humidity data, low resolution (4 km) visual and infrared images, high resolution (1 km) images from all spectral channels.	Direct broadcast of weather data through APT/HRPT for local use in environmental monitoring, warning, and prediction.

**Not all-inclusive. New applications continually being developed by NOAA and users*

For years now, land-based plants and animals have served as a major source of chemically active agents for the treatment of a variety of human disorders and diseases. Such well-known substances as belladonna, digitalis, morphine, and even aspirin had their origins in natural land organisms. In fact, most of the drugs now in use are derived from land-based plants and animals or are synthetics based on structures of natural land-based molecules.

Recently, however, man has turned more and more to the sea as a source of drugs. An estimated four-fifths of the world's animal life and a significant portion of its plant life live in the ocean, creating the belief among scientists that many resources remain unexploited, with many of the marine bioactive molecules with potential medical application awaiting development.

Because of the possibilities in the oceans, a number of Sea Grant scientists have focussed their attention on research in biomedicinals and marine extracts, and their work appears highly promising. Some are being carried out at the University of Oklahoma, which is about as far removed from the oceans as one might get. There, a team which includes biochemists, organic chemists, and a pharmacognosist has been conducting studies aimed at isolating anticancer drugs and drugs which influence the central nervous and the cardiovascular systems. The researchers have identified 246 marine species with confirmed anticancer properties and about a dozen with potentially useful activity in cardiovascular and central nervous systems.

Work in this field has been supported by Sea Grant at the University of Oklahoma since 1971. The National Cancer Institute also has funded the research.

Professors involved in the program, along with their students, skin dive to collect their specimens for study. They collect marine plants and animals from the tropical coral reefs of the Bahamas, Bermuda, Jamaica, Florida and Eniwetok.

The team first derives crude extracts from the specimens. After the extracts' pharmacological action has been confirmed, they are subjected to chemical study to isolate the pure compounds with potential usefulness as drugs, and the structure of these pure compounds is determined. Larger quantities are obtained either by harvesting or by synthesizing them in the laboratory. They are then referred to interested pharmaceutical companies for the preclinical and clinical studies required before new drugs may be introduced.

Marine organisms of the greatest interest to the Oklahoma scientists are corals, sea whips and sea fans, anemones, and other animals low on the evolutionary ladders. The scientists also have studied sponges because extracts from sponges lower blood pressure and improve the tone of the heart muscle.

Introduction of a new drug into clinical use normally requires seven to ten years after its initial discovery. In the case of natural product drugs, the preclinical development alone—detection, isolation, structure determination, pharmacological evaluation, and toxicological studies—may require five to ten years.

Another important Sea Grant development concerning medicines from the sea was the discovery by researchers at the University of California of a substance in an alga that is active against the herpes simplex virus. Herpes simplex is responsible for common cold sores, a prevalent form of venereal disease, and an eye infection that causes about 18,000 cases of blindness in the United States each year. The discovery is particularly promising, because there are so few antiviral agents available for use in medicine.

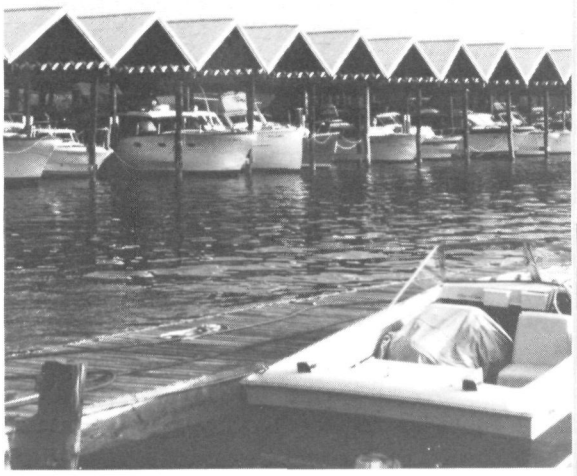
In related work, the Sea Grant Program also has carried out considerable research in marine extracts. For example, at the University of Rhode Island, scientists determined that "red tide" organism that causes paralytic poisoning among fish in New England contained six additional toxins besides the previously known saxitoxin. The results of these studies are expected to be applied in establishing new regulatory measures and detoxication procedures, thus eliminating any unnecessary closing of commercial shellfish beds.

In other marine extract research, scientists at several of the Sea Grant institutions are making studies of chitin and chitosan, derivatives of shellfish wastes. At the University of Washington researchers have developed new uses for chitosan in nonwoven fabrics and paper. They also have established a theory for predicting how chitosan content affects properties of paper and nonwoven fabrics, showing that the addition of only one percent chitosan to paper increases its wet strength by 44 percent and improves its printability.

A review of the Sea Grant research in biomedicinals and marine extracts is contained in the recently published annual report of the National Sea Grant Program. The 84-page report, required this year for the first time under legislation enacted last year, outlines the variety and magnitude of scientific research being carried out at the nation's colleges and universities under the Sea Grant program and the impact the research might

Sea Grant reports on a decade of progress

Unlocking Neptune's Treasure Chest



Research is an important part of Sea Grant, and scenes such as those at the left and top are typical on Sea Grant campuses. The marina is a place where Sea Grant Marine Advisory Service agents often provide advice to marina operators, recreational fishermen and others.

have on the scientific and educational communities, as well as on the public. The report also covered the educational and marine advisory services activities within the Sea Grant program.

Because the report was the first of its type, the narrative was expanded beyond the Fiscal Year 1976 and transition quarter so that some of the major programs and projects that took place earlier in the program's history could be described.

In addition to the biomedicinal and marine extract studies, Sea Grant scientists are involved in research in aquaculture, living resources, coastal zone management support, pollution studies, environmental models, socio-economics, ocean and coastal law, marine recreation, marine technological research and development, seafood science and technology, and marine transportation.

One of the most important areas of Sea Grant research is the culture or husbandry of aquatic plants and animals—aquaculture. The advancement of aquaculture is cited in the original Sea Grant legislation as one of the purposes of the program. And because of the potential for expansion of our fisheries and food resources through aquaculture, Sea Grant has invested heavily in that activity. At least 30 colleges, universities, and other research institutions are participants in aquaculture programs. The studies range from intensive culture in closed laboratory systems to culture in bays and coastal areas where little manipulation of the environment is required. The aquaculture efforts have concentrated primarily on salmon, perch, shrimp, prawns, oysters, mussels, lobsters, and marine plants—all with an eye towards advancing the process to the point where inexpensive species can be produced economically in large quantities.

Some of the significant achievements outlined in the report include:

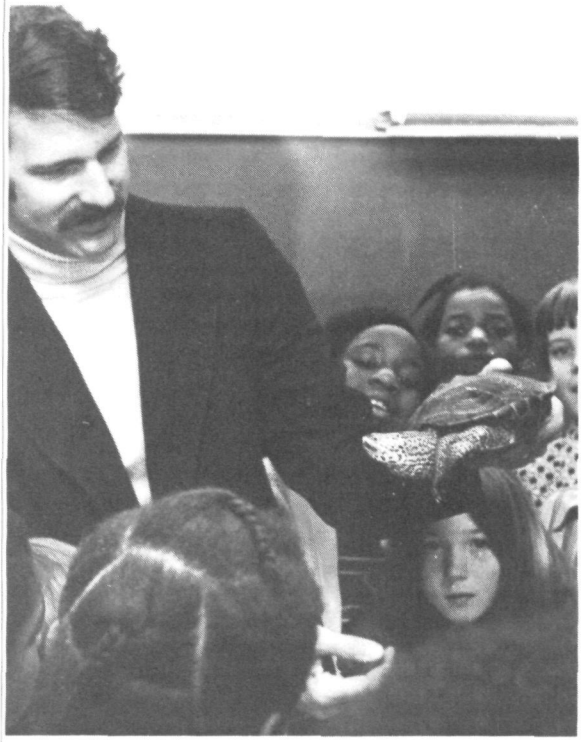
1. During the 1975–76 season, 16 percent of the coho salmon released from a University of Washington hatchery returned for spawning—a total of 5,000 salmon. In nature, where they are not as strong as the hatchery-raised fish, the salmon return at a rate of less than 1 percent.

2. At the University of Wisconsin, the Sea Grant researchers have grown perch to a marketable size in 9 to 11 months, a process taking 3 to 4 years in nature.

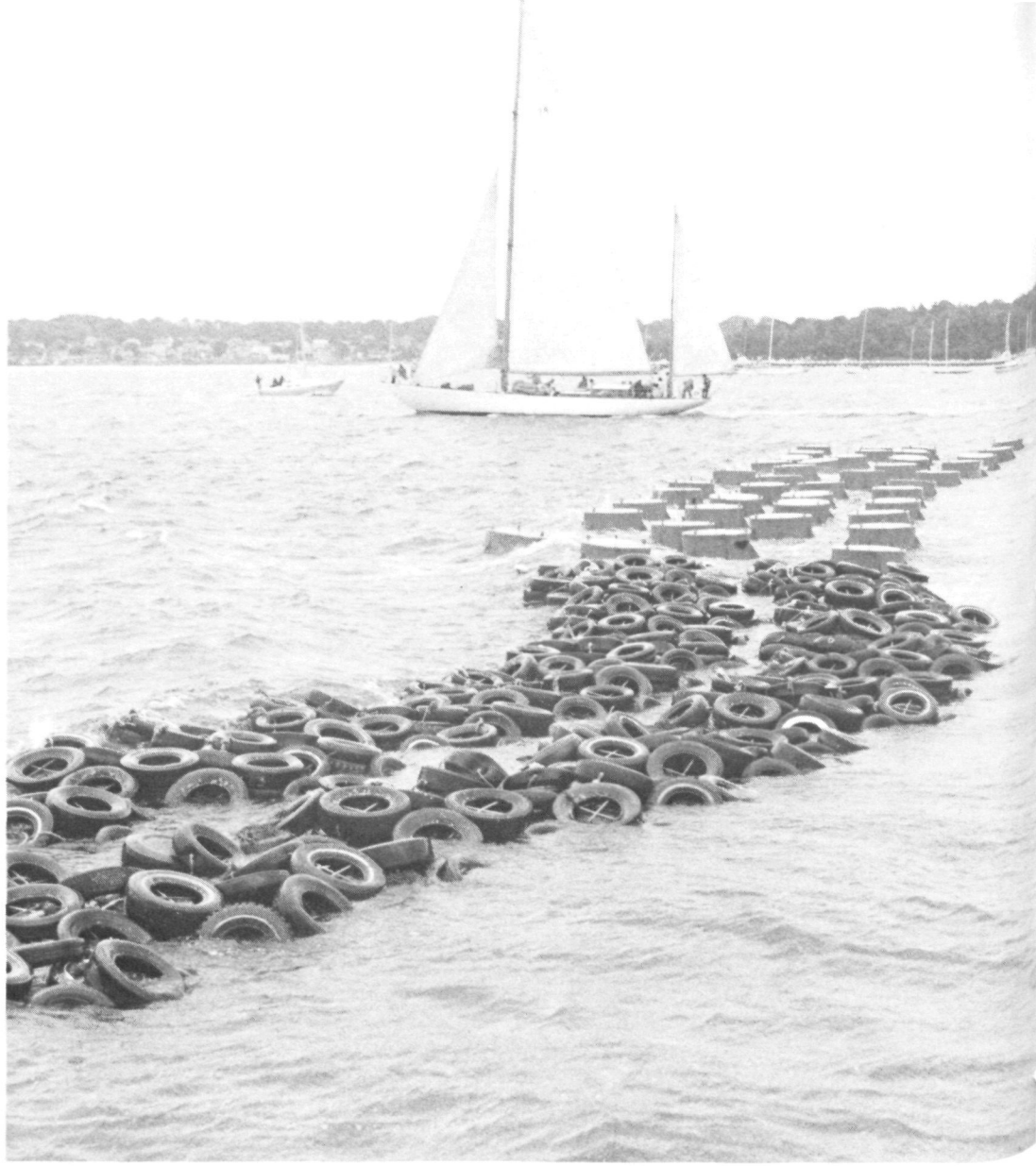
3. At the University of Delaware, scientists have grown oysters to market size in just 36 weeks instead of the 36 months required in nature.

4. At the University of California, giant kelp that doubles its size in less than 2 weeks has been developed. This work has attracted the attention of the Japanese who are establishing a new culture facility in Hokkaido.

5. The University of California scientists also have developed a strain of barley that can pass its entire cycle of life in salt-water—a step that shows great promise in the development of productive food crops that can be irrigated with seawater.



A "live" turtle generates considerable interest among the students who watch, perhaps cautiously, as Jim Lanier of the Virginia Institute of Marine Science lectures on life in the sea.



Since its organization in 1966, Sea Grant has encouraged teams of specialists from many professional disciplines to define problems and to respond to local, state, and regional needs in research. It also has encouraged successful inter-institutional cooperation in education and public service. Through its marine advisory services, Sea Grant maintains a system for alerting researchers to the needs, problems, and opportunities over a wide spectrum of activities and for addressing itself not only to problems of marine industries, but also for providing advice to local, State, and Federal government agencies.

The economic benefits of some of the research have been significant, indeed. A very favorable cost benefit ratio was achieved through the application of applied educational research to a faltering industry in Hawaii.

In 1971 the precious coral industry in that State had retail sales of $2.6 million and employed 100 people. Primarily because of Sea Grant research over a 4-year period, retail sales jumped to $11.4 million and employment in the industry to 500 workers. The researchers discovered and mapped the major beds of pink and gold coral and developed an improved harvesting technique. They also designed a management plan to conserve the resources. A total of $148,500 in Federal money was invested in the project. More than $550,000 in Federal and State taxes was generated by the precious coral industry in Hawaii in 1975.

As man steadily reduces his supplies of nonrenewable land-based resources—gas, hard minerals, and petroleum—he has been turning increasingly to that natural extension

Top photos shows a floating tire breakwater, an innovation aided by Sea Grant research, for the protection of marinas, coves, and other areas. Lower left, an MAS agent examines the conditions of shellfish with a commercial oyster farmer. Lower right, University of Wisconsin scientists show living proof of the effects of PCB's (polychlorinated biphenyls) on monkeys. The primate at the right obviously was the one exposed.

Decked out in oilskins, a Sea Grant MAS agent assists a commercial fisherman check his nets.

of the land, the continental shelf and near-shore areas, as a source for these valuable substances. While Sea Grant's involvement in the development of these vital mineral resources has been relatively small compared to the overall needs, the program nevertheless has made significant advances in solving the problems associated with the exploration and use of marine minerals, including important documentation of the economic, engineering, legal, and sociological aspects of the field.

Sea Grant researchers have focussed attention, too, on the necessity for a balance of use, conservation, and preservation of America's coastal zones. Coastal ecosystems are quite complex, subject to extreme and violent environmental changes. Under stable conditions, nutrients and energy in an ecosystem tend to be in equilibrium. But the activities of man can disturb this balance, and increasingly, Sea Grant has turned attention to this problem.

Pollution studies also have been a significant element of the Sea Grant program. With emphasis on protection of marine resources of commercial or recreational importance, Sea Grant studies have been concerned primarily with heat, viruses, metals, pesticides, petroleum, and polychlorinated biphenyls (PCB's).

In one of the most significant programs of its kind, Sea Grant researchers at the University of Wisconsin found that monkeys kept on a diet with very high concentrations of PCB's (300 to 5,000 parts per million) for 3 months suffered acne, discharges of pus from their eyes, swollen eyelids and lips, hair loss, and weight loss. The PCB's were found to be toxic to primates over a wide dosage range. Although the possibility of man's consuming a steady diet containing those concentrations of PCB's is remote, the Wisconsin scientists believe these data do point out that even small amounts of PCB's are toxic, and that a safe level of consumption has not yet been established for these compounds.

At the Massachusetts Institute of Technology, researchers studied the economic and environmental impacts of petroleum development of the continental shelf. The scientists there also have developed environmental models for predicting the movement of oil spills under varying conditions.

Unless a spill is actually witnessed, of course, it is usually impossible to determine its source. Approximately 10,000 "mystery" spills occur along U.S. coasts each year. University of Rhode Island chemists, partially supported by Sea Grant funds, have perfected a method that uses infrared spectroscopy to identify spilled oil and trace it to the source. The unique system has been used already to locate the source of a large oil spill in Narragansett Bay and to determine the sources of several others for Coast Guard Officials.

Even before passage of the Fishery Conservation and Management Act of 1976, managerial technique for fishery resources was an area of expanding effort by Sea Grant economists. The establishment of the 200-mile conservation zone has increased the importance of that work. Economists at the University of Rhode Island and at Oregon State University, following a study of the probable economic impact of extended jurisdiction on domestic fisheries, were able to offer modifications to help realize the law's full potential.

Underutilized fish species—those that exist in large enough numbers to warrant harvesting, but for which no profitable market has been developed—are showing up in increasing numbers in the nation's supermarkets and restaurants due to Sea Grant research. The possibility of marketing such "exotic" animals as alewives, blue mussels, eel, freshwater mullet, red crab, shark, squid, and white sucker have been examined by Sea Grant economists. Researchers at the University of North Carolina have been of great assistance in the establishment of an eel industry in that State.

Other Sea Grant activities covered in the report include the development of:

1. Improved underwater welding techniques.

2. Better treatment against internal decay of wooden waterfront structures.

3. Floating-tire and other breakwaters for the protection of shorelines and marinas.

4. Energy sources from the oceans.

5. Better equipment and diving data for scuba divers.

6. Advancements in the sanitary quality, nutritional value, shelf life, appearance, and taste of fresh, frozen, and canned seafoods.

During its existence, Sea Grant has played a major role in education and in the training of specialists for marine careers. In the field of education, the program has helped considerably in increasing public awareness of the oceans and related marine activities. It has created graduate programs in economics, law, marine affairs, and ocean engineering; supported the improvement of existing programs in marine disciplines; and developed a number of training programs for marine technicians.

Following a lead from the Land Grant program, Sea Grant has developed a comprehensive network of marine advisory service agents who act as intermediaries between researchers and users. The marine advisory service program operates with more than 225 advisory service agents in 27 States.

Typical of the work carried out by the agents is a case where commercial New England fishermen were becoming increasingly uneasy about the towing block system that had been used for years by the fishermen to stabilize their trawl nets and prevent the two cables from fouling in the vessels' propellers. Use of the block had led to serious injury among crewmen and resulted in higher insurance premiums for the boat owners.

Engineers at M.I.T., alerted by the marine advisory service, developed a new and safer system for the fishermen, which now is in use.

The advisory service agents assist schools, businesses, industries, marina operators, pleasure boat operators and owners, seafood processors and many others as well through seminars, workshops, or individual meetings.

This type of eyeball-to-eyeball exchange between the advisory service agents and the public, coupled with Sea Grant's research and education activities, serves to underscore the unique Federal-State-university partnership that has been developed in the program. When Sea Grant was first organized, it was described by many as one of the most revolutionary programs in maritime history. The results that have been achieved since then would not appear to detract from that definition. □

TWO NEW SHAPES OF WORLD OCEAN MAPS

By ATHELSTAN SPILHAUS

All maps of the globe must have interruptions. Sometimes a pinpoint is stretched to make a circular edge of the world map. More commonly a cut is made along a half great circle. Some dissected maps have a greater number of interruptions.

Generally, because people are more interested in land they put the interruptions through the oceans. In 1942, I produced a map of the whole world ocean with the half great circle interruption passing entirely through land. This has been widely used in oceanography. Sea people want the oceans interrupted as little as possible.

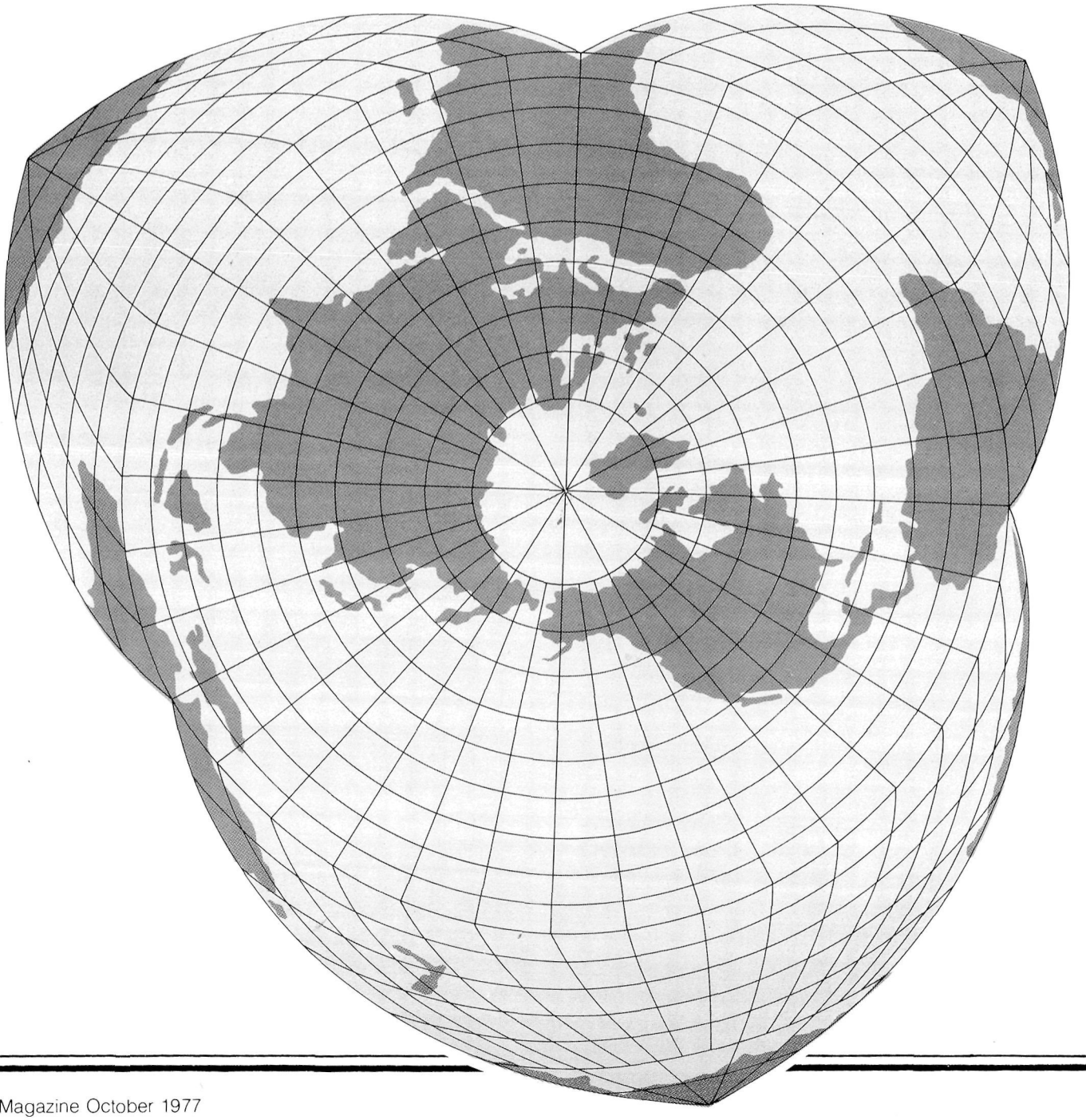
The correct choice of interruptions can enhance the usefulness and appearance of the map for a particular purpose. With the oceans as the purpose, I have sketched the maps on the following pages.

The first projection derives from the heart shaped map of Johann Werner of the 16th Century. Werner simply drew evenly spaced circles all centered at the North Pole for the parallels and then spaced the meridians correctly as on the globe for each parallel. (Thus making an equal area map.)

I simply sliced Werner's heart in half along the straight line meridian joining North and South Poles and rearranged one half with a mirror image of the other. I then shifted some uninteresting land masses such as Siberia around, having in mind that the cut (or interruption) does not have to go along a latitude or longitude line.

The "S" map that results shows the three oceans in their entirety, yet, shows the poles as almost polar caps. It is essentially a combination of two polar maps with a more conventional mid latitude center portion. The resulting map is pleasing and may be useful in depicting global oceanic or land relations.

The second petal-like map has three interruptions of 60 degrees latitude each. These interruptions are chosen to cut the Circum-Antarctic Ocean along the meridians usually chosen as the boundaries of the three oceans. Thus, each of the three oceans is shown as a whole. The interruptions terminate in three land continents Africa, Australia and South America. This map can be made also equal area. The same interruptions may be carried higher than 60 degrees—say to the equator or the same interruptions and latitude and longitude grid may be used for emphasizing the land by putting the interruptions in the oceans.



WHEN THE EARTH TURNED COLD

By LOUISE A. PURRETT

Photos: National Park Service

OVER the past million years the earth's climate has periodically gone haywire, turning so cold that ponderous sheets of ice crawled thousands of miles south of their normal habitat.

These frozen periods we call the ice ages. Their existence, clearly marked in the geologic record that forms earth's autobiography, has puzzled scientists of many disciplines: meteorology, oceanography, geology. Speculations on the cause of the ice ages range from the provocative to the mundane. Perhaps dust from a volcanic explosion darkened the sky and blocked the sun; perhaps some trigger, yet unidentified, set off the growth of the ice sheets and they fed on themselves, their whiteness reflecting away a greater proportion of sunlight. Or, these cold periods may simply be within the normal fluctuations of a climate that is more capricious than we had thought.

Scientists at NOAA's Geophysical Fluid Dynamics Laboratory in Princeton are pursuing the problem through mathematics. Researchers at the laboratory construct models—sets of equations—that describe the behavior of the fluid part of our planet, the oceans and atmosphere. The models can simulate the earth's climate, and predict how a change in solar radiation, or the location of mountain ranges, would affect it. Through manipulations of these models, the researchers study climate and the things that determine it, with the ultimate goal of achieving the power of prediction.

To these scientists, the ice ages are a nagging question, a thorn in their theories. "Sure the ice ages happened long ago," says Dr. Syukuro Manabe. "The last one was 18,000 years ago. But unless we can explain why they happened, we feel insecure discussing the changes in present climate. So we are working very hard on the ice age problem."

The group has a powerful tool to pry apart the problem: a computer model to simulate the general circulation of the atmosphere. The model responds to changes in a large number of factors that can affect circulation, and simulates the geographic and seasonal distributions of rainfall, evaporation rates, and temperature.

Manabe and his team at the laboratory (one of the Environmental Research Laboratories) are using the general circulation model to learn more about ice age climate and how it maintains itself. He and Dougles G. Hahn have recently completed a major experiment in which they simulated the climate of July and August under both present-day and ice age conditions. Only three critical "boundary conditions" were changed for the ice age simulation: sea surface temperature, glacial ice and albedo (reflectivity of the earth's surface), quantities that other scientists have estimated.

"How do they know sea surface temperature during the ice age? That's a very clever thing," says Manabe. The key is a tiny animal entombed in ocean sediments. A large group of geologists, says Manabe, have embarked on a major project, called Climap, to reconstruct conditions at the earth's surface—sea surface temperature, glacial ice—during the last ice age. Climap scientists have taken a census of foraminifera, radiolaria, and coccolithophoridae, the microscopic hard-shelled planktons, in sediment cores from the bottom of the ocean. Since different species of these animals prefer different water temperatures, the scientists could infer past sea surface temperatures from their populations at different core depths, corresponding to different ages.

During the two summer months of their computer experiment, Manabe and Hahn found, less rain fell on the ice age earth than on the simulated earth of today. But that does not mean that all parts of the earth were drier; there were wide geographic variations. Except for a narrow band south of the Equator, the tropical oceans were generally rainier, to varying degrees, during the ice age simulation than the present-day one. Over the continents, on the other hand, the rate of precipitation in the model ice age earth was generally less than the modern earth's. This was especially true at low latitudes.

Precipitation over the tropical continents, such as Africa, the northern parts of South America, and much of southern Asia—the Himalayas, and the northern parts of Burma

and India, was much less in the ice age simulation.

Rainfall is only half of the picture, emphasize Manabe and Hahn. The dryness of the land depends as well on how much is lost through evaporation or runoff. The scientists therefore calculated the difference between rainfall and evaporation for different geographic areas and their results confirmed the aridity of the tropical continents.

Scientists have been debating, says Manabe, whether the tropics were wet or dry during the ice ages. "For a long time, it was thought that the tropics were wet during the ice ages; but more recent geological evidence suggests the opposite, that they were drier than now." The Princeton experiment seems to support the "drys," he says.

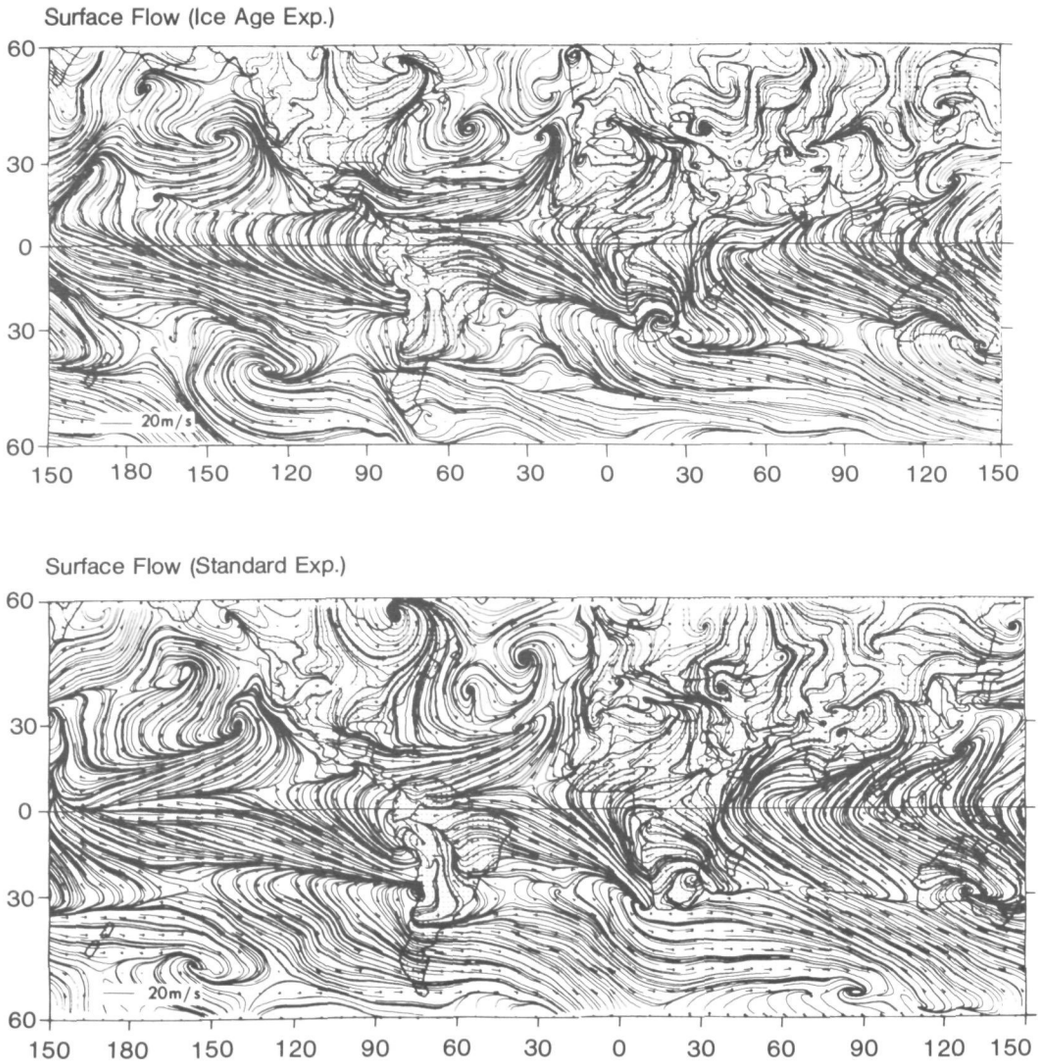
Geologists have found, for example, that during the last ice age the Sahara apparently extended much farther toward the Equator, and sand dunes covered the northern portions of tropical Africa, where grassy savannah now reigns. In Angola, the Orinoco river basin of Venezuela, and the northwestern part of India—all areas that the model says had a smaller water supply than now—sand dunes also developed in the past. Geological evidence also indicates a reduction of runoff over tropical continents during the last ice age. "For example, it has been suggested that Lake Victoria and Lake Albert in Uganda were low for an unknown time just before 12,000 years ago," note Manabe and Hahn. Other evidence suggests that Lake Chad was very low between 20,000 and 13,000 years ago.

What caused this tropical aridity? According to the model it was a change in atmospheric circulation caused in turn by the altered sea surface temperature and albedo.

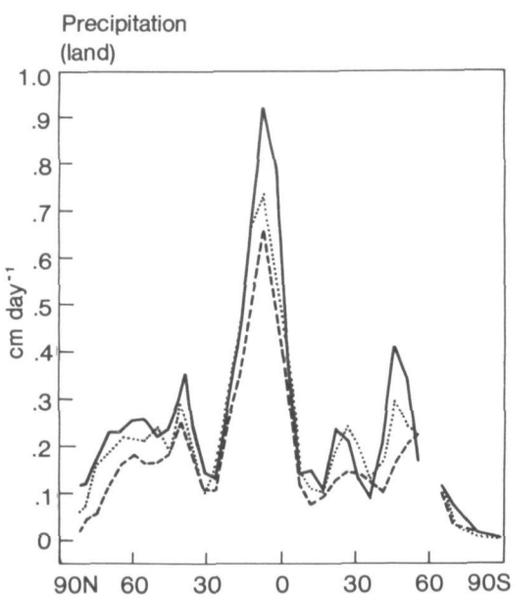
During the ice age sea surface temperatures were generally colder as might be expected. But flanking the equator in the ice age model are long east-west patches where the sea surface temperatures were relatively high—in fact, close to present-day levels. Over these zones, according to the model, precipitation rate, moist convection, and the intensity of tropical disturbances increased, because of the temperature contrast with surrounding cold waters.

The extensive snow, ice, and barren ground over the continents during the ice age would have reflected away much more of the sun's radiation so land masses would be proportionately much colder than the oceans and the difference in temperature between land and sea would be greater than it is now. This means, explain Hahn and Manabe, that during the ice age, surface barometric pressure over land tends to be higher than that over oceans. The resulting pressure gradient, they continue, would cause winds to blow outward from the land to the sea, causing drying over the tropical continents.

Both albedo and ocean temperatures, conclude Hahn and Manabe, seem to contribute to the aridity of the tropical continents during the ice age. To evaluate the relative importance of the two factors, the researchers conducted a third experiment, in which they simulated a "hybrid" world that has present-day sea surface temperatures and ice age albedo. They then compared mean precipitation rates at different latitudes in the ice age, present-day, and hybrid models.



What was the climate like in the ice age? Scientists as NOAA's Geophysical Fluid Dynamics Laboratory ran this computer experiment, showing surface winds 18,000 years ago (top) and today.



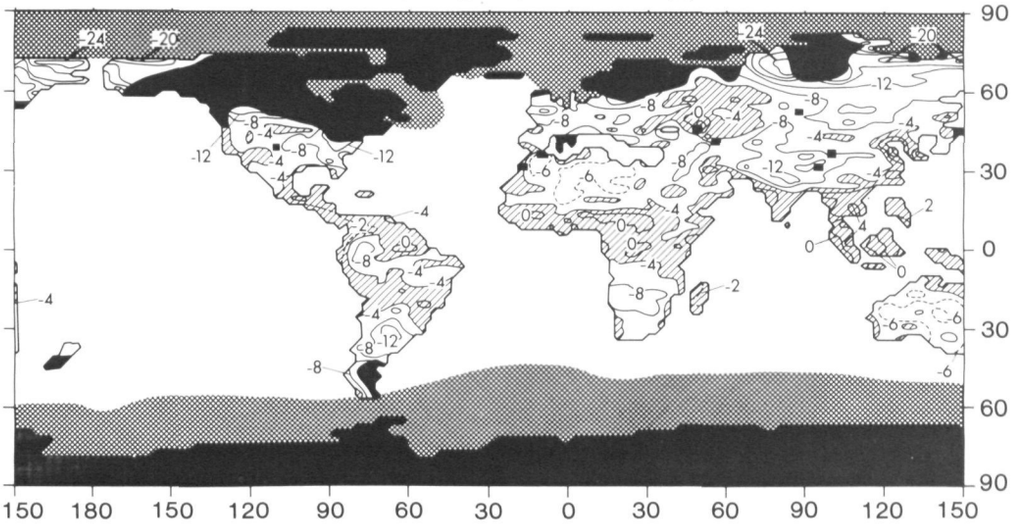
A precipitation experiment showed that rainfall during the ice age (dashed line) was less than today (unbroken line), and also less than a hybrid world with the colder ocean waters of the ice age but today's reflectivity (dotted line).

The precipitation rate over tropical continents was largest in the present-day simulated earth, substantially smaller in the hybrid, and smallest in the ice age earth. "In other words," say Hahn and Manabe, "both the change in sea surface temperatures and the relatively high continental albedo values in the ice age experiment contribute significantly to the comparatively low precipitation rate over the tropical continents."

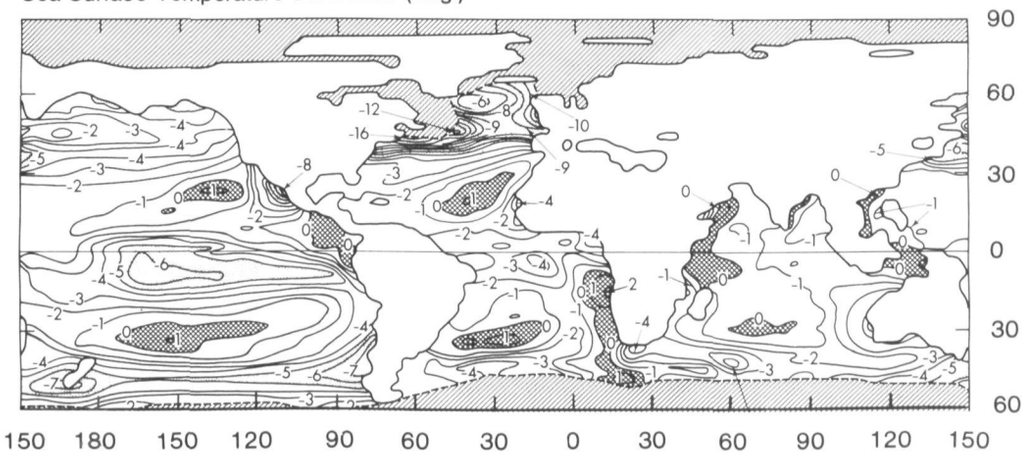
There were exceptions, however. Over India, the surface albedo appears to be the more important determinant of the subcontinent's dryness. During the ice age, the cold land surface apparently kept the southwesternly winds, the monsoons that carry moisture, from blowing as far inland as they do today.

The study, though, answered only some of the questions about ice ages. "This may not really tell you why the ice age took place," notes Manabe, "because you already are assuming a lot; you give a sea surface temperature which is much colder than now, and

Sea Surface Temperature Difference (Ice Age Exp.-Standard Exp.)



Sea Surface Temperature Difference (Aug.)



GFDL scientists also modeled land (top) and sea surface temperature differences between the ice age and today. The cross-hatched areas on the top map show the extent of sea ice during the ice age.

you know you will get a colder climate. But by using boundary conditions that are drastically different from now, such as lower sea surface temperature, we can learn how the atmosphere responds to an abnormal distribution of sea surface temperature. In addition we get some idea about the mechanism of ice cap formation and growth. Given the sea surface temperature of 18,000 years ago, and the ice cap of 18,000 years ago, does that ice cap continue to grow?" With future simulations, Manabe and his group hope to answer such questions.

"But the fundamental question of the ice age may not be answered by such a thing, because you assume colder conditions." Other studies that the group is conducting home in on the basic question: What triggers an ice age in the first place?

There are now two groups of theories about the ice ages, says Manabe. One is that they happen simply because there is an atmosphere, an ocean, and ice. "The atmosphere changes fast, the ocean changes much more slowly, and ice may change even more slowly. When you couple these three different time scales, with each component and the system as a whole changing, an ice age may occur as a manifestation of such a long-term drift of climate by this coupling." In other words, ice ages may be part of a "normal" oscillation of climate.

Such a cause would be very difficult to test, says Manabe. If, for example, the computer model of the climate were set in motion to see if an ice age evolved, it might have to be integrated over millions of "years." "If we started from the last ice age and kept integrating, marching forward to the present climate, and beyond, about the time I'm getting into my coffin, my computer might still be running."

This first type of theory attributes climate change and ice ages to internal factors within the ocean-atmosphere system. "Another possibility is that ice ages happen because of a change in external conditions, such as in the orbit of the earth around the sun," Manabe says.

The tilt of the earth relative to the sun, or the eccentricity of the orbit, change with time. And they change in ways that are well understood and predictable.

The variations in these so-called orbital parameters during the past several hundred thousand years can be computed with great precision. Changes in the earth's position relative to the sun would affect the amount of sunlight reaching the top of the atmosphere, a quantity also easily calculated. With a mathematical model of climate it is possible to study the climatic effects of such a change in radiation.

Two researchers in Manabe's group at the NOAA laboratory decided to test the orbital theory of ice ages by feeding the past orbital changes into a mathematical model. They used a simplified two-dimensional model into a simplified two-dimensional model and comparing the model's simulations of climate with those inferred from geology. "No other theory of the ice ages admits of such a straightfoward check on its validity," says Drs. Max J. Suarez and Isaac M. Held. With the climate model, the scientists computed the equilibrium climate that would result from each set of orbital parameters. For different latitudes and seasons, the model predicted the temperatures of two layers of the atmosphere, the surface of the land and ocean; the depth of snow over land; and the thickness of sea ice.

The researchers then compared the climate that the model generated from the orbital parameters of the past 150,000 years with the geologic record, past temperatures inferred from abundances of plankton in a sediment core from the North Atlantic. For the present, and for times at 5,000-year intervals into the past, they plotted the latitudes representing the seasonal limits of land snowcover and sea ice, as reconstructed by the model. The northernmost line, which varied from latitude 84 to 60, was the southern boundary of the ever-frozen region where snow accumulates from year to year, the domain of the continental glaciers. To the south, matching the curves of the glacial line, are the maximum and minimum extents of sea ice, and, farthest south, the winter snow line.

The researchers noted some differences between northern and southern hemispheres. Changes in snowcover and sea ice, for example, are much smaller in the southern hemisphere, which is mostly ocean. The southern hemisphere is more impervious to changes in the influx of solar radiation than the northern hemisphere, and its snowcover and sea ice are less changeable.

There were some discrepancies between the model's reconstructions of past climate and the paleo-record. It may mean, says Suarez and Held, that other factors are at least partly responsible for climatic variation, or that there is a lag resulting from the time required to build and destroy continental glaciers. But on the whole, they believe "a substantial portion of climatic variability" on the time scales they studied can be attributed to the atmosphere's response to perturbations in the earth's orbit.

Such studies at the Geophysical Fluid Dynamics Laboratory have yet to provide final answers to the puzzle of the ice ages. There may be no final answer. But they have cast new light on what the earth was like in the years it turned cold, and the continuing work of Manabe and his colleagues can, at least, weed out the forces that *could* have caused the ice ages. That may be the best anyone can do. □

NOAA employees are helping to clear

The Cloudy Side of Learning

By VALERIE A. GILLEN

The smiling faces of children: (seated, from left) Moses Robinson; Debbie Tate; Vicky Tate; (standing, from left) Leiland Crawford; Thomas Toye, Counselor, Prince Georges County Schools; Jerome Gray; Pat Anderson, Chairman, Community Concern Committee; Kathy Tate; Doug Beauman, Counselor, Prince Georges County Schools; and Loretha Gray.

PICTURES were appearing on the blackboard as the first grade teacher talked. "Class," she said, "how many apples and how many oranges have I drawn?"

In the back of the classroom sits Joey. The scratching of the chalk across the blackboard is the only cue he has that something is being drawn. Too shy to tell of his inability to see from his seat, he fails to answer the question correctly.

Joey is a victim of an educational syndrome that places slow learners in the back of the room. However, his problem is not an inability to learn, but an inability to see.

His plight is multiplied thousands of times in our country's schools. He is an example of a child from a needy family that cannot afford eye examinations or eyeglasses.

The employees of NOAA's Finance Division have set out to help some of our Joeys through a Community Concern Committee.

The Committee was organized in March, 1976. It was proposed under Section VI of the 1975 Affirmative Action Plan for Equal Employment Opportunity by employees of the NOAA Finance Division in Rockville, Md. The goal of the committee was "to initiate and implement a 'stay in school' program for children in the Washington metropolitan area by providing audio and visual aids."

In order to accomplish these goals, the committee held fund raising drives. With the funds raised during the first year, eye examinations and glasses were furnished to 25 needy children.

Pat Anderson, a supervisor of voucher and accounting technicians in the Washington Field Finance Office, was one of the original members of the committee and its first chairperson. She explains how it began:

"The people in the Finance Division expressed a concern about working in the community but they just didn't have the time. So, we decided to form a committee that everyone in Finance could be a part of—even if just through donations."

It was formed and the 22 active members elected officers, developed by-laws, and made up sub-committees.

Pat Anderson became Chairperson while Joe Dean, also a supervisor of voucher and accounting technicians in the Finance Division, was elected Vice-Chairperson.

NOAA's Voluntary Action Committee (NOVAC) volunteered to make the Community Concern Committee a subsidiary, to facilitate becoming a non-profit organization and obtaining a tax-exempt number.

The committee's next step was to decide what it would do. Members knew they wanted to help the community, but weren't sure how. They decided on a "stay in school" program that would be lasting which led to helping the children obtain audio and visual aids.

The committee members immediately set out to begin the project. They contacted local school boards and were welcomed with great enthusiasm. The local school boards felt it was a fantastic idea and agreed to help in any way that they could.

"Next," says Pat Anderson, "we contacted members of the Lions Club. They have been doing this kind of work for several years and were able to give us advice on how to go about it. They said that they were unable to reach everyone and would be grateful if we could help the children they could not."

The school boards assisted the committee in determining the eligibility of the children. The counselors found the school lunch program determined where the need was. Children within the community receive free lunches if the family's income is below average.

The county gives this kind of aid to some needy families. The parents of some of these kids, however, make just enough so that they cannot get aid from the county. The counselors use this as a guide in determining where the needy children are.

Clockwise from top left: Ben Brown, Chief Washington Field Finance Division, speaking at the Committee's Anniversary Luncheon; one of the attractions at the fashion show; Ruth Turner, Fashion Coordinator, and Jerry Phillips of the Morning Sound, WHUR Radio, emcees for the fashion show; "Little Dynamite"; and the Committee (from left) Peggy Selby, Pat Roland, Virginia Cummings, Lois Lenori, Joan Bozzonetti, Pat Anderson, Rose McClyde, Bob Coleman, Berta Johnson, Joe Dean, Lawrence Carter, Lillian Stolting, Beverly Thompkins, Beatrice Smith, Joan Doores, and (not pictured) Katherine Starr, Shirley Long, Frank Lattanzi, Julie Saposnekoo, Auki Hart, and James Pettus.

The group then sends the names of the children to a department store, where eye examinations are set up and the youngsters are fitted with glasses.

So far, it has been able to find 40 children fitting this category and has helped them all.

The committee has held several fund raising activities. The first was a luncheon. Members made up a menu and everyone in the Finance Division donated a dish. The luncheons were served to NOAA employees at a minimum donation of $2.50. This project raised $500.05.

Other drives included a bake sale, a Flea Market, a pecan sale, a dinner sale, and a bake sale and craft show with NOVAC.

The committee celebrated its first anniversary with a luncheon and fashion show under a tent at a nearby Washington country club. The minimum donation was $7.00. Nearly two hundred people attended, which brought in $207.

Pat Anderson describes how worthwhile the experience over the first year has been:

"When we originally decided on the eyeglass program," she explains, "I knew there was a need; but I didn't know the need was so great. It has been rewarding to know these kids we've helped and the conditions their eyes were in before they were given glasses."

The committee's Vice Chairperson, Joe Dean, tells of one of the children:

"One kid was failing in school and the teacher realized it was basically because he couldn't see," he explains. "The parents said they knew he needed glasses, but couldn't afford them. As far as they could tell, he could see well enough. Then the little boy's sister became ill and needed an operation; which left no chance for his glasses for quite some time. So he continued to fail in school.

"This is an example of the stories we hear about these kids," he continues. "We are very proud to be able to help them so that they can have the same opportunities as other children."

Doug Beauman, a counselor with the Prince Georges County School Board expresses the importance of this committee and what it is doing:

"Seeing is one of the main functions of a child's education. The school board is very happy about the help the committee has given our children. If it weren't for this committee, a lot of children would not be seeing today."

The committee now plans to help children with hearing aids. This means new fund drives.

"We'll find a way," says Joe Dean. "We do not intend to turn away a child in need although we may have to postpone it until we can get the funds."

Pat Anderson thinks that there may be other ways to give audio aid other than buying hearing aids. "We may be able to help more people by donating to another organization already in the process of helping in this way," she suggests. "We had no idea when we made this one of our goals how expensive it would be. We also may be able to provide batteries for these hearing aids. However, we are going to make an effort to help in any way that we can."

"It was a new experience for all of us," explains Pat. "We've learned a lot in our first year. I think over the next few years we will be able to build.

"When we are out there helping and trying to raise the money," she continues, "it's just fantastic working together. It's something you don't get just working on the job. The relationship and the drive that everyone had to really want to make it has made many people feel that they have accomplished something of great value."

Ben Brown, Chief of the Washington Field Finance Division, said at the committee's anniversary luncheon:

"In working with this committee and in helping and listening to the stories, I have found that this is an example of how we can find all the enrichment we need in our own backyard. Through our committee, there is enrichment for everyone and the opportunity to serve. I believe that if you can improve one life, you improve many others. And we're helping a lot of people."

Employees of NOAA's Finance Division have developed a new understanding of this enrichment. However, they have only just begun. Many more Joeys will be grateful to this committee for their ability to see and possibly an ability to hear and for shining a little light on the cloudy side of learning. □

AFTER THE ROAD THE REEF

By GERALD D. HILL, JR.

CHANCES that the recreational fisherman will catch the big one are being increased along U.S. coasts, and in other parts of the world, through the use of artificial reefs.

These unnatural habitats are constructed by private citizens, clubs, and local and state governments—in some cases with the assistance of the federal government and industry. Their common goal is to increase the number and different kinds of fish that can be caught by those who like to wet a hook and feel the thrill of a fish on their line.

One such group of public-minded citizens is the Stuart Sailfish Club in Stuart, Florida.

"We started the artificial reef about six years ago," said Bill Donaldson, one of the mainstays of the project. "So far we have put in over 70,000 tires that extend for approximately one-half mile."

Bill Donaldson is one of the original "Eleven Old Men" who began the reef. He lived in Pontiac, Michigan, for 65 years, served as its mayor, and from 1960 to 1972 was postmaster of the city.

Although he is the only active member of the original eleven, he says he has a list of about 125 people he can call on to help in assembling the materials to add to the reef.

"I call them my 'reeftirees,' " said Donaldson. "Each time we decide there are enough tires available, I start calling and have no trouble at all in getting 30 to 40 people to show up. We have a good time as well as really getting something done. We use concrete to fill the tires and can usually fill from 1200 to 1400 tires in a couple of hours. A recess between the delivery of the loads of concrete gives us time for a cool drink and chance to catch up on our 'socializing.'

"The average age of the active group is 65 but we do have at least 12 of the group who are 'youngsters' in their 70's," he added. "We are bound and determined to wear out rather than rust out."

The reef is located about five miles offshore from the St. Lucie Inlet in 60 feet of water. It has produced a good number of red snapper, grouper, trigger and other bottom

Photos: The Stuart Times

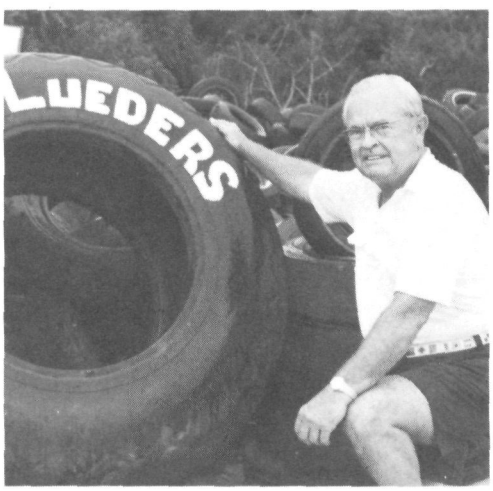
fish as well as serving as a "cafeteria" for game fish of all kinds. Donaldson said that divers have to shoo the bait fish away in order to photograph the tires that serve as the home for the fish.

"The actions of Bill Donaldson and the Stuart Sailfish Club are typical of many people who are interested in improving the environment for the enjoyment of many. At the present time, there are over 300 artificial reefs along the coast of the United States, many of them started by groups such as Bill's," said Richard Stone, Acting Director, Office of Marine Recreational Fisheries, National Marine Fisheries Service. Dick Stone began to work with artificial reefs when he was assigned to the NMFS Sandy Hook lab in Highlands, New Jersey, in the early 60's. When the reef project was moved to Beaufort, North Carolina, in 1972, he went with it. He directed the project until it was completed in 1974, and continues to act as a clearing house for questions about artificial reefs.

The Fisheries Service became involved in artificial reefs because it began to get a lot of questions about them. It appeared that there was a good opportunity to assist the recreational fishermen and at the same time remove a lot of unsightly, useless material from the countryside.

"We were aware of some work that had been done in California and Hawaii," said Stone, "but there didn't seem to be one central place that someone could go to for firm, factual information. The Service went to Congress for a special appropriation to begin the project and other government agencies assisted us with funds."

Fishermen have known for a long time that they could catch more fish over areas of the ocean bottom that were rocky or where



(Opposite) "Reeftirees" filling tires with cement before (top) being added to the 70,000 tire reef (above). Bill Donaldson leads the reef project in Stuart, Fla.

natural reefs were located. These areas permit barnacles, corals and mussels, and other small organisms to settle and become part of the food chain. The reefs also provide areas for fish to hide from predators and to rest from the currents in the area. The Atlantic Continental Shelf extends outward from the coast to depths of 600 feet; however, much of the area is relatively barren and consists of a flat sand or mud bottom which offers little food or protection to the fish in the area. Artificial reefs have shown that these barren areas can become productive.

The idea of placing material in the water to increase the number of fish is not new. In the mid-1800's, the Hon. William Elliot of Beaufort, South Carolina, tells us in his publication, "Carolina Sports by Land and Water," that fishing for sheepshead was greatly improved with the use of logs placed in the water. "They (sheepshead) were formerly taken in considerable numbers among our various inlets, into which large trees had fallen to which barnacles soon became attached; but as the lands have been cleared for the cultivation of sea-island cotton, the trees have disappeared, and with them the fish; and it has been found necessary to renew their feeding grounds by artificial means. Logs of oak and pine are formed into a sort of hut without a roof, five or six feet high; it is floored, and then floated to the place desired, and sunk in eight feet of water by casting stones or live oak timbers within; as soon as the barnacles are formed, which will happen in a few weeks, the fish will begin to resort to the ground."

In 1916, the Boatmen's Association of the Great South Bay, New York, constructed a reef near Fire Island Inlet which provided productive fishing for over 30 years.

The construction of artificial reefs started in earnest in 1935 when the Cape May-Wildwood Party Boat Association sank four vessels loaded with tons of material about 10 miles south of Cape May Inlet in 65 feet of water. One of the railroads in the area offered a one-day trip fisherman's special for $1.25 from Philadelphia to Cape May. The Atlantic City, New Jersey, Chamber of Commerce followed close behind with a reef in 1936. Little was done in the construction of reefs in the 40's other than rebuilding the Great South Bay Reef off New York. Building began again in 1950 with the construction of McAllister Ground off Long Beach with material from buildings being demolished in Manhattan. Since the 50's many reefs have been built along the coast of the United States.

"Some of them failed and some of them really improved the supply of fish in the areas," said Stone. "When the reefs were first built many types of material were used. People literally dumped anything they could find and move into the ocean. Car bodies, wooden railroad cars, refrigerators, and even the proverbial "kitchen sink" went into the drink. It was found, however, that car bodies and other thin metal objects only lasted five or six years before rusting away. Some of the lighter materials such as stoves and refrigerators would move in strong currents. Although this was not a frequent occurrence, when they did move it became hard for the fishermen to find them again and in some cases they were moved into areas where they fouled the nets of commercial fishermen."

Stone and his co-workers, after experimenting with many materials, zeroed in on the use of automobile tires as a primary source of material for constructing the reefs. They found that they were easy to handle, in good supply, and didn't pollute the water. In fact, it was soon discovered that this was probably the best way of disposing of some of the 200 million tires that are discarded each year.

In 1968, the National Marine Fisheries Service entered into an agreement with the Solid Waste Management Program of the

U.S. Environmental Protection Agency and the National Tire Dealers and Retreaders Association to study the possibility of using large numbers of discarded tires to build artificial reefs in the ocean.

"We had five goals in this project," said Stone. "We were trying to determine methods of assembling tires into units that would be inexpensive, easy to assemble and handle, and that would be effective once they were in place. We also needed to determine the cost of building the units and transporting them, how the reefs functioned in the marine environment, the effects of reefs on angling success in the New York Bight, the number of reefs that could be established, and the potential number of scrap tires that could be used effectively in the marine environment."

Although tires had been used for years to build the reefs, little had been done in determining the best design to be used. Stone and his group created tests to determine the designs that could be assembled and transported easily, with a minimum of cost.

We tested six tire unit designs in the study and obtained data from state agencies on two others," said Stone. The cost of material for the units ranged from $0.07 to $0.68 per tire; for labor, $0.19 to $2.05 per tire; and transportation $0.08 to $2.09 per tire. The cost of the majority of the designs fell in the lower end of the cost range."

Designs ranging from 12 tires in a unit to single tires weighted with concrete cylinders were tested. All had advantages and disadvantages depending primarily on the cost of

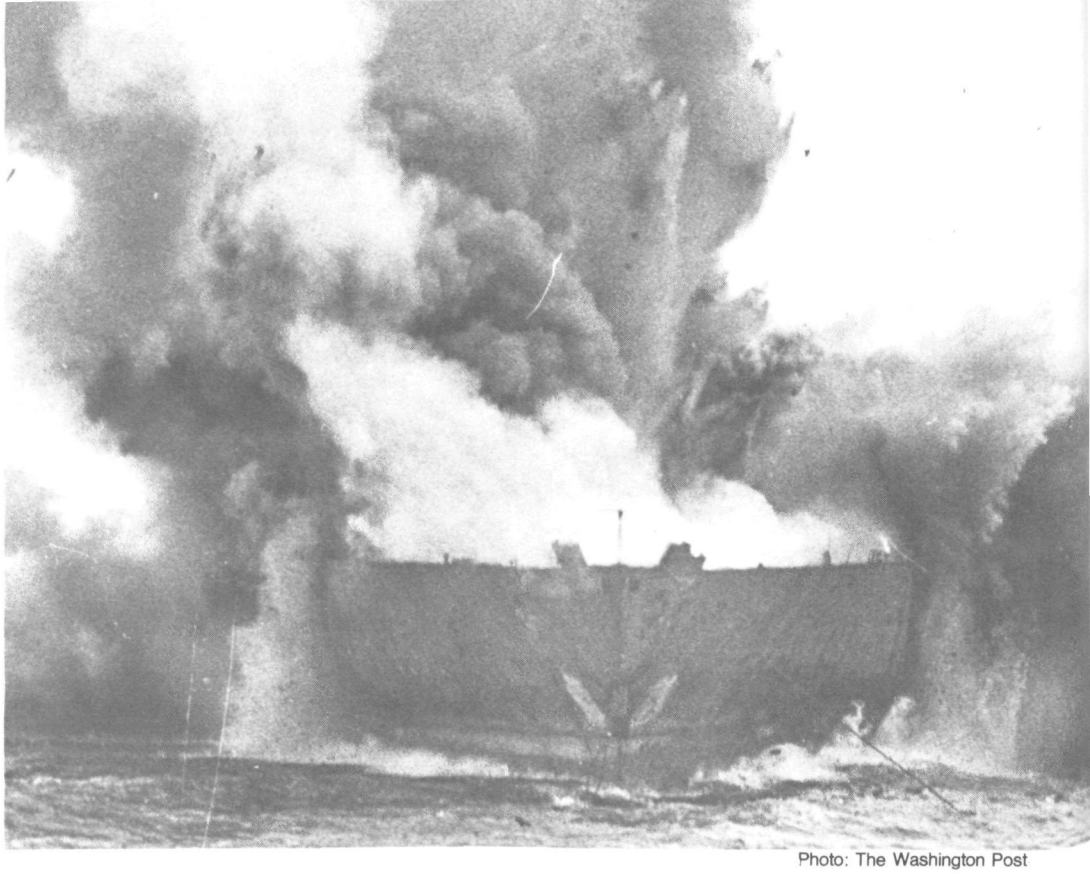


Photo: The Washington Post

Photo: NOAA

(Above) NMFS Diver-Geologist identifying fish on a new reef. (Top right), Liberty ship heads for the bottom to form a new reef. (Right) bait fish on an artificial reef.

transportation of the units after they were assembled. The 12-tire unit cost approximately $15 each and offered an excellent habitat because of its height and the large surface area that it provided. The one-tire unit proved the most easy to place since it could be handled by one man and could be carried to the drop site in almost any size boat.

"Probably the best unit for shallow water is the three-tire unit consisting of three tires standing upright with a piece of reinforcing rod inserted through the side walls," said Stone. The unit is weighted with concrete poured around the rod and air vents are drilled in the tire face opposite the concrete. The unit is easy to build, provides about two feet of elevation, and has proved to be stable in strong currents and wave surges. Some of the other designs are better for deeper water because they give a higher profile underwater and furnish more surface area for organisms to cling to and more crevices for the smaller fish to hide in."

Other items have been used to construct artificial reefs. Probably the most publicized are sunken ships. Several states have obtained surplus ships from the Federal Government and sunk them off their coasts. The use of ships, however, is a major undertaking that requires much planning before the charges are set, the bottom is blown, and the ship starts its dive to the bottom.

Virginia has a very active reef program using World War II Liberty Ships. In May, the sixth and last of the old ships was sunk in 115 feet of water 30 miles off Virginia Beach. In a fiery explosion, the 440-foot ship settled to the bottom in line with three other ships in the area known as the Triangle Wreck Area. The ships are expected to last at least 150 years, and as time passes will become the home for thousands of fish and the delight of many recreational fishermen.

Some of the factors that must be considered are where the ship will be placed, how it will be marked and what has to be done to the ship before it is sunk.

"Site selection is of utmost importance, especially if the ship is large," said Stone. "In the case of Liberty Ships which are normally 30 feet high even after part of the superstructure is removed, a depth of 80 feet is required. The U.S. Corps of Engineers requires that there be a minimum of 50 feet clearance from the top of the sunken ship to the water surface. In addition, the ships must be placed at a safe distance from shipping lanes and anchorages. Commercial fishing areas must also be avoided so that the reef doesn't interfere with the fishermen's gear."

Another point to consider is the accessibility of the reef to the recreational fishermen. A large number of fishermen trailer their boats to the water's edge, and generally consider 30 miles out the absolute maximum for safety.

Artificial reefs are also used by fishermen other than the ones with hook and line. Scuba diving over the reefs is very popular in most areas of the country and the capabilities of the divers should be considered. Normally most divers consider 100-110 feet the maximum safe diving depths and the reef

Once the reef is in place, it must be suitably marked, not only for easy location by fishermen and divers but also to indicate an underwater obstruction. This is especially important if commercial fishing grounds are nearby. When the large Liberty Ships are used, they must be marked with a lighted buoy, radar reflector, and whistle or bells. Marking the reefs in such a manner can be costly since the installation and maintenance may be as much as $6,000 to $7,000 annually.

Sometimes large ships become artificial reefs by accident or disaster. An example is the V.A. Fogg, a 572-foot tanker that was heading out to sea on February 1, 1972, to empty its tanks of benzene residue. She was about 43 miles south of Galveston, well out of the shipping lanes, when she was ripped apart by an explosion and sank immediately, carrying 39 men to their graves in 100 feet of water.

She was found 12 days later with the top of her radar mast visible above the surface of the Gulf. To eliminate her as a navigation hazard, all of her superstructure more than 60 feet above the bottom was removed by demolition.

One-inch thick steel plates, used in the construction of the hull, were ripped apart in the initial explosion and further openings were made when the demolitions charges cleared the hull to 60 feet of clearance. This provided many openings and nooks and crannies for fish life, and since the heavy steel plates offer long term resistance to the sea water, the reef is expected to last more than 40 years.

Within a few months after the ship sank, red snapper, hard tailed jacks, barracuda, and spade fish began to make the ship their home. As the growth of various organisms on the ship increased, the numbers and species of fish increased. The reef has become quite an attraction for fishermen and divers from all over Texas and from as far away as Chicago and New Jersey.

"Factors other than accessibility and avoiding shipping lanes and commercial fishing areas must be considered," said Stone. "Normally a soft muddy bottom will not be suitable for a reef because the reef will eventually sink into the mud, the organisms and fish that inhabit reefs don't like muddy water and the benefits of underwater study and scuba diving are lost. Placing these artificial reefs in an area that already has underwater obstructions is also a good idea, as commercial fishermen normally are already aware of the obstructions and avoid the area."

Commercial fishermen may also provide some support for the development of the new reef, since offspring from the organisms and fish in the area will move to it quickly. "There is less competition with the permanent settlers there than on the old homestead," said Stone.

Do the reefs actually increase the number of fish in the area or do the fish simply move from other areas to the new reef? According to Stone, the reefs actually increase the number of fish present and take very few of should not exceed this depth so that they may take advantage of the reef.

them away from other areas. Artificial reefs, like natural reefs, can provide living space for a limited number of fishes. So the more reef material in an area, the more reef fishes that can live in that area.

Historical data available seems to bear this out. A letter from the conservation chairman of the Bay Shore Tuna Club to the New York Bureau of Marine Fisheries stated, "Within two months from laying the habitats, fishing territories previously known as good became excellent. Poor areas which had been abandoned by bass, blackfish or weakfish, showed signs of amazing improvement. After steady fishing of these emplacements, statistics show that the number of fish specimens caught during 1947 season, as compared with 1946 available results, increased as follows: sea bass—25 times; blackfish—2 and one-half times; and weakfish—double."

The Division of Fish and Game in Hawaii began studies on artificial reefs in 1957 to determine the effect of man-made structures on the standing stocks of fish found on their natural reefs. They discovered that the amount of fish by weight in one of the areas increased 16 times and based on this began constructing a series of artificial reefs.

J. E. Randall built and began studying a concrete block reef at Lameshur Bay, St. Johns, Virgin Islands, in 1958. Twenty-eight months later he found the standing stocks of fish on the artificial reef was 11 times greater than on an adjacent natural reef. Based on these findings, he recommended artificial reefs for the enhancement of recreational and commercial fishing around the Virgin Islands.

In 1972 the National Marine Fisheries Service placed an artificial reef northwest of the Pacific Reef Light in Biscayne National Monument, Florida, so that a comparison of the productivity of an artificial reef could be compared with a natural one.

At the end of the 24-month experiment, the small artificial reef had doubled the number of fish in the immediate vicinity of the natural patch reef. Although the artificial reef was less than 25 meters from the natural patch, it did not decrease the number of fish on the natural reef by attracting them to the artificial one.

The United States is not the only country that has seen the value of artificial reefs. In Japan, records indicate there were reefs built in the late 1700's and there is reason to believe they were used even before then. Between 1952 and 1970, Japan spent almost $3 million building and improving reefs to increase the catch of commercial fishermen.

Both France and Australia began building reefs in the 1960's and have found they are highly successful in attracting fish for the recreational fishermen.

Artificial reefs have proven themselves as a means of increasing the numbers and kinds of fish in an area. Reef building can be a productive community affair that benefits many. As Bill Donaldson said, "The Lord made the earth one-third land and two-thirds water—and intended everyone to spend two-thirds of his time fishing." The "reeftirees" and hundreds like them are doing their bit to make this time productive and fun. □

NOS Experiments Track Wastes

Dumping and the Marine Environment

By JOHN G. STRINGER

A DUMPING barge carrying several thousand tons of organic sludge produced by a Shell Chemical, Inc., plant near Houston, Texas, became the focal point last summer for three government agencies to launch a major waste tracking experiment 120 miles south of Galveston in the Gulf of Mexico.

The ocean dumping tracking operation was one of the larger and more complex environmental research endeavors coordinated by the National Ocean Survey's Ocean Dumping Program. The Coast Guard and the National Aeronautics and Space Administration joined NOS in the attempt to find out how dumping waste materials at deepwater waste disposal sites affected the ecology of the area.

The National Ocean Survey began the series of field investigations on July 18, to assess the impact of ocean dumping at three sites ranging from 6000 to 9000 feet (1750 to 2700 meters) deep in the Gulf of Mexico and the Atlantic Ocean. The Researcher under the command of NOAA Corps Capt. Philip J. Taetz and a U.S. Coast Guard vessel, the USCG Acushnet, participated in the exercise in the Gulf of Mexico. Working in the Atlantic were two NOAA ships—the Peirce, captained by Cdr. Carl W. Fisher and the Albatross IV, under the command of W. E. Beatteay.

The Gulf of Mexico operation involved two dumping sites south of Galveston and New Orleans, with the major effort applied at the Galveston site. The Galveston work centered around an acoustical waste tracking experiment designed to portray the manner in which the waste dumped by the Shell barge at the site would disperse in the ocean. During the waste tracking experiment, conducted by Dr. John Proni of NOAA's Sea-Air Interaction Laboratory in Miami, scientists aboard the Researcher attempted to follow dispersion patterns of the waste plume. The scientific party aboard the Acushnet, working under the direction of Dr. Elliot Atlas of Texas A&M University, collected and analyzed water samples from the waste plume to determine the physical and chemical nature of the plume, and to confirm the findings of the acoustical experiment.

The waste tracking experiment was preceded and followed by physical and chemical field efforts to determine seasonal oceanographic characteristics of the dumping site. The work included current, salinity and temperature measurements, releasing and tracking of drogues, and chemical water analyses.

Dr. Edward R. Meyer of the National Ocean Survey Ocean Dumping Program planned the Gulf exercise, and also provided overall field coordination for the work at both sites in the Gulf. "Weather conditions couldn't have been better," Meyer said, "and the degree of cooperation and enthusiasm extended by all parties involved in the exercise was outstanding. The waste tracking experiment was a success, as were all other aspects of the projects."

Dr. Proni, who directed the acoustical experiment off Galveston said, "The water in dumpsite was extremely quiescent, that is, very little mixing activity occurred. There was no noticeable surface wave action.

"The material that was dumped," said Proni, "remained near the surface of the ocean and dispersed extremely slowly." Small fish and crabs were seen feeding near the surface in the dumping area.

Later, about 25 miles southeast of the dumpsite, the scientists aboard the Researcher observed a huge anticyclonic eddy, believed to be a part of the loop current from the Gulf Stream. It appeared to be on the order of 200 miles across, with a 1.5 knot current at its boundary.

"When the eddy strikes the dumpsite," said Proni, "we will see a movement northward of the material dumped into the zone which will be dramatically different than what we observed in the cruise."

In addition to their acoustic measurements, the scientists hung a device over the side of the ship that detects material dumped into the ocean, enabling them to accomplish a substantial amount of chemical and particulate sampling.

"The cruise proceeded very well," said Proni. "We can now characterize the material both from the point of view of its growth in space and time and also its chemical changes."

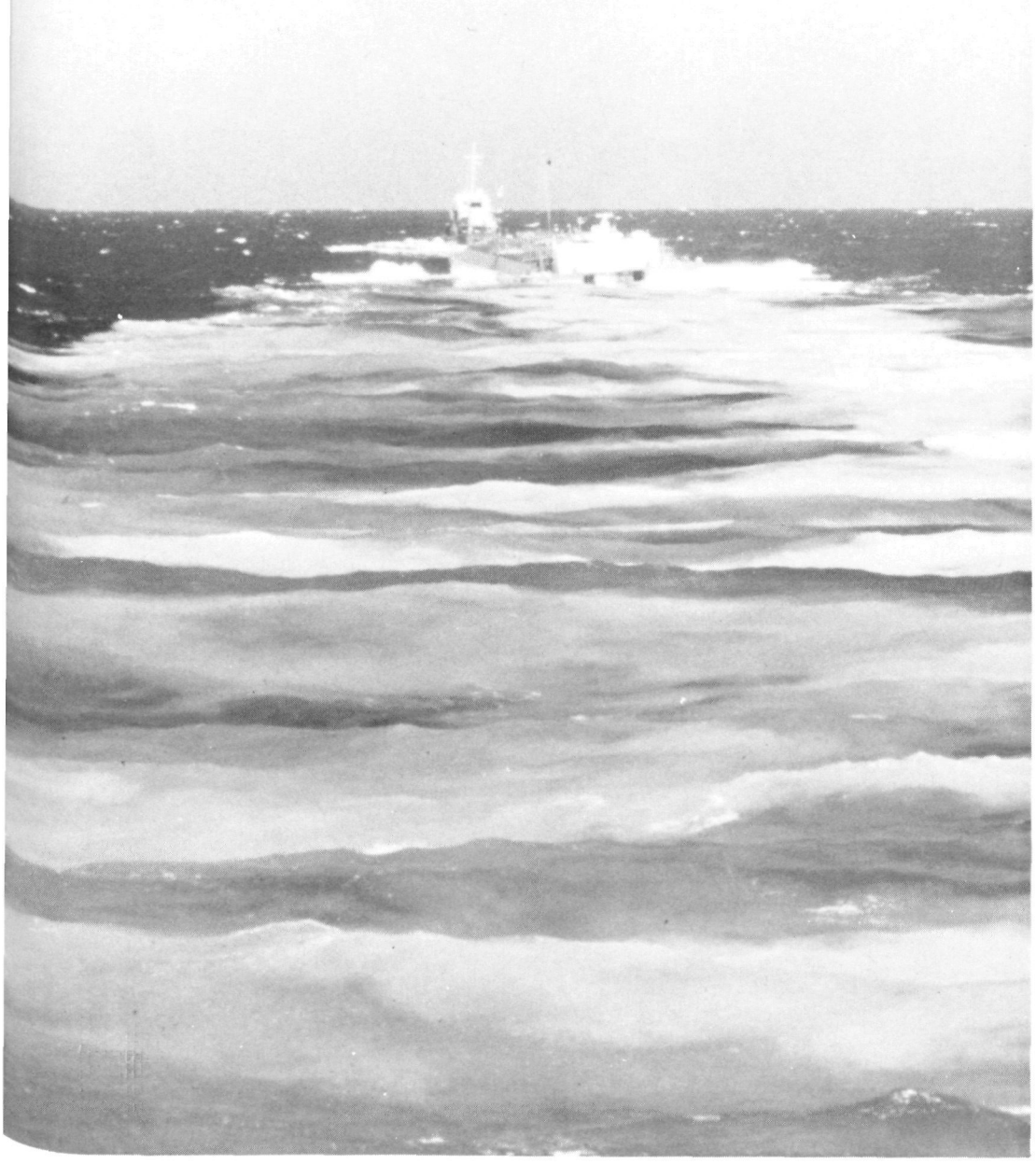
Also participating in the waste tracking experiment in the Gulf was the Environmental Quality Program Office of the NASA Langley Research Center, Hampton, Va. The NASA group collected photographic and multispectral images of the dumping operation from an aircraft that passed over the disposal area at intervals of roughly 15 minutes. The efforts were directed by Dr. Robert Johnson of NASA. The results of Dr. Johnson's work will be compared to those of Dr. Proni's acoustical experiment, and the combined findings should provide a detailed picture of movement of the waste plume in and around the dumping area. "The work completed by NASA," Meyer said, "represents a significant contribution to the task of developing routine methods for monitoring ocean dumping operations."

Following completion of the waste tracking exercise, the Acushnet steamed north to the dumping site south of New Orleans where Dr. Atlas and his group aboard the Acushnet established a seasonal oceanographic picture of the site. The picture will form a portion of the scientific description of the New Orleans site as well as provide a background for a waste tracking exercise NOS intends to undertake at the New Orleans site next summer.

Located 100 miles east of Cape Henlopen, Del., Deep Water Dumpsite 106 (DWD 106) has been utilized by 12 industrial dumpers from New York-northern New Jersey area for the disposal of various waste products. The dumping burden received at this site was increased this year by the addition of acid-iron waste from the Dupont plant in Edge Moor, Del., and sewage sludge from Camden, N.J. Both of these wastes had previously been dumped at sites much closer to the coast and in shallow waters over the Continental Shelf.

DWD 106 has been under investigation by Federal agencies since 1974 when the Environmental Protection Agency requested NOAA to assess the environmental impacts of dumping at that site. As part of this continuing investigation, NOAA dispatched on July 20, the 163-foot Peirce from NOAA's Atlantic Marine Center in Norfolk which was to rendezvous with the Albatross IV, whose home port is NOAA's Northeast Fisheries Center in Woods Hole, Mass. Their mission was to determine the dispersal patterns and chemical interactions of waste dumped during the cruise period and biological changes induced by both the newly dumped waste and previous dumpings in the same water mass.

The first scheduled dump was at 7 a.m. on July 23, when one million gallons of sewage sludge from Camden, N.J., were discharged



Shear patterns from the dumpsite off Galveston (top) define the limits of the 200-mile diameter eddy. Members of scientific party and crew included (bottom, l. to r. standing) Jack Foreman, EDS; Lt. Cdr. William L. Stubblefield, NOAA Corps; Capt. Philip J. Taetz, NOAA Corps; Charles Lauter, AOML; T. Ichiye, TAMU; Carmen Cerasoli, ERL; Doyle Horne, TAMU; J. C. H. Mungall, TAMU; Lt. Cdr. Ronald L. Sellers, NOAA Corps; Lt. (jg) Bryce M. Scott, NOAA Corps; Lt. Chris J. Nelson, NOAA Corps; (seated) Catherine Walsh, NOS; Harris B. Stewart, Jr., AOML; Fred C. Newman, AOML; John R. Proni, AOML; Terry Nelson, AOML.

at a rate of about 20,000 gallons per minute while the barge moved at a speed of five knots. The second dump—one million gallons of acid-iron waste from the Dupont plant in Edge Moor—was discharged on July 26, at a rate of about 3700 gallons per minute, again with the barge proceeding at five knots.

Dispersal patterns were determined by using specially designed acoustic gear to track the vertical and horizontal movement of solids in the sludge, and the action of the ferric hydroxide floc that is formed by the mixing of acid-iron waste with seawater. Chemical measurements included determination of concentrations of trace metals and organic matter and the partitioning of trace metals and organic matter between dissolved and particulate forms. Biological work included bacteriological measurements, analysis of organisms collected in nets, and assessment of the biological conditions of different organisms. The chemical and biological data will be compared with that collected earlier in the cruise at a site well outside of DWD-106.

T. P. O'Connor, Chief Scientist for East Coast Studies in the NOAA Ocean Dumping Program, said that although the Dupont waste "seemed to stay above 15 meters which is the depth of the seasonal thermocline, part of the sludge did penetrate the thermocline.

"This means that sewage sludge can enter the deep ocean rather quickly," said O'Connor. "There were indications, though, that part of the sewage sludge like the acid-iron waste stayed near the surface."

O'Connor said that in both cases, the entire waste plume tended to move in a northeasterly and then southeasterly direction. "The reason," he said, "is that both dumps were in the northern edge of a large Gulf Stream eddy where a clockwise motion is northeasterly then south followed by southeasterly." The presence of the eddy was anticipated beforehand on the basis of satellite data prepared by the Naval Oceanographic Office in Washington, D.C., and a second eddy to the east-northeast of DWD-106 was used as a control site.

The acoustical experiments completed in the Gulf and at DWD-106 indicated that certain types of waste do not penetrate deeply into the oceans when dumped. Some particulate materials contained in the wastes appeared to remain suspended in the warmer, upper layers of water which O'Connor said is very important for scientists to know when deciding where to look for biological effects of dumping.

The Gulf and Atlantic projects last summer form only a portion of the NOS Ocean Dumping Program, which includes a variety of laboratory efforts designed to provide physical and chemical descriptions of waste materials, to portray chemical reactions of wastes with sea waters, and to measure efforts of the waters upon plants and animals.

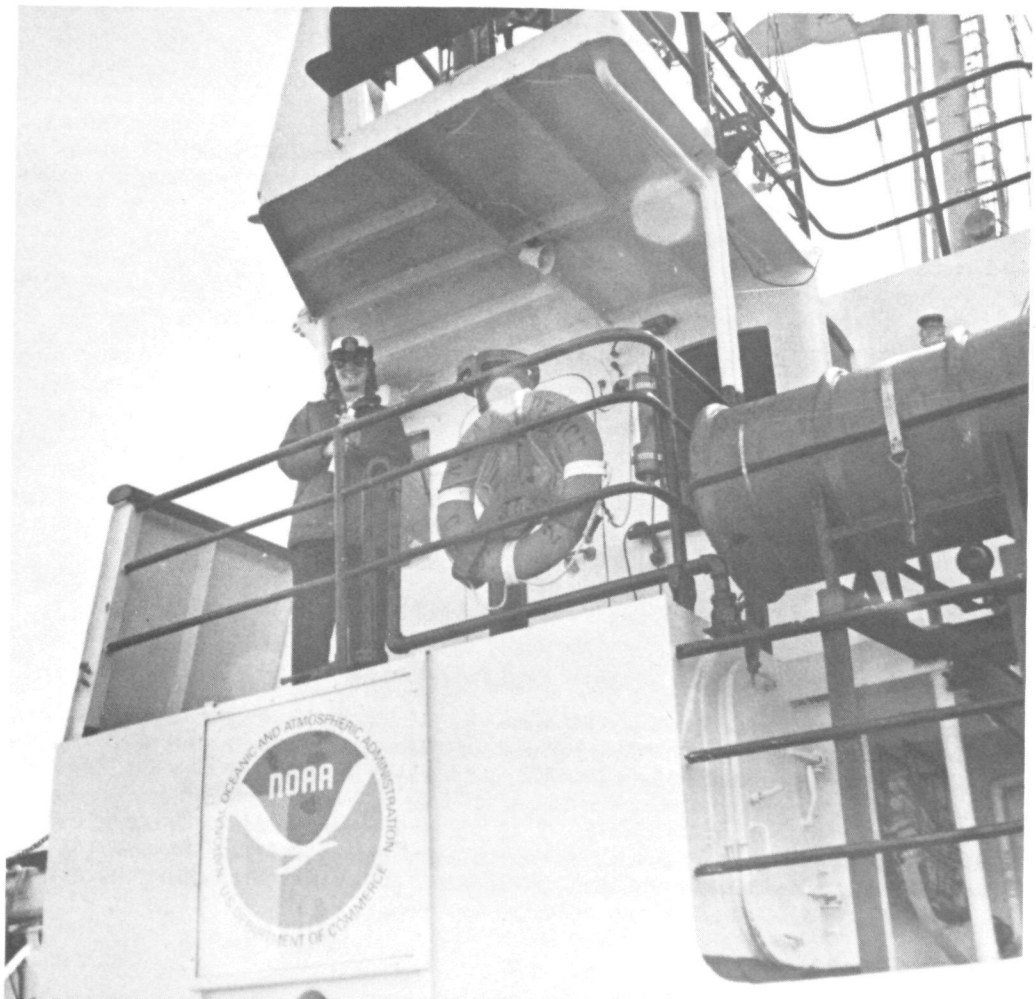
"These studies are underway at a number of Federal and university laboratories," said Meyer. "Their primary purpose is to illustrate where in nature to search for environmental effects of ocean dumping."

The complete report on last summer's investigations in the Gulf of Mexico and at the DWD-106 site in the Atlantic will be available next year. □

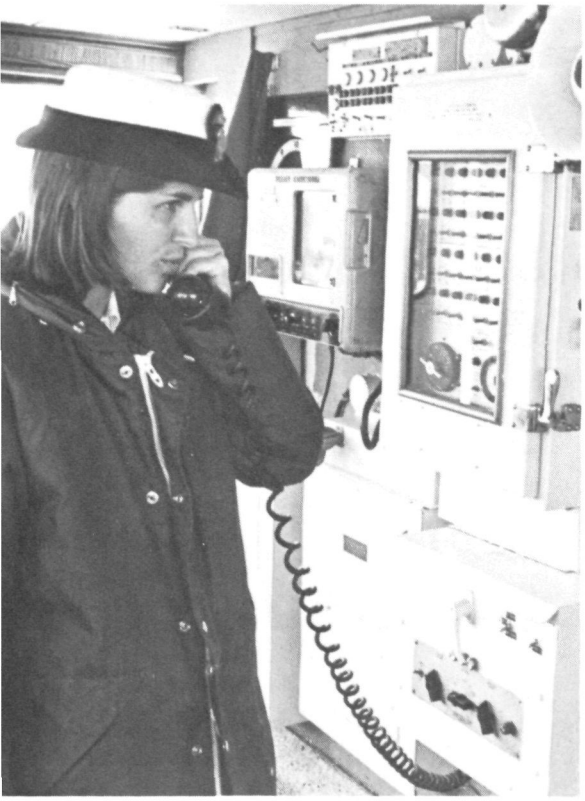
A First For Women Officers

Photography by John Roseborough

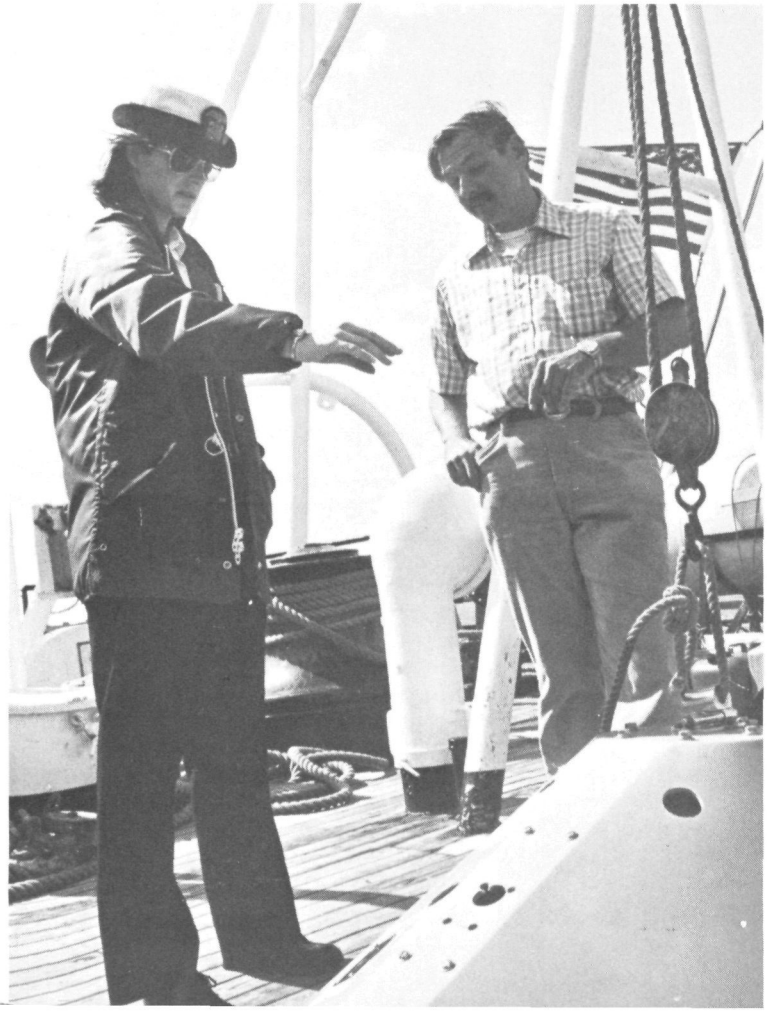
Lt. Pamela Chelgren, NOAA, now holds the highest shipboard operating post ever held by a woman in any United States uniformed service. Recently appointed Field Operations Officer of the 162-foot hydrographic survey ship Peirce, Lt. Chelgren's responsibilities include scheduling the ship's hydrographic work, and reviewing it for accuracy. As Field Operations Officer, she is the third in command of the ship.



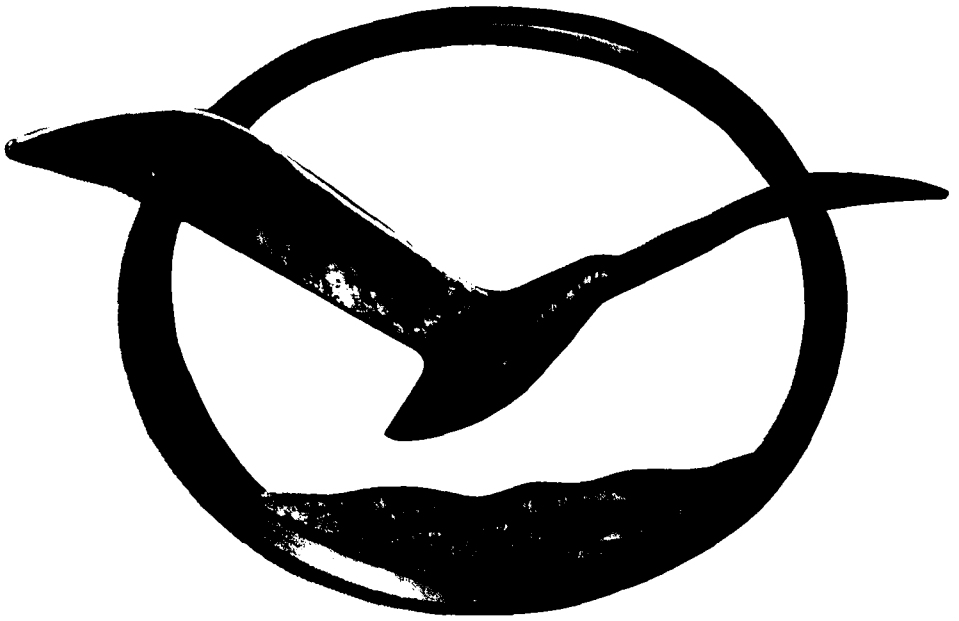
Ship officer duties are many and varied. As the ship leaves the Atlantic Marine Center, Lt. Chelgren messages the engine room (facing page, top) to change speed; later (below), on the bridge, she oversees topside activity. At sea, the Field Operations Officer works with a survey technician (top) on bottom contour sheets, turns a huge control wheel to adjust equipment, and relays orders from the bridge.



Other activities of the young officer include making an announcement to the ship from the bridge; relaxing in her stateroom; and preparing for departure with fellow officer Ens. Karen Cox. Peirce's skipper Cdr. Carl W. Fisher, is her C.O.



Lining up a gyro repeater, Lt. Chelgren takes bearings on chartable features such as buildings on shore; she discusses the Seismic Reflection Profiler – a new piece of equipment to determine bottom contours – with Dr. Richard B. Perry of NOS, the visiting scientist aboard the Peirce. Above, Ens. Cox takes over the engine controls. The placard in Lt. Chelgren's stateroom is self-explanatory.



Young Sculptor Honors the Agency

NOAA'S GULL IN BRONZE

By NANCY PRIDGEON

THERE are many different ways to express one's feelings: For a writer, it may be a novel. For an engineer, it may be a bridge. For an artist, it may be oils on canvas or the patient chipping at a marble monolith to release the hidden figure within.

For David Boon, undergraduate art major at the University of Kansas, the way to express his feelings is in bronze. Impressed by the work NOAA does, he decided to show his appreciation by creating a stylized version of the gull in the NOAA emblem.

"People don't realize the good the weather service does," said Boon. "They get hung up on small details and forget that weather people go on day after day getting reports out and piling up masses of data."

NOAA first came to Boon's attention when he was the associate advisor of the Air Explorer Squadron 8 in Topeka. He's been interested in sea and air interactions since he was a small boy growing up on Lake Shawnee, a navigable body of water just south of Topeka.

So in 1975, Boon proposed to honor NOAA by making a bronze as an extra credit project, on his own, at his own expense. He talked his idea over with his teacher, Professor Eldon Tefft, the head of the University's National Bronzecasting Center, and a full-time professor on the university faculty. Tefft encouraged him to talk to the Weather Service.

In Topeka at the time, plans were underway for a new National Weather Service Forecast Office, designed and built to accommodate computer-communications facilities—the Automation of Field Operations and Services (AFOS). The National Weather Service will have a nationwide network of AFOS facilities operating in the 1980's.

Meteorologist-in-Charge of the Topeka WSFO, Philip E. Shideler, was enthusiastic about the proposed artwork, and put Boon in touch with the new building's architect, Bill Groth. A few adjustments in the design of the building's face were necessary to make room for the bronze adornment, but space was arranged so that the plaque later could be joined to the building.

The new Topeka office was dedicated in the summer of 1976. It needed only the plaque to complete its facade. According to Shideler, who followed the progress of the bronze step by step along the way, the bronze is unique and a beautiful work of art.

"It is truly a tribute and something to be proud of," said Shideler, "not only at this office, but Weather Service-wide."

On July 16, 1976, Shideler and David Brandon, a hydrologist at the Topeka WSFO, attended a "pouring party" at the university for the outer ring of the plaque. The gull already had been cast, and when the other part of the plaque was complete, the parts could be welded together. The last step would be hours of rubbing the bronze down to give it patina.

Pouring parties are an institution with the National Bronzecasting Center. Each time a pouring is made for a work of art, it is cause for a celebration, complete with food and drink and well wishes all around. Patience is the name of the game in bronzecasting, so the parties help to fortify the resolve through the long, slow cooling process ahead and assure the sculptor of help if it's needed.

"A sculpture is an expression of the inner self," said Boon. "A sculptor doesn't design something from a drawing or a scene. I'm expressing my feeling about NOAA and all I can see everyone in NOAA doing."

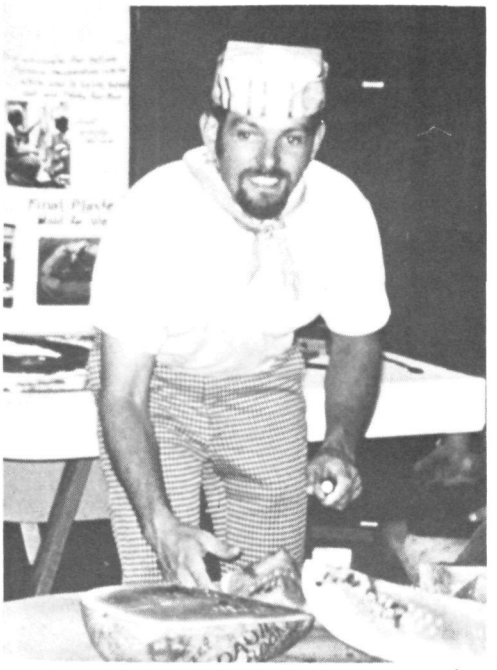
To cast one's feelings in bronze takes some doing, too. Unlike some art forms, bronzecasting is hot, heavy work. But long before the pouring of molten metal can begin, the sculptor must visualize an image. The image must be modeled in clay or directly in wax. In the lost wax process, the model is then buried in a silicon mold. When the hot liquid metal—with a temperature around 2000°F.—is poured upon it, the wax evaporates.

The problem with this method is that the original model also is destroyed. So Boon used a variation of the lost wax technique by making plaster casts of the wax model for a reference file. That way, if something went wrong with the first casting, another model could be made, or more copies could be cast.

Bronzecasting technique depends on a combination of physics, chemistry, metallurgy, and ceramics. Problems can crop up all along the way. The work of art must not shrink or crystallize, or be marred by cracks, blisters or unwanted inclusions. The mold, built of silica, plaster of paris and water, weighs about a half a ton and must be able to withstand the thousands of degrees of temperature without cracking or fusing with the casting.

The cooling and solidifying process must be carefully controlled, for it is during this time that the backbone of the structure is formed. The process can take days, weeks, or even months, depending on the size of the finished product. During the cooling phase of each pouring, Boon slept on the floor next to the mold with an alarm clock to wake him at intervals to check that the bronze was cooling evenly.

Bronze, made mostly of copper with tin and sometimes zinc or lead, is an alloy known and used for nearly two thousand years. It is more difficult to work with a



(Top) David Boon puts the finishing touches on the NOAA gull before mounting it on its ring. (Above) A pouring party, complete with watermelon, celebrates the work in progress. (Right) Professor Eldon Tefft, who designed the tongs used to lift the crucible, drosses the molten metal just before the temperature is taken.

combination of metals than with a single kind, since the ingredients may have different melting and cooling temperatures.

Copper-base alloys like bronze, however, usually are available in small ingots with the precise final content already measured. Crucibles are used to melt the metal—much smaller than the monstrous blast furnaces required for pig iron. Instead of the traditional artist's smock, workers in bronze wear a costume that is fire- and heat-resistant.

"Bronze is a notably durable material," said Professor Tefft. "It is an ideal medium for art work that is exposed to climatic variations and weather extremes."

Tefft, who is well known for his work in metal castings, has been on hand to assist and supervise Boon in his work. He also has worked for the past six years on a statue of Moses, two and a half times life size, to be placed in front of the Religion building of the Kansas university.

Of Boon, Tefft said: "He's a bit older than most of my students. His is a training situation. He's learning how to work in bronze, and he's also learning how to work with people."

"I learned self-control while I was waiting for the agency to come through with the approval," Boon said. "I learned associations with people. Many of my classmates haven't had this experience. They don't know what it's like to work with the real world. I think that's just as important as knowing how to weld something together."

But the plaque wasn't finished before near-tragedy struck the venture. Boon became ill this past winter just as the end of his project was in sight. He had to undergo a long hospitalization caused by one of the bouts with epilepsy he's suffered from thoughout his life.

His NOAA project, and another he was working on—a 17-foot high sculpture of three heads of wheat, to be placed in front of the Kansas State Capitol building—were temporarily suspended. Professor Tefft offered to complete the work on the NOAA plaque, but Boon wanted very much to finish what he had started. It was decided to wait and see.

By this spring, Boon had recovered sufficiently to leave the hospital and resume his work. Despite his chronic illness, which limited the fields he could enter when he got out of high school, Boon doesn't consider himself handicapped.

"If man can control himself with just what he's given to use," Boon said, "he can accomplish great works."

He hopes to build his own foundry in time and looks forward to a lifetime career of working in bronze.

Soon now, the NOAA plaque will be in place in its permanent home on the front of the Topeka WSFO.

"No matter what, you can't hurry a work of art," said Shideler. "Once it's in place, we hope it'll be there a long, long time."

"My work shows my philosophy, what I believe in," said Boon. "My favorite quotation is 'Designs are created by God and discovered by man.' "

To the enrichment of us all. □

First woman on the job

An Agent's Life is a Varied One

By JAMES C. ELLIOTT

TO watch the commercial fishermen in the Great Lakes in the winter is enough to generate the thought that almost anything would be better than THAT. Miserable temperatures, breath-taking winds and rough seas are day in and day out occurrences. Mother Nature is bad enough, but add to that the freezing nets, the icy lines and the slippery decks, and one might logically figure that nobody would choose to work in such surroundings.

Anyone who thinks that way hasn't met Lynn Frederick. For her, those kinds of conditions are part of the job. She's a Marine Advisory Service agent with the Wisconsin Sea Grant Program, and the first woman agent in the National Sea Grant Program.

As an agent, she maintains a close liaison with fishermen and others in marine-oriented occupations in Northeast Wisconsin, attempting to inform them of any new technological developments and seeking out problems they might have so that she can relay them back to Sea Grant research scientists for solution.

There are many women in many activities within the Sea Grant network, but she is the first to take up the challenge of being what Athelstan Spilhaus once described as "an extension agent in hip boots." Like most pioneers, however, she is little impressed with being first. For Frederick, the job is a natural evolution in her career, an opportunity to work and live in an area that she likes, and a chance to continue some of the research she has conducted on whitefish over the past several years.

The knowledge she developed from her research is one of the factors that was behind her appointment to her present position. Another was her acceptance—she had become a familiar sight in the area, and was known by every fisherman around.

"I don't yet understand what all her responsibilities are," said Dennis Hickey, who operates a large commercial fishing operation at Bailey's Harbor, "but she's certainly well

Working closely with commercial fishermen is an important part in any Marine Advisory Service Agent's life. Ms. Frederick watches a Sandy Bay gill net fisherman repair his net (top), then moves in closer to give a little assistance (lower left). A qualified charter boat operator, Ms. Frederick is at home at the controls of her twin-engined boat.

Researchers from the University of Wisconsin (in oilskins) discuss their progress with Ms. Frederick (top). Lower left, the MAS agent at Gill's Rock chats with commercial fishermen who have just returned with their day's catch. Well acquainted with fishing gear, Ms. Frederick discusses the virtues of this rod and reel with Bailey's Harbor Dockmaster Todd Siening (lower right).

qualified to work with us."

Several of the fishermen in the area recalled how they had been impressed by her while she had been doing her research.

"Listen," one of them said. "She'd get in a boat, go out on the lake, throw out her nets and haul 'em in . . . she knew what she was looking for, and how to go about getting it."

"There's no question," added Hickey, "but that she knows how fishermen work."

Gene Woock, Coordinator of Field Advisory Services with the Wisconsin Sea Grant Program, had not been aware that Frederick was the first woman agent.

"We didn't think it was a big deal," he said. "After all, there are many other women in the program—nutritionists, scientists, and so on—we just hired her because she is a natural for the job, based on her interest, experience and education."

"Her biological research with the whitefish would be helpful we knew," he continued. "And she had gained a great deal of respect among the commercial fishermen up there for that work.

"She also has operated her own charter boat. So she knew the sport fishermen in the area, too. Knowing both sides is very important because one has to walk a fine line if everyone is going to be happy."

Lynn Frederick credits her interest in her work, particularly the marine biology part of it, to having grown up on a farm in Wisconsin.

"We had a lake on the farm," she said, "and we did a lot of fishing. Really, fishing has been a part of my whole life. And, marine biology has fascinated me ever since I was a kid."

An honor student in high school, she earned her B.S. in biology at the University of Wisconsin and her M.S. in water resources at the University of Michigan.

In her new job since last February, she finds that her responsibilities vary widely. In addition to dealing with the sport and commercial fishermen, she works out programs for the schools, writes articles for newspapers, and conducts lectures. This past summer, for example, she held a weekly meeting in the Bailey's Harbor Town Hall for tourists and local citizens. Her subjects ran from lakeside architecture to whitefish research. She talked about the PCB (polychlorinated biphenyl) problem in the Great Lakes, scuba diving (in which she frequently participates), underutilized fish, salmon imprinting, aquaculture and other projects.

This winter she will conduct a course in statistics for the commercial fishermen. The program is designed to give them the necessary background to evaluate catches in terms of management decisions to be made.

As the tourists did with the summer program, the fishermen have expressed considerable interest in her plans. As a result, her six- to eight-week program will include presentations on biology, fish population, stock assessment, migratory patterns, pollution problems, water quality measurements, fish growth statistics and gear development.

"The fishermen have indicated they want to be more professional in their approach," she explained. "They want to be better able to ask more intelligent questions about some of the decisions being made that might or that do have a great impact on their lives and on their investments. More importantly, they want to be able to make better assessments of the decisions being made by others."

In both her programs, she calls upon other experts in the Wisconsin Sea Grant Program for assistance in making the lectures.

In her area of Door, Brown and Kewaunee Counties, the commercial fishermen have had to face many difficulties, including the invasion of the eel-like lampreys in the 1950's. Before the lampreys were brought under control, they had destroyed stocks in the lake to the extent that commercial fishermen were left with only a single species fishery—the whitefish, not as vulnerable to the lampreys as the trout and salmon—and whatever incidental fish that came along. Trout and salmon fishing is limited to the sport fishermen in that area.

Because some commercial fishermen have invested as much as $50,000 in their operations, these problems represent severe setbacks for them.

"Fishing is a historic tradition with these people," she explained, "and a person in my position has to be aware of their situation.

"There are many times when I can't take sides on an issue, but I'm always interested. One of the reasons I get up at 5 a.m. and go out on the boats, help them string nets or lug boxes of fishes around is to learn what it's like to be a fisherman. When you realize how their nets get ripped out, the costs of replacement and the labor of repair, you have a much better understanding of what they are going through. And that helps me do a better job."

Would she recommend that other women pursue a career in marine advisory service?

"If they have the interest and background, why not? she asked. "There are probably a lot of things I do that I don't have to do—like carrying around 100-pound boxes of fish. But there are few, if any, of the jobs on a boat that a man can do that I can't. And if I can do it, so can others." □

Seafood Slimmers

Striped Bass with Low-Cal Stuffing

3 pounds dressed striped bass or other dressed fish, fresh ro frozen
1½ teaspoon salt
Low-cal Stuffing
2 tablespoons melted fat or oil
Lemon wedges

Thaw frozen fish. Clean, wash, and dry fish. Sprinkle inside and out with salt. Stuff fish loosely. Close opening with small skewers or toothpicks. Place fish on a greased bake and serve platter, 16 x 10 inches. Brush with fat. Bake in a moderate oven, 350° F., for 40 to 60 minutes or until fish flakes easily when tested with a fork. Remove skewers. Serve with lemon wedges. Serves 6.

Approximately 310 calories in each serving.

Low-Cal Stuffing

¾ cup chopped onion
1½ tablespoons butter or margarine, melted
2¼ cups chopped, peeled apple
⅓ cup chopped celery
⅓ cup chopped parsley
2 tablespoons lemon juice
¼ teaspoon salt
⅛ teaspoon thyme

Cook onion in butter until tender. Combine all ingredients and mix thoroughly. Makes approximately 3 cups stuffing.

Scallop-Vegetable Salad

1½ pounds scallops, fresh or frozen
1 quart boiling water
2 tablespoons salt
1 can (1 pound) cut green beans, drained
1 cup sliced celery
¼ cup chopped onion
¼ cup chopped green pepper
1 tablespoon chopped pimiento
Marinade
6 lettuce cups

Thaw frozen scallops. Rinse with cold water to remove any shell particles. Place in boiling salted water. Cover and return to the boiling point. Reduce heat and simmer for 3 to 4 minutes, depending on size. Drain and cool. Slice scallops. Combine all ingredients except lettuce. Cover and chill for at least 1 hour. Drain. Serve in lettuce cups. Serves 6.

Approximately 140 calories in each serving.

Marinade

½ cup cider vinegar
1 tablespoon sugar
¼ teaspoon salt
Dash pepper
¼ cup salad oil

Combine vinegar, sugar, salt, and pepper. Add oil gradually, blending thoroughly. Makes approximately ⅔ cup marinade.

Chef's Salad Chesapeake

1 can (12 ounces) blue crab meat or other crab meat, fresh, frozen, or pasteurized or 2 can (6½ or 7½ ounces each) crab meat
1 package (10 ounces) frozen asparagus spears
6 lettuce cups
Lemon-Caper Dressing
3 hard-cooked eggs, sliced
Paprika

Thaw frozen crab meat. Drain crab meat. Remove any remaining shell or cartilage. Flake the crab meat. Cook asparagus spears according to directions on package. Drain and chill. Place 3 asparagus spears in each lettuce cup. Place about ⅓ cup crab meat on asparagus. Cover with approximately 2 tablespoons Lemon-Caper Dressing. Top with 3 slices hard-cooked egg. Sprinkle with paprika. Serves 6.

Approximately 130 calories in each serving.

Lemon-Caper Dressing

½ cup low calorie salad dressing (mayonnaise type)
1 tablespoon drained capers
1 tablespoon lemon juice
½ teaspoon prepared mustard
½ teaspoon Worcestershire sauce
2 drops liquid hot pepper sauce

Combine all ingredients. Chill. Makes approximately ⅔ cup salad dressing.

King Crab-Celery Victor

2 packages (6 ounces each) king crab meat or other crab meat, fresh, frozen, or pasturized or 2 cans (6½ or 7½ ounces each) creab meat
2 celery hearts
2 chicken bouillon cubes
3 cups boiling water
1 cup low calorie French dressing
6 large lettuce cups
Pepper

Thaw frozen crab meat. Drain crab meat. Remove any remaining shell or cartilage. Cut crab meat into 1 inch pieces. Wash and trim celery hearts so that they are about 5 inches long. Cut each heart into thirds lengthwise. Place celery in a 10 inch fry pan. Dissolve bouillon cubes in boiling water and pour over celery. Cover pan and simmer for 10 to 15 minutes or until tender. Let celery cool in bouillon. Drain. Place celery in a shallow baking dish. Pour French dressing over celery and chill for at least 2 hours. Remove celery from dressing. Drain. Place in lettuce cups. Sprinkle with pepper. Place approximately ¼ cup crab meat on celery. Serves 6.

Approximately 70 calories in each serving.

Savory Baked Haddock

2 pounds haddock fillets or other fish fillets, fresh or frozen
2 teaspoons lemon juice
Dash pepper
6 slices bacon, chopped
½ cup soft bread crumbs
2 tablespoons chopped parsley
¾ cup thinly sliced onion
2 tablespoons bacon fat

Thaw frozen fillets. Skin fillets and place in a single layer in a greased baking dish, 12 x 8x 2 inches. Sprinkle with lemon juice and pepper. Fry bacon until crisp. Remove bacon from fat. Add to bread crumbs and parsley. Cook onion in bacon fat until tender. Spread onion over fish. Sprinkle crumb mixture over top of onion. Bake in a moderate oven, 350° F., for 25 to 30 minutes or until fish flakes easily when tested with a fork. Serves 6.

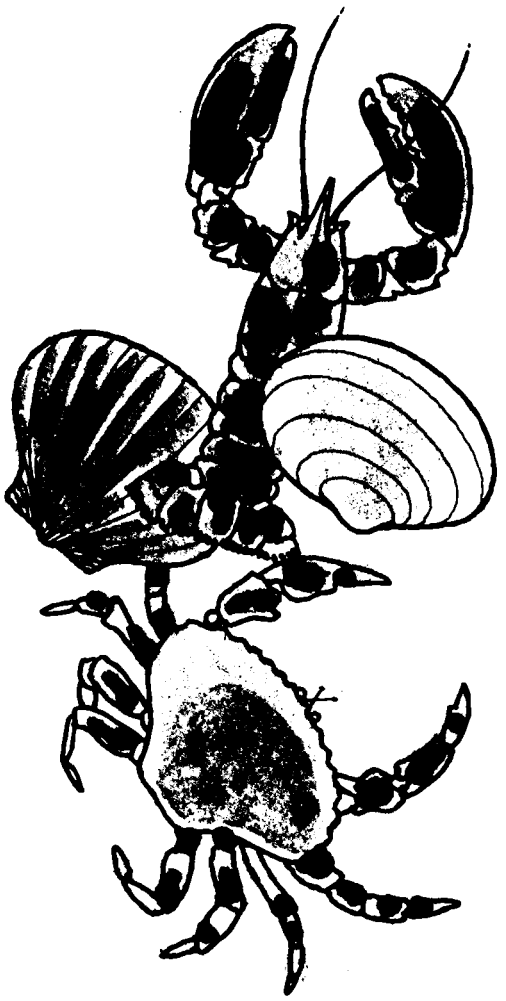
Approximately 170 calories in each serving.

Crab Divan

3 packages (6 ounces each) Dungeness crab meat or other crab meat, fresh, frozen, or pasteurized or
3 cans (6½ or 7½ ounces each) crab meat
2 packages (10 ounces each) frozen broccoli spears
2 tablespoons flour
1 teaspoon salt
¼ teaspoon pepper
1 tablespoon butter or margarine, melted
½ cup skim milk
¼ cup grated American cheese
1 can (1 pound) tomatoes, well-drained
2 tablespoons crushed cornflakes

Thaw frozen crab meat. Drain crab meat. Remove any remaining shell or cartilage. Cut crab meat into 1 inch pieces. Cook broccoli half as long as directed on package. Drain thoroughly and place in a greased baking dish, 8 x 8 x 2 inches. Spread crab meat over top of broccoli. Blend flour and seasonings into butter. Add milk gradually and cook until thick and smooth, stirring constantly. Add cheese and stir until melted. Stir in tomatoes. Pour sauce over crab meat. Sprinkle with crushed cornflakes. Bake in a hot oven, 400° F., for 20 to 25 minutes or until lightly browned. Serves 6.

Approximately 165 calories in each serving.



Smoked Fish Oriental

1 pound smoked whitefish or other smoked fish
1 can (1 pound) bean sprouts, drained
6 eggs, beaten
½ cup finely chopped green onion
Dash pepper
Foo Yung Sauce
1 tablespoon toasted sesame seeds

Remove skin and bones from the fish. Flake the fish. Combine all ingredients except sauce and sesame seeds. Pour ⅓ cup fish mixture onto a hot greased griddle or fry pan. Fry at moderate heat for 2 to 3 minutes or until brown. Turn carefully and fry 2 to 3 minutes longer or until brown. Drain on absorbent paper. Pour Foo Yung Sauce over patties and sprinkle with sesame seeds. Serves 6.

Approximately 300 calories in each serving.

Foo Yung Sauce

2 chicken bouillon cubes
½ teaspoon sugar
2 cups boiling water
2 tablespoons cornstarch
2 tablespoons soy sauce

Dissolve bouillon cubes and sugar in boiling water. Combine cornstarch and soy sauce. Add cornstarch mixture to bouillon mixture and cook until thick and clear, stirring constantly. Makes approximately 1⅔ cups sauce.

Hearty Halibut

2 pounds halibut steaks or other fish steaks, fresh or frozen
⅔ cup thinly sliced onion
1½ cups chopped fresh mushrooms
⅓ cup chopped tomato
¼ cup chopped green pepper
¼ cup chopped parsley
3 tablespoons chopped pimiento
½ cup dry white wine
2 tablespoons lemon juice
1 teaspoon salt
¼ teaspoon dill weed
⅛ teaspoon pepper
Lemon wedges

Thaw frozen steaks. Cut into serving-size portions. Arrange onion in bottom of a greased baking dish, 12 x 8 x 2 inches. Place fish on top of onion. Combine remaining vegetables and spread over top of fish. Combine wine, lemon juice, and seasonings. Pour over vegetables. Bake in a moderate oven, 350° F., for 25 to 30 minutes or until fish flakes easily when tested with a fork. Serve with lemon wedges. Serves 6.

Approximately 230 calories in each serving.

Scallop-Vegetable Salad

1½ pounds scallops, fresh or frozen
1 quart boiling water
2 tablespoons salt
1 can (1 pound) cut green beans, drained
1 cup sliced celery
¼ cup chopped onion
¼ cup chopped green pepper
1 tablespoon chopped pimiento
Marinade
6 lettuce cups

Thaw frozen scallops. Rinse with cold water to remove any shell particles. Place in boiling salted water. Cover and return to the boiling point. Reduce heat and simmer for 3 to 4 minutes, depending on size. Drain and cool. Slice scallops. Combine all ingredients except lettuce. Cover and chill for at least 1 hour. Drain. Serve in lettuce cups. Serves 6.

Approximately 140 calories in each serving.

Marinade

½ cup cider vinegar
1 tablespoon sugar
¼ teaspoon salt
Dash pepper
¼ cup salad oil

Combine vinegar, sugar, salt, and pepper. Add oil gradually, blending thoroughly. Makes approximately ⅔ cup marinade.

Salmon Paysanne

2 pounds salmon steaks or other fish steaks, fresh or frozen
½ teaspoon salt
¼ teaspoon white pepper
1 can (4 ounces) sliced mushroom, drained
½ cup sliced green onions
¼ cup catsup
2 tablespoons butter or margarine, melted
½ teaspoon liquid smoke

Thaw frozen steaks. Cut into serving-size portions. Place in a greased baking dish, 12 x 8 x 2 inches. Sprinkle with salt and pepper. Combine remaining ingredients and spread over top of fish. Bake in a moderate oven, 350° F., for 25 to 30 minutes or until fish flakes easily when tested with a fork. Serves 6.

Approximately 275 calories in each serving.

FRANK APPOINTED NOAA ADMINISTRATOR

Commerce Secretary Juanita M. Kreps administers the oath of office to Richard A. Frank.

Richard A. Frank, former director of the Nation's first and largest public interest law firm, has been appointed NOAA Administrator by President Carter.

Mr. Frank took over the NOAA post from Dr. Robert M. White, the organization's Administrator since its formation in 1970. Dr. White has accepted the Chairmanship of the Climate Research Board of the National Academy of Sciences.

Prior to his new appointment, Mr. Frank headed the Center for Law and Social Policy in Washington, D.C. The Center's activities include health care, women's rights, and mine health and safety.

In his first months as NOAA Administrator, Mr. Frank has taken several steps toward reshaping the organization to help it meet new and growing responsibilities for ocean use and resource management and climate and weather modification.

A reorganization plan, recommended by Mr. Frank and approved by Commerce Secretary Juanita M. Kreps, will involve major realignment of administrative duties and the addition of several new offices at the top levels of the Administration.

Another of Mr. Frank's major concerns since taking over as NOAA Administrator has been the bowhead whale issue involving the International Whaling Commission's action extending its ban on bowhead hunting to include the traditional hunting of the creatures by Alaskan natives.

In October, Mr. Frank announced the formulation of an expanded research program on bowhead whales and initiation of the development of a management and conservation regime of the bowhead whale stock in cooperation with the Eskimo communities involved in hunting for bowheads. Mr. Frank stated that he would personally work for IWC approval of a reasonable subsistence hunt.

Within NOAA, Mr. Frank has dealt with several complex areas of concern including formation of a multi-use facility at Sand Point in Seattle, Wash. Mr. Frank visited the future site of the 116-acre Western Regional Center which will bring together nine NOAA elements now scattered in seven locations in Seattle.

Shortly after coming to NOAA, Mr. Frank supported a program requesting NOAA employees to submit suggestions for humanizing the work place. More than 400 employees responded with more than 900 suggestions. Each idea was sent to the appropriate unit in NOAA for evaluation and, where practical, resolution.

Mr. Frank's experience in environmental issues and Government policy matters extends back over a varied career in the practice of law.

Prior to his appointment as NOAA Administrator, Mr. Frank was involved with the Center for Law and Social Policy's International Project, representing a wide range of public-interest clients—consumers, church groups, environmental organizations—on such international issues as trade, ocean environment, and human rights.

During his tenure with the International Project, Mr. Frank participated in such areas as law of the sea, deepsea mining, pesticide exports, nuclear export policy, and weather modification.

Born in Omaha, Nebr., in 1936, Mr. Frank received an A.B. degree from Harvard College in 1958 and a J.D. degree from Harvard Law School in 1962.

From 1962 to 1969, he was with the State Department's Office of the Legal Advisor, in Washington, D.C., where he was responsible for economic-legal matters in trade, transportation and communication, international business and banking, international environmental issues, foreign assistance and military assistance.

Frank aboard the NOAA ship Rainier during visit to Seattle with (from left) Leonard Saari, Representative of the Secretary of Commerce, Region X, R. Adm. Eugene Taylor, Director Pacific Marine Center, and Lt. Cdr. Thomas Richards.

During his State Department tour, he participated in a wide variety of activities, such as the 1969 arbitration with Brazil over coffee; as U.S. spokesman during the INTELSAT conference; and representing the United States at conferences to draft oil pollution conventions. He participated in the drafting and negotiation of the Panama Canal treaties, served as counsel before Senate and House investigating committees and with respect to the Warren Commission Report.

New NOAA Radar May Become Major Environmental Tool

A current-sensing radar developed by NOAA may become a major tool for monitoring sea pollutants and setting environmental baselines where petroleum and other exploration are planned.

The radar permits monitoring of surface currents up to 50 miles and enables production of current-movement computer maps over 750 square miles every half hour, according to NOAA scientists.

Developed by scientists of the Wave Propagation Laboratory, the new radar system could provide an effective alternative to surface drifters, drogues, and other ocean current determination methods now used that measure water motion only at a single point.

According to Dr. Donald Barrick, the Alaska results showed that "...we can produce a single current-vector map covering thousands of square kilometers after only 15 minutes of operation; we can gather at least a thousand times more data in a given twelve-hour period than any alternative technique; and our system error is at worst half a knot of current velocity, and probably much better."

NOAA's new radar system deduces ocean current velocity by sensing the scattering of radar echoes by ocean waves. The underlying principle of the system was first demonstrated experimentally by Dr. Douglass Crombie, now director of the Commerce Department's Institute for Telecommunications Science in Boulder. Nearly a decade later, in the mid-1960's, the observed phenomenon was confirmed theoretically by Barrick, in what is considered a breakthrough in wave propagation theory.

noaa/update

Fish Shortage Predicted By NOAA Report

Although worldwide output from aquaculture doubled in the past five years to about six million metric tons, a shortage in the global supply of seafood can be expected in ten years, according to a NOAA report.

Edited by John B. Glude, NOAA Aquaculture Program Coordinator, the report describes the increasing world demand for seafoods, notwithstanding current landings exceeding 64 million metric tons, and an estimated maximum harvest of 100-150 million metric tons.

At present, roughly 10 percent of world fisheries production comes from aquaculture—public and private hatcheries and "fish farms." In the United States, public aquaculture of salmon and private culture of oysters, catfish, trout, shrimp, clams and other species yield about 65,000 metric tons, equalling about three percent of landings, or two percent consumption of fishery products.

The report includes state-of-the-art summaries of the culture of high priority species, such as salmon, marine shrimp, freshwater prawn, American lobster, oysters and marine plants; medium priority species including clams, catfish, abalone, scallop and yellow perch; and low priority species, such as mussels, crab, and various marine fishes.

NMFS Reports N.J. Waters Improved

Environmental conditions in the ocean off New Jersey appear improved over last year, when they led to massive mortalities of surf clams and other bottom-dwellers.

This cautiously encouraging conclusion is based upon results of scientific cruises by the NOAA ships Delaware II, Albatross IV, and George B. Kelez. Oxygen in bottom waters was found to be at healthy levels.

Survey cruises this year show that the normal seasonal decline in bottom oxygen is present, as measured by Marine EcoSystems Analysis (MESA) Project scientists, and fisheries experts from the National Marine Fisheries Service. This summer-fall oxygen decline is due to natural oceanographic and biological processes, and exceptionally large quantities of nutrients and carbon from human activities in the New York-New Jersey metropolitan area.

Sea Grants Fund Possible Biomedicinals

A team of scientists at the University of Oklahoma—almost 500 miles from the nearest salt water—is collecting marine animals from as far away as the Caribbean and Bermuda to determine if they contain substances that could prove helpful in the fight against cancer and heart disease.

Professors L. S. Ciereszko, F. J. Schmitz, and P. N. Kaul and their students skin dive to collect their specimens from tropical coral reefs of the Bahamas, Jamaica, Florida, and Bermuda.

Although the search for these drugs from the sea starts with animals found in nature, it is unlikely that they will be the ultimate source of any useful drugs that may be discovered. According to the University of Oklahoma scientists, after the structures of the compounds are known, it will generally be cheaper to produce commercial quantities in the laboratory by synthesizing the drugs than by obtaining them from natural marine sources.

Introduction of a new drug into clinical use normally requires seven to ten years after its initial discovery.

NOAA Ships Rude/Heck Save 20 in Sea Rescue

A flash fire that threatened to explode and sink a 135-foot seismographic survey vessel, working in the Gulf of Mexico, was battled by the NOAA Ship Heck while its sister ship, Rude, picked up the burning ship's crew in a daring, close-quarters rescue.

The Rude and Heck, the National Ocean Survey's vessels equipped with drag machinery to sweep for navigational hazards, had set out on a wire drag on a hot, sultry day with relatively calm seas. They were about 23 miles off Freeport, Tex., at 1:40 p.m., when a "Mayday" was received from the distressed Midnight Sun.

"We were about eight miles away," said Cdr. Robert V. Smart, the Rude/Heck commanding officer, "We could see the pillar of smoke."

Radioing the captain of the Midnight Sun that the Rude and Heck would be there in 45 minutes, Smart turned the two NOAA vessels toward the scene and notified the U.S. Coast Guard base at Freeport, which immediately sent a cutter to the rescue.

"We were instructed by the Coast Guard to pick up all 20 crew members," said Smart. "When we got there, the 21-foot pleasure craft Lazy 1 was trying to assist.

"She had picked up three or four, and thrown out a life line and a raft. Some of the crew were in the water, and some were still aboard the Midnight Sun."

The fire spread so quickly that the Midnight Sun's fire hoses and life rafts were consumed. The fire, burning on the starboard side, amidships, was threatening the ship's stored containers of volatile liquids. The captain and some of the crew members were vainly trying to stop the fire from spreading.

Using fire-smothering foam and water, the Rude and Heck approached within 20 or 30 feet—close enough for the Rude to pick up the crew members in the water and the rest of the crew and captain still aboard the Midnight Sun. Some of the crew and the captain had sustained burns, so the Rude left for Freeport, while the Heck stayed behind to put out the fire.

The Heck, with the Rude/Heck's Executive Officer, Lt. Cdr. Thomas W. Ruszala, in charge, continued to fight the fire which meanwhile had spread to the starboard engine room, pilot house, and most of the port engine room.

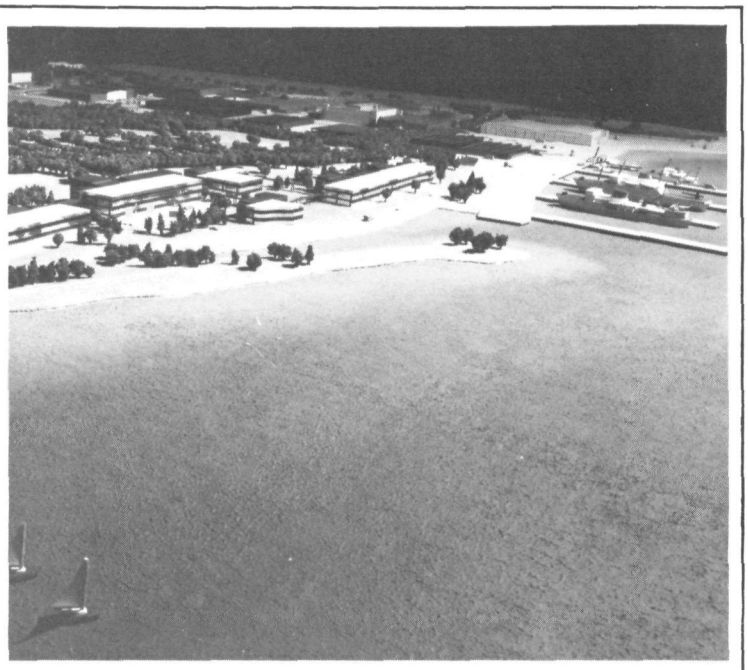
About 4 p.m., the U.S. Coast Guard Cutter Point Monroe arrived, only to lose power in her port engine within an hour. Unable to maneuver safely, the cutter was forced to the sidelines but was able to supply more cans of chemical foam when the Heck exhausted all she had on board.

At sunset the Heck was directed by the Point Monroe to stand by until further notice. After an all-night watch, the Heck and the Point Monroe approached the disabled ship at daybreak and proceeded to cool her down until it appeared all danger of fire was past.

At 10:38 a.m. the next morning—20 hours after the ordeal began—the Heck was relieved, and instructed to return to the Coast Guard Base at Freeport.

"Through the immediate action of the Heck," said Smart, "the Midnight Sun did not explode or sink. This is important because she was burning in the Seadock area, a proposed deepwater port."

The Midnight Sun, owned by Guzzetta Offshore Marine of Berwick, La., has been towed to Galveston, Tex., where she will be overhauled so that she will sail again.



NOAA at Sand Point . . . large scale model shows how the new NOAA complex in Seattle will look, a few years hence. To be built on the shore of Lake Washington, the complex will house scientific laboratories, administrative offices, and the Pacific Marine Center, with piers for NOAA's ships to tie up. Model is scheduled for display at various locations in Seattle.

Council Members Appointed

Richard A. Frank, NOAA Administrator, acting in behalf of the Secretary of Commerce, has appointed seven new members and 13 incumbents to vacancies on the Nation's eight Regional Fishery Management Councils.

The Councils, established by the Fishery Conservation and Management Act of 1976, are responsible for preparing fishery management plans for stocks of fish found in waters within their geographical areas.

The Act requires that members to the Councils be selected from lists of qualified individuals submitted by the Governors of the states involved. Forty-eight Council members were appointed last August for two- or three-year terms.

New members appointed were: Herbert R. Drake, General Manager, H. R. Drake & Sons, Rye Harbor, N.H.; Omar G. Allvard, Electric Boat Division, General Dynamics Corp., Groton, Conn.,; and, Robert Lowry, retired State conservation officer, Carolina, R.I., all to the New England Council; Barbara B. Porter, President, South Shore Marina, Inc., Bethany Beach, Del., and Harry M. Keene, Easton, Md., charter boat owner-operator, both to the Mid-Atlantic Council; Margaret (Peggy) Stamey, Raleigh, N.C., to the South Atlantic Council; and Gordon Jensen, commercial fisherman, Petersburg, Alaska, to the North Pacific Council.

Presidential Scholars Visit NOAA

Twenty Presidential Scholars selected from the nation's graduating high school seniors for their outstanding leadership and scholarship by the Commission on Presidential Scholars, U.S. Office of Education, recently attended a NOAA science seminar during their four-day visit to Washington, D.C.

Chaired by Dr. Daniel H. Lufkin, Deputy Director of Environmental Monitoring and Prediction's Meteorological and Hydrological Services Office, the specially arranged seminar featured discussions of NOAA's role in the recently established fisheries conservation zone, weather modification, the ozone layer, and Alaska's oil resources.

Bluefin Tuna Regulations Adopted

Regulations to help conserve the supply of Atlantic bluefin tuna—a favorite of both commercial and recreational fishermen—have been adopted by the National Marine Fisheries Service and are effective immediately. The regulations apply to catches off the east coast of the United States during 1977, and change some of the rules that were in effect last year.

Under the new regulations all recreational and commercial fishermen who fish for bluefin weighing more than 300 pounds must obtain a certificate from the NMFS Regional Director, Gloucester, Mass. In addition, purse seine fishermen catching bluefin weighing from 14 to 115 pounds must also obtain such a certificate.

For tuna weighing between 115 and 300 pounds, a special 25-ton quota has been established, to obtain scientific data and for tagging purposes. Tuna weighing more than 300 pounds cannot be caught and released unless they have been tagged with NMFS tags.

Vessel certificates issued for 1977 will be valid until returned to the Regional Director or until the vessel leaves the fishery. If ownership of the vessel changes, the new owner must obtain a new certificate for that vessel.

Homeowners Ignore Pleas To Conserve Natural Gas

Homeowners using natural gas apparently are ignoring national pleas to conserve the valuable resource, a study by two NOAA scientists suggests.

The rate of natural gas use has not changed significantly over the last three years, an analysis of the 12 quarters from 1974 through 1976 has shown. This indicates, Dr. Richard Lehman and Henry Warren report, that the average gas-heating customer has not appreciably changed heating habits in spite of conservation pleas from government and industry, as well as sharply rising prices.

Using a measurement of cold weather known as the "heating degree day," as well as American Gas Association residential sales data, the scientists found that the per-customer consumption of gas for heating in multi-state regions is determined almost entirely by the heating degree days occurring in a quarter.

The regions studied included states which together use about half of the Nation's residential space heating natural gas.

Lehman and Warren reached their conclusions after developing a new, short-term natural gas consumption model and testing it against the American Gas Association's sales data and the heating degree day statistics.

The heating degree day information is routinely computed for all of NOAA's National Weather Service temperature observing stations throughout the United States. Each degree the mean daily temperature is below 65 degrees Fahrenheit is one heating degree day. This is commonly used by the heating industry to estimate homeowners' fuel consumption since most furnaces are turned on when the temperature drops below 65 degrees.

Joint Study

Earth's Magnetic Field Probed

The first phase of a joint project by NOAA and the U.S. Geological Survey to probe the earth's magnetic field and the earth's near-space environment has been completed.

The project, funded by the National Science Foundation, involves placing specially designed magnetometers—devices which accurately measure earth magnetic field intensities—at more than 25 strategic and remote sites in Alaska, Canada, Brazil, and several islands in the Pacific Ocean.

Data from the devices will be "sensed" by instruments aboard NOAA geostationary spacecraft and transmitted back to a facility at Boulder, Colo., to be made available to earth, atmospheric, and space scientists only minutes after the data are received.

The project represents a major contribution to the United States and Canadian programs for the International Magnetospheric Study, an effort by the United States, many European countries, the Soviet Union, Japan, and other nations to develop a better understanding of how the earth interacts with its immediate space environment.

The magnetometer systems were deigned and assembled by the USGS Branch of Electromagnetism and Geomagnetism, Golden, Colo., and by NOAA's Space Environment Services Center.

The heart of the system is a small magnetic field sensor located in a non-magnetic housing. Information from this sensor is processed by a microcomputer system located some distance away in a small shelter and transmitted to the satellites. The entire system uses only about 75 watts of power and can operate unattended at remote sites for periods up to a few months.

Planet Ocean, an ocean showcase in Miami, now features an exhibit, funded by NOAA, on the mysteries and movements of the Gulf Stream. Fiber optics are used for the more than 3,000 tiny pulsating lights showing the flow of the Stream on the 10' x 10' map. Other parts of the exhibit include video-taped programs on NOAA's hurricane tracking efforts, and models of a weather satellite.

First Lady Honors NWS Technician

Herbert W. Hoffman, a meteorological technician at the National Weather Service Forecast Office in Chicago, Ill., and a victim of cerebral palsy since birth, was one of ten winners nationwide selected by the Civil Service Commission to receive an Outstanding Handicapped Federal Employee of the Year Award.

The awards were presented in Washington, D.C., by the First Lady, Rosalynn Carter.

Hoffman, 30, is a native of Chicago. In high school, he developed a special interest in science. By the time he was graduated, he had won four awards at Chicago science fairs.

One high school science project, "The Ionosphere and Effects of Thunderstorms," brought him in contact with the Commerce Department as early as 1965. Later, he worked for the Office of Telecommunications, in Boulder, Colo.

In 1973, Hoffman graduated with honors from Southern Illinois University, Carbondale, Ill., with a major in earth science. He shortly will receive a Master of Science degree from Northeastern Illinois University.

In his work at the Chicago WSFO, Hoffman prepares weekly, monthly, and yearly crop summaries which involve tabulating statistics from 18 WSO's and computing the Palmer Index for the climatological divisions within the State of Illinois.

He helps prepare the Severe Storm Summary by reading news clips, checking the Weather Wire, sending and receiving severe storm report forms, and keeping track of tornadoes when they occur.

Also, he has a special research project ongoing to extract monthly temperature information for Lake Michigan and Lake Superior, using satellite infrared.

For the past year or so, he has handled climatological requests from the public. He is a keen observer and has made suggestions that resulted in improved operational procedures at the Chicago office.

All this is the more remarkable because Hoffman is confined to a wheelchair, without the use of his arms or legs. He has severely restricted speech and is rather frail.

But the use of the toes of his left foot enabled him to learn to type as a child, to learn to write with a pencil, and later to use calculators and copying machines. Now that he has a self-correcting typewriter, he prepares letters and reports in final form.

Florida Rain Increased By NOAA Seeding

Preliminary results of cloudseeding experiments conducted by the Cumulus Group section of ERL's National Hurricane and Experimental Meteorology Laboratory, Miami, Fla., indicate that seeding of developing tropical cumulus clouds increases the net rainfall over an area on experimental days from 20 percent to as much as 70 percent.

The Cumulus Group, directed by Dr. William L. Woodley, has conducted field studies for the past decade on the effects of seeding tropical cumulus clouds. The latest results come from recent analysis of data obtained in last summer's Florida Area Cumulus Experiment—FACE '76—and from four earlier seasons of field experimentation.

"There is now persuasive statistical evidence," said Woodley, "that dynamic seeding in Florida is effective in increasing the sizes and rain production of individual convective clouds, in promoting cloud mergers and in increasing the rainfall from groups of convective clouds. And there are strong indications that dynamic seeding is effective in producing a net increase in rain over the fixed target area."

Dynamic seeding uses silver iodide dropped into supercooled water—water cooled below freezing but still in liquid form—high in the rising cumulus cloud tower. As the water turns to ice, freezing and additional condensation release large quantities of heat energy in the cloud, causing it to become more buoyant, develop more fully, last longer, and produce more rain.

"This means," said Woodley, "that dynamic seeding essentially invigorates processes within the cloud to produce the desired results."

NOAA Conducts First Conference By Satellite

NOAA's first interactive audio-visual telecommunications conference was held recently, when NOAA elements in Rockville, Boulder, and Seattle, were linked by telecommunications satellite to conduct a "face-to-face" NOAA EEO meeting, an Environmental Data Service program review, and an Environmental Research Laboratories student cooperative program review.

During the four and a half hour telecast, participants could ask and answer questions, and monitor each other's responses on three color TV monitors, set up in each of the studios. Two-way television conferences have been feasible for some time, but three-way hook-ups are more difficult and not widely used.

The conference was sponsored as an experiment by the Environmental Research Laboratories in Boulder. ERL's Vernon Zurick directed the Telecommunications Opportunities Project (TOP). Satellite television communications could become an operational reality in NOAA's future, not only for meetings but also for the high-speed transmission of timely scientific and administrative data.

The historic first for NOAA was made possible by the cooperation of U.S. and Canadian agencies—members of the Public Service Consortium—who donated their reserved experiment time to allow NOAA to see if the method improved its cross-country conferences.

The cooperating agencies included the National Aeronautics and Space Administration (NASA), Canadian scientific agencies, and a trio of medical groups—the National Institutes of Health in Bethesda, Md., the University of Colorado Medical School in Denver, Colo., and the University of Washington Health Sciences Group in Seattle, Wash.—who made their television studios available for NOAA's use.

First Lady Rosalynn Carter and Civil Service Commissioner Ersa Poston present award to NWS's Herbert W. Hoffman, as Commerce Secretary Juanita M. Kreps looks on.

New Lake Superior Brochure Published

Volume one of *Lake Superior Soup, A Who's Who for the Minnesota Coast of Lake Superior*, attempts to unscramble the Federal alphabet for coastal residents. It gives a concise description of what all those organizations with the funny initials do—GLERL, SPAD, CZM, LSBSC, and the like. The helpful brochure was published by the Minnesota Marine Advisory Service.

Lake Superior Soup, Vol 1, is available free to anyone requesting a copy. Write to: Minnesota Marine Advisory Service, 109 Washburn Hall, University of Minnesota, Duluth, Duluth, MN. 55812.

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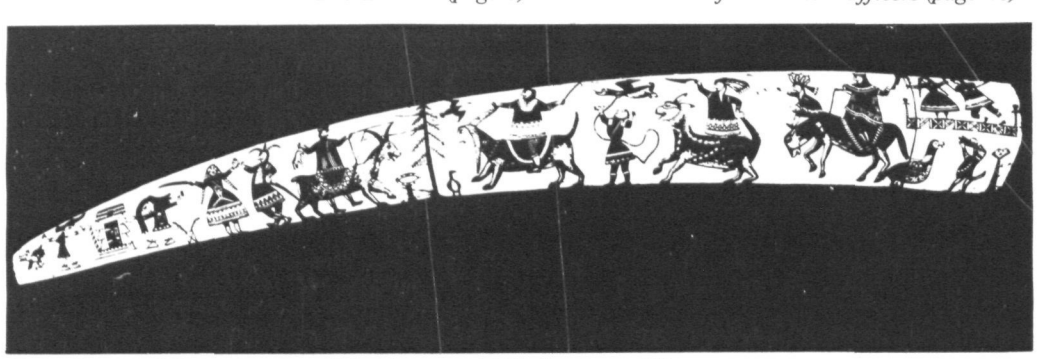

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