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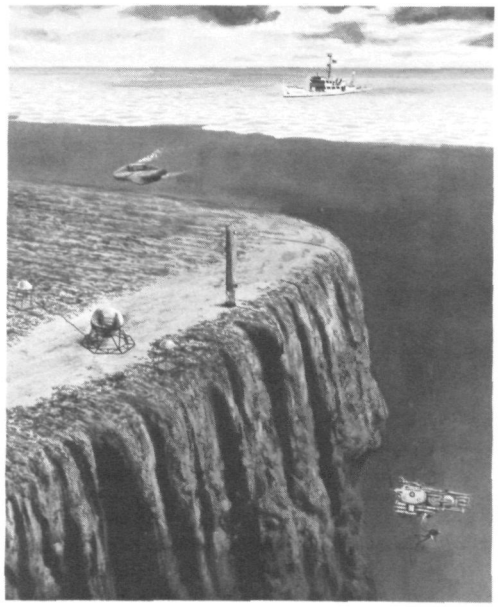

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AMERICAN REVOLUTION BICENTENNIAL 1776-1976

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION NOAA U.S. DEPARTMENT OF COMMERCE

Fisheries Management: New Challenge For NOAA

William C. Brewer, Jr.
General Counsel

It is common knowledge that the oceans of the world are in the midst of a revolution. Old laws and customs are being scrapped, and new ones painfully constructed to reflect the realities of technology and politics today. One highly visible symbol of all this turmoil is the Third United Nations Conference on the Law of the Sea.

What is not so widely known is that the management of fisheries is undergoing revolutionary changes as well. It appears almost a certainty that coastal state jurisdiction over fisheries will very quickly be extended at least 200 miles from shore. In fact, everything in this vast area is likely to fall within the jurisdiction of the coastal state except passage of ships and aircraft.

In the case of the United States, this means that Congress will have the right, and indeed the obligation, to enact new legislation to manage the fisheries in a zone of more than 2,000,000 square miles. Within it fall some of the richest fishing grounds in the world.

This is a challenge with great risks and great rewards. Many of the species involved have been overfished by U.S. and foreign fishermen and have been reduced to a fraction of their former populations. Our knowledge and determination will be severely tested by the task of rebuilding. Yet, in a world where the desire and need for food fish grows more intense every year, the ownership and good husbandry of the great ocean fishing banks is a sort of public trust.

NOAA is at the center of this particular revolution. A task force in the National Marine Fisheries Service has been working on the problem of extended jurisdiction for more than a year, cooperating closely with the Coast Guard and the Department of State. Representatives of NOAA, led by Deputy Administrator Howard Pollock, have played a significant part at the Law of the Sea Conference. Environmental Research Laboratories and Environmental Data Service are working actively to acquire and process baseline information about the coastal seas. There is a general understanding in the Congress that NOAA is to be the management agency for any plan of fisheries regulation which may be adopted.

There are many fascinating aspects of government service, but none more so than being in at the start of a great new enterprise. It is a piece of luck for all of us in NOAA. We will of course be measured by how well we do, but that is fair enough, and I think we are ready for the job.

CENTERVILLE SCHOOL
SCHOOL
N

In a life-and-death arena

SOME NEW IDEAS ABOUT TORNADOES

BY EDWIN P. WEIGEL

The incredible outbreak of 148 tornadoes on April 3-4, 1974, was one of the most violent meteorological episodes in U.S. history. From it has come new knowledge about how to cope with the concentrated fury of twisters.

It began about 1 p.m. April 3, 1974, when a small tornado touched down near Morris, Ill., a few miles southwest of Chicago, causing no deaths and little property damage. From this inauspicious beginning came a meteorological episode of almost unbelievable proportions—the most massive outbreak of tornadoes in U.S. history. In the ensuing 18 hours, a total of 148 tornadoes gouged paths through parts of 13 states east of the Mississippi River, killing more than 300 people, injuring about 6,000, and causing more than half a billion dollars in property damage.

According to a NOAA Natural Disaster Survey Team and other investigators, many of these tornadoes churned across the landscape at 40 to 60 miles per hour, and in their destructive fury were among the most powerful ever recorded. Their average path length was 18.7 miles, compared with an average for all tornadoes in 1973 of 4.7 miles, and in 1972 of 3.3. One of them slashed a path 134 miles across northwest Indiana. Their combined total path length was considerably more than 2,000 miles—compared to the total path length of all tornadoes for an average year of about 4,000 miles.

"The threat that frightens me most," said Weather Service Director George P. Cressman after the April 3-4, 1974, tornado outbreak, "is that of a tornado hitting a school filled with children without warning." He urged improvements in public awareness of how to cope with tornadoes, more and better systems of detecting and tracking tornadoes, and faster and more-reliable communication of storm warnings. Investigations by a team of architects and engineers of the "super-outbreak" showed that the worst effect of a tornado comes from the side of the rotating funnel whose windspeed is augmented by the tornado's forward speed over the ground.

The toll of 307 tornado fatalities on April 3-4 was exceeded in U.S. history only by the tri-state tornado outbreak of March 18, 1925, when seven tornadoes traveled a total of 437 miles across Missouri, Illinois and Indiana and caused 746 deaths. Next in notoriety was the Palm Sunday outbreak of April 11, 1965, which spawned more than 30 tornadoes with paths totaling 853 miles, and killed 256 people in five Midwest states.

So—by all counts except death toll—the April 3-4 outbreak was by far the most devastating on record. Many investigators believe the death toll, too, would have been a record had it not been for improvements in tornado watches and warnings, in communications and in community preparedness efforts.

The April 3-4 tornadoes affected 13 states—Alabama, Georgia, Illinois, Indiana, Kentucky, Michigan, Mississippi, New York, North Carolina, Ohio, Tennessee, Virginia and West Virginia—and Windsor, Canada, across from Detroit, where eight persons were killed when a 25-foot masonry wall of an ice rink collapsed on top of them.

As would be expected after such a death-dealing and far-ranging episode, a large number of investigators—Federal, state and local—quickly converged on the scenes of greatest devastation, trying to piece together exactly what had happened, and how the public had responded. Six states were the focus of maximum attention, because they had the greatest numbers of fatalities. According to NOAA's Environmental Data Service, these were Alabama, with 77; Kentucky, with 71; Indiana, with 47; Tennessee, with 44; Ohio, with 40; and Georgia, with 16.

Warnings throughout the 18-hour episode, according to NOAA investigators, were about as good as could be expected considering the chaotic circumstances, and in some instances were outstanding. So were the reactions of state and local officials in caring for the injured, trying to maintain order, and restoring vital public utilities.

In the days, weeks and months that followed, one important series of contributions by investigators consisted of detailed studies of individual tornadoes in the outbreak by teams of NOAA field examiners under the direction of University of Chicago Professor T. Theodore Fujita. These men painstakingly mapped out the paths and strengths of each of the 148 tornadoes in the "super-outbreak," and tried to get a reasonable profile of the meteorology and forces involved. They discovered that a number of the tornadoes hugged the terrain very closely, crossing ridges and sweeping down into valleys with little loss in power. Engineers believe this finding has important implications for future design of tornado-resistant structures in mountainous or hilly terrain—particularly such vital facilities as nuclear power plants. This finding is only one of many significant contributions to tornado knowledge by the Fujita group.

Another important type of contribution was made by a team of architects and engineers who studied the effect of the April

South and west walls of this school in Parker, Ind., caved inward when a northeast-bound tornado hit on April 3, 1974. This was a typical effect.

Upper floors are invariably dangerous. This three-story school in Talma, Ind., was struck by a maxi-tornado on April 3— after school-closing time.

Southwest rooms on third floor of Talma, Ind., school were almost completely demolished.

Talma, Ind., school gym adjacent to the main building also was reduced to a heap of rubble.

Even autos become missiles when propelled by a tornado. This one was stopped by a telephone pole.

3-4 tornadoes on buildings. These men were working for NOAA's National Severe Storms Laboratory, the Defense Civil Preparedness Agency, the National Academy of Engineering, and the National Science Foundation. Members of the team included Kishor C. Mehta, Joseph E. Minor, and James R. McDonald, of Texas Tech University; Billy R. Manning, of Auburn, Ala., University; Uwe F. Koehler, of Ball State, Ind., University; James J. Abernethy of Lawrence Institute of Technology, near Detroit; and Thomas Hanson of the University of Detroit.

The results of their investigations are described in a 118-page report called "The Engineering Aspects of the Tornadoes of April 3-4, 1974." It was prepared for the Committee on Natural Disasters of the National Research Council, National Academy of Sciences-National Academy of Engineering. It documents "the extent and severity of the damage" and makes recommendations for "mitigation of disasters resulting from future storms."

Among key findings:

- Windspeeds in these tornadoes, some of which appear to have been as severe as any previously documented, probably did not exceed 250 miles per hour, based on examinations of structures that failed and structures that did not. This finding is lower than some previous estimates of maximum tornado windspeeds, which ranged to more than 300 miles per hour or more, but the April 3-4 investigators believe their estimates are probably closer to reality.
- In spite of their severity, these tornadoes in most instances would not have caused deaths in well-engineered buildings such as schools, *if* the occupants knew in which places in the schools to seek safety and *if* they had sufficient warning to go there. Marginally engineered structures such as many commercial and light industrial buildings, apartment buildings and motels, would be less safe because tornadoes frequently cause their walls, ceilings and floors to collapse. Private homes have little or no resistance to extreme winds, although they frequently have pockets of protection such as basements, bathrooms and interior closets. Mobile homes "offer no opportunity for occupant protection."
- If the meteorological profession can provide a minimal warning time, through emerging improvements in satellite photography, radar analyses and other means of tornado detection, this "will have a significant influence on design of structural systems for occupant protection." In years past, the team members believe, there has been a tendency toward fatalism about design of structures against tornadoes, because there was a feeling tornadoes were so unpredictable and overwhelmingly destructive that efforts to design against them were futile. The team believes this attitude has led to a loss of opportunities to provide a considerable degree of protection against tornadoes when a moderate amount of added strength would have done the job.
- In particular, the team feels there is a significant opportunity to advance the art of school design "to include tornado-protected areas for schoolchildren."

The team of architects and engineers examined 20 severely damaged schools that

School buses are even more dangerous than autos when hit by a tornado, because they have a higher center of gravity. This one turned over and rolled.

A "safest corridor" in an Indiana elementary school was this one, which runs east and west. It was nearly perpendicular to the path of the tornado.

This corridor in a Xenia school became a wind tunnel for a tornado's strongest blast.

Load-bearing walls of schoolroom in Parker, Ind., were pushed in. The roof then collapsed.

Tornado punched holes in walls of school gym in Alabama. Steel frame kept roof in place.

were hit in the April 3-4 outbreak in Indiana, Ohio, Kentucky and Alabama. Schools hit at other times by other tornadoes also were examined by members of the team. One finding has been that the nation has been extremely fortunate in that most recent tornadoes that hit schools did so when the schools were not in session. The investigators thus feel that there is an urgent need for school officials, architects, engineers and weather forecasters to delay no longer in pooling their knowledge—in each tornado-prone area—to select in advance those places in schools which will provide the greatest protection from a direct hit by a large tornado.

In a nutshell—do it now! Next time, Nature may not be so merciful.

Professor James Abernethy of Lawrence Institute of Technology in Southfield, Michigan, a member of the team, prepared for the National Weather Service a slide lecture that is now being distributed throughout the nation to help arouse appropriate public officials to select the best-available tornado shelters in schools. What follows are excerpts from that slide-lecture.

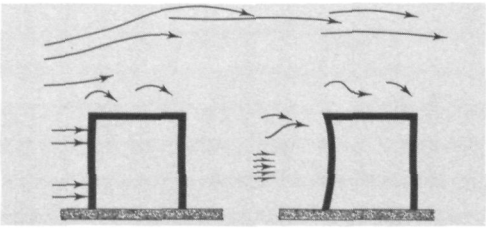
One key point is that the worst effect of a tornado on a school is not caused by explosive decompression as the tornado "eye" passes overhead—as has often been said—but, rather, by the savage blast of wind from that portion of the rotating funnel which is augmented by the tornado's forward speed over the ground—which may be as much as 50 miles an hour. This means that a tornado with a 150 mile per hour rotational speed, counterclockwise, will have a wind force on its right-hand side 100 miles per hour stronger than on the left.

Then, since most tornadoes come from the southwest, this means the extreme blast of wind will usually come from the same direction and schoolrooms on upper floors facing the approaching tornado will be the most dangerous places to be, because they will receive the maximum impact. Conversely, the safer places in a school with no basement usually will be on the lowest floor, in interior corridors that open to the east and north, where wind forces usually will be less destructive.

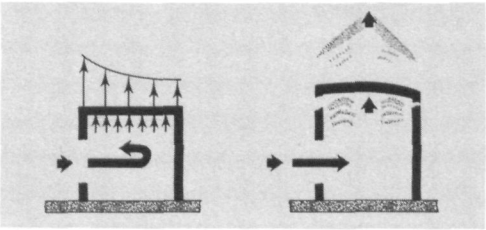
If the school—or any other building involved—has a basement, that of course remains the safest place—and not necessarily the southwest corner of it as has often been said. The important thing is to get under a heavy piece of furniture such as a workbench or sturdy table, to protect yourself from falling debris.

The team's finding that the most damage usually is a result of a strong blast of wind rather than explosive decompression comes as something of a surprise to many people who have been reading about tornadoes over the years.

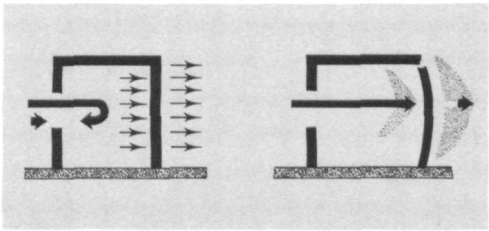
"But time and time again," Abernethy said, "we found windows and walls on the south and west sides pushed *in*, not out, while if a north wall failed it usually fell outward. But such failures were rare. We also frequently found window glass imbedded in interior walls of south- and west-facing classrooms, again illustrating the extreme danger of remaining in such areas. Windows on north-facing rooms were often intact. And it didn't seem to matter whether we were in Alabama or Indiana. The de-



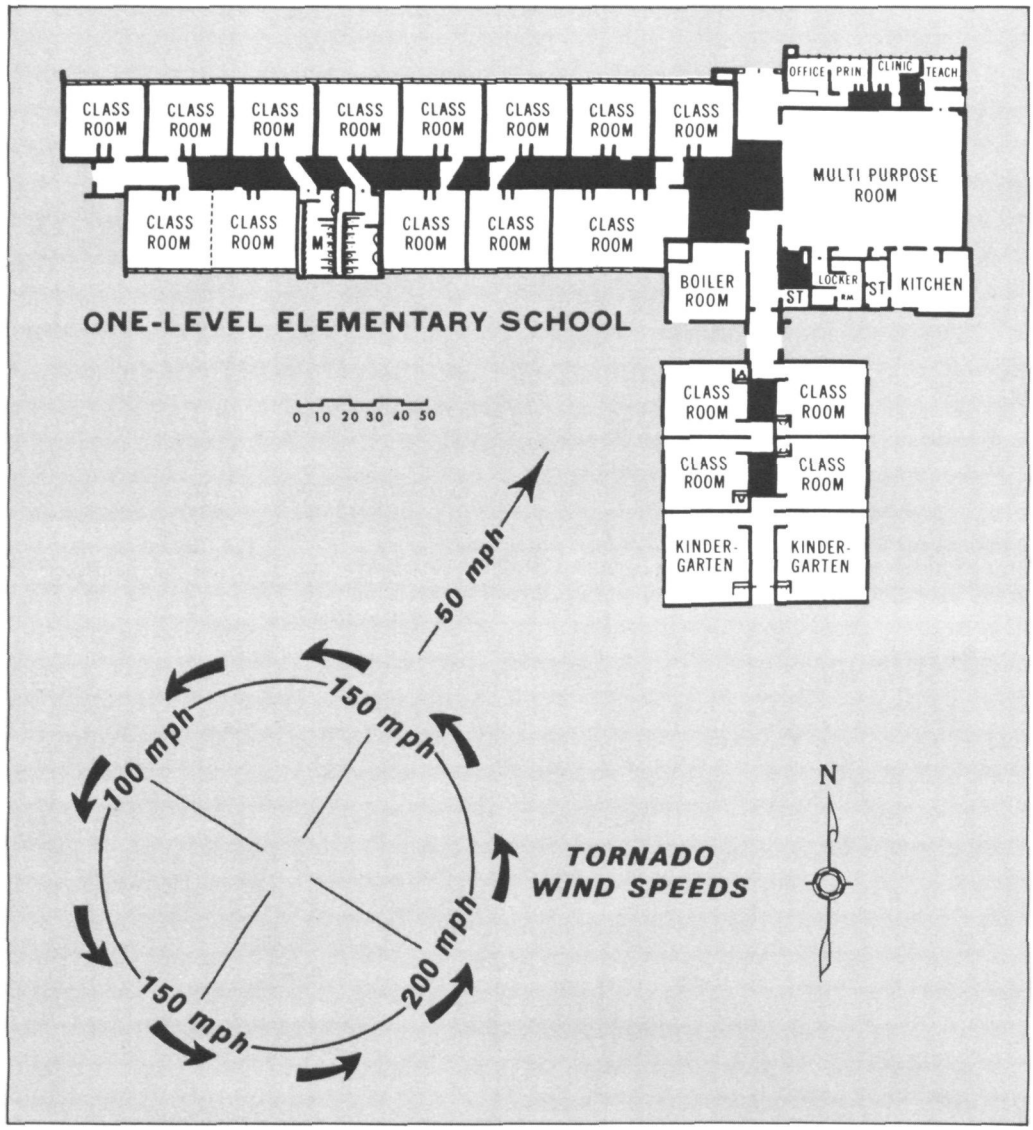
Savage blast of wind from direction of the approaching tornado causes walls to buckle.



Wind destroys roofs by aerodynamic lifting and "ballooning" effect of internal pressure.



Walls leeward to tornado sometimes fail because of internal pressure—but this is rare.



Drawing at right shows "best available" shelter areas in school with 508 pupils and 32 staff, with each person allotted six square feet of shelter space. Schematic drawing of tornado with 150 mile per hour rotational speed and 50 mph forward speed shows why wind force on one side may be 100 mph stronger than on opposite side.

scriptions of survivors and the evidence pointed to the same general conclusion."

The researchers said that in their opinion the principal effects of a large tornado are, in order of importance: first, the disintegrating pressure of wind against windows, doors, and walls; second, the devastating effect of missiles propelled by these winds; third, the collapse of high portions of buildings such as chimneys into lower parts which otherwise would suffer little damage, and fourth, the explosive pressure differential when air pressure inside a building is momentarily greater than outside. They said schoolbuildings designed to meet usual code requirements seldom failed because of explosive decompression, but usually because of some combination of the other three.

In agreement with previous National Weather Service warnings, the researchers cautioned that large rooms with free-span roofs are particularly dangerous because of the likelihood of roof failure and subsequent showering of debris on people below. They said roofs of gymnasiums, cafeterias and auditoriums fail because of aerodynamic "lifting" by winds passing over the roofs, plus "ballooning" from within, caused by the inrush of air through openings in windward walls.

Other places to be avoided besides rooms on the windward side and rooms with broad roofs are listed as areas with lots of glass, which when shattered acts like shrapnel; corridors and spaces likely to become "wind tunnels," and areas with load-bearing walls.

The wind-tunnel effect occurs in corridors in line with a tornado's travel. Tornado survivors report that glass, gravel, dirt and all kinds of debris will actually move horizontally through such tunnels. The architects and engineers point out, however, that those corridors, although not the safest of corridors, are still preferable to rooms on either side. They advise people seeking shelter in such corridors to be particularly careful to crouch or lie flat and cover their heads. If there is a choice, interior corridors facing north are usually safest, followed by those facing east. If the best-available choice is a corridor with a door facing an approaching tornado, stay well back from the door.

The warning against load-bearing walls applies to rooms where roofs and floors depend on walls for their support. If the wall collapses, the roof or floor also fails—a very dangerous combination.

Reversing the coin, the investigators list "good features" for a tornado shelter, in order of importance, as a place on the lowest floor, under a short-span ceiling, in the interior of the building, in a room with framed construction rather than load-bearing walls. They recommend six square feet per person in shelter areas. They also strongly advise any school official seeking to designate best-available shelter areas to seek advise from the local weather office on frequency and behavior of tornadoes in his region, and, most important, the advice of qualified architects or engineers on the places in schools which will provide maximum protection. The illustration accompanying this article shows such a plan for a one-story elementary school without a basement.

Ultimately, it is expected that the findings of the team of architects and engineers who examined schools hit by the April 3-4 outbreak will lead to improved standards of school construction, with tornadoes specifically in mind.

But, at this writing, the investigators say there is much more information to be gathered and analysis to be done before they are ready to make such recommendations.

For the present, however, knowledge of where a damaging tornado is likely to hit a school hardest, and where the safest shelters are likely to be, undoubtedly will save lives.

A school bus was lying upside down on the stage

FOUR MINUTES IN XENIA

Xenia, Ohio, a city of 27,000 people, suffered the greatest damage of any community hit by the 148 tornadoes of April 3-4, 1974. Thirty-four people there were killed. Property damage in Xenia was estimated at 75 million dollars.

The tornado that struck Xenia approached from the southwest and churned northeast through the heart of the city for about four minutes, damaging or destroying almost 3,000 homes, commercial establishments, and five of the city's 11 schools. It narrowly missed Greene Memorial Hospital. Path width varied from 2,000 to 3,000 feet. Estimated destructive power was at or near the top of the Fujita-Pearson scale of tornado-intensity, with winds probably exceeding 200 miles per hour.

The tornado struck at about 4:40 p.m. So most of Xenia's children were not assembled in the stricken schools. The five schools that were hit—two elementary schools, two junior high schools, and one high school—sustained very heavy damage to upper stories, exterior classrooms, gymnasiums, cafeterias, and auditoriums.

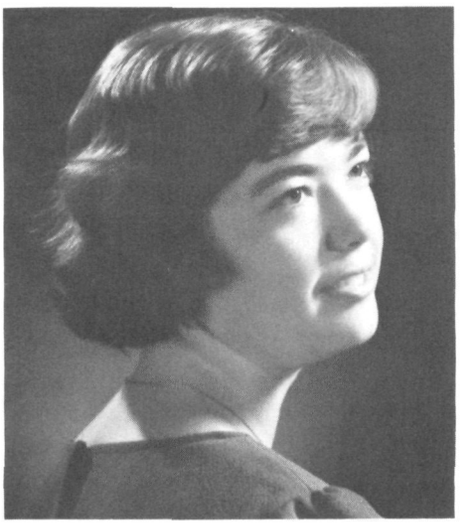
The important point made, however, by a team of architectural experts on the scene soon after was that interior hallways, particularly on lowest floors perpendicular to the tornado's path, sustained negligible damage and would probably have provided safe shelter in most instances, even if the schools had been in session and children huddled in the corridors.

One of the most dramatic episodes illustrating this point was the experience of a teacher and a group of 15 students who by chance had remained at Xenia High School after hours and were in the school when the tornado hit. What follows is a condensed version of narratives of two of the survivors' recollections.

The first is that of Ruth Venuti, an 18-year-old senior, who had stayed after school waiting for a friend to drive her home. The time was about 4:20. She was standing by a doorway, facing west. School had let out at 3, as usual, so there were few others about.

Ruth said there had been heavy rain since about noon, intermittently, and that some of the students were aware there was a tornado watch in effect for the area, but, since tornado watches were so frequent, there was not widespread concern. She did say, however, that some of the students had evidenced nervousness about the heavy rain and threatening clouds.

She said that, at about 4:25 p.m., as she gazed out the doorway, she saw a black cloud about a block long and perhaps 2½ miles from the school. Lightning associated with the cloud was becoming intense, and it began changing from a vertical to a more-horizontal position as she watched. Then the cloud seemed to shrink into a column just north of the center. It became grayish-white.



Ruth Venuti, 18-year-old senior at Xenia High School, spotted huge tornado bearing down. She ran to opposite end of school and warned others in time for all to seek shelter.

"I realized it was a tornado when I saw the air currents begin to swirl."

Ruth quickly began looking for a school official to spread the alarm to others remaining in the building. Knowing the school's drama cast was rehearsing in the auditorium at the opposite end of the school she went there and told members of the drama group that there was a tornado a few blocks away.

At first, said English teacher David Heath, the director, "I thought it was a joke. I came very close to telling everyone to forget it and to go through a dance number they were rehearsing again. That would have been a fatal mistake. Instead, I jumped off the stage and told everyone to follow me so we could get a view of the tornado. I imagined a funnel cloud in the sky that we could look at and then return to rehearsing.

"We ran to the front doors that were nearest the auditorium, and saw what looked to be a column of dirt or smoke swirling around. We couldn't see anything that resembled a clearly defined funnel cloud. It appeared to be between 100 and 200 yards away. Then cars parked in front of the school began to bounce around. It was beyond belief. Someone said we'd better take cover, so we all ran toward the center hall of the school. The lights went out just before we turned the corner and crouched against the walls on both sides of the corridor."

Heath estimated the interval between the moment Ruth sounded the alarm until the tornado hit was about one minute. "In any case we had very little time." He added:

"The impact of the wind was immediate, with no build-up. The first thing I heard was the sound of shattering glass. Even though other people in Xenia said the tornado sounded like a freight train, it didn't sound like that to me. With the sound of breaking glass there was a noise like the clattering of a thousand sets of Venetian blinds, along with tremendous crashing and grating sounds. When I opened my eyes a couple of times I saw large pieces of dirt and wood flying horizontally down the corridor. Lockers clanged open and shut. Several sections of lockers were pulled from the wall and thrown to the floor."

Heath said the tornado had a calm "eye," like a miniature hurricane. "For an instant the wind subsided and I looked up. One boy started to stand and I shouted him down. Then the wind hit again with seemingly greater force. We were all hit with dirt, broken glass, mud, wood and Heaven knows what else. I was still picking glass out of my scalp two days later."

Heath said the air pressure "kept constantly changing in the building. My ears hurt a lot and I was constantly swallowing to make them pop. I have no idea how long the winds pelted the building, although it was probably about a minute. It seemed like an eternity.

"Finally it stopped, and there was total silence."

No one in the school was killed or even seriously injured.

Heath said after it was over he and the students went back to the auditorium where they had been rehearsing. The roof had collapsed and was resting on the auditorium seats. A school bus was lying upside down on the stage.

"When we went outside the school, the park across the street looked like a part of a planet that had burned up years ago. Then I turned around, and was completely stunned. The entire top floor of the high school was missing. Rubble was everywhere. Fountains of water were streaming up from where the second-floor chemistry labs had been. It was then I realized just how bad the tornado really had been.

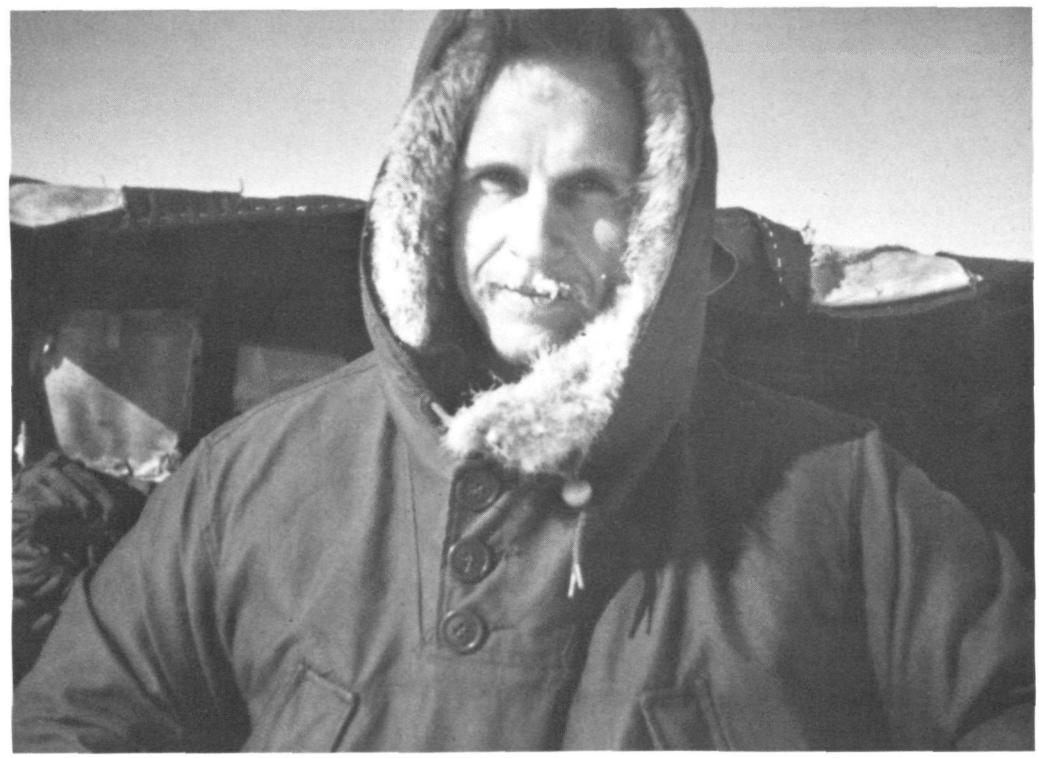
"In the discussions following the storm, there have been many rumors about what actually happened in the school that day. Some say we had no warning whatever. But we did have warning, even if it was partly by luck. Ruth Venuti, the girl who warned us, had been waiting at the other end of the school. If she had not come to the auditorium, many of us there surely would have been maimed or killed.

"At the risk of sounding preachy, I feel I must pass along some advice. It pays to take time to find out in advance the safest places from tornadoes in your schools or homes. Find out how tornadoes work, how they move. Above all, don't ignore tornado warnings. Take cover while you can. It could save your life."

NOAA Profile

A MILLION MILES TO THE TOP

BY RAYMOND WILCOVE



Bugle tucked smartly under an arm, the Admiral-to-be is seen as a 10-year-old. At right, in 1949, Ensign Harley D. Nygren braves the rigors of winter on the North Coast of Alaska, where 55 degree-below-zero temperatures were not considered surprising.

Whoever that other fellow is—the one who wakes the bugler up—he got one young man started on the road to the very top.

Rear Admiral Harley D. Nygren, Director of the NOAA Corps, says that his proficiency with the bugle launched him into his 33-year career—a career that began in the Navy, led to the Coast and Geodetic Survey, and then to NOAA.

"I was a pretty good bugler," he said. "I started when I was about 10 and played in the Boy Scouts, at the YMCA camp and finally in a drum and bugle corps. And this got me into the Navy because when I graduated from high school in 1942, I applied for the Naval ROTC at the University of Washington, along with some 1500 others. The NROTC commander had heard about me and wanted me in his band. He got me in and I became the NROTC battalion bugler. My Navy experience led me to the Coast and Geodetic Survey."

Nygren began a colorful and varied life in the officer corps when he joined the Coast and Geodetic Survey in 1947 as a deck officer. He served on the Survey ships Explorer, Pathfinder, Pioneer and Hodgson in various capacities and on the Surveyor, which he commanded. He was assigned to hydrographic gravity survey and geodetec survey field parties, often traveling with Survey caravans criss-crossing the North American continent.

His duties took him to all 50 states, the West Indies, Europe, Africa, South America, Canada, Mexico, the Falkland Islands, the Arctic and the Antarctic. He served as Associate Administrator of the Environmental Science Services Administration, predecessor of NOAA, and since 1970 as Director of the NOAA Corps.

Nygren's links with the sea go back to his youth in Seattle, Wash., when he joined the Sea Scouts and helped man their 40-foot sloop, the Yankee Clipper. By this time, he had already learned to play the bugle. After a brief stint with the Army as a civilian warehouse laborer following graduation from high school, he enlisted in the Naval Reserve in 1942 and was assigned to the NROTC College Training Program at the University of Washington, where he received his B.S. degree in engineering in 1945.

It was during his three years at the university that part of his character was molded—the hard way. He was an apprentice seaman in the NROTC and had to contend with the college graduates the Navy was training to become officers. "They called them 90-day wonders," Nygren recalled, "because their course took only

Photos: Frank Oxley

three months. Boy, we had to take a lot of guff from them. Take it and like it!"

In the spring of 1945, Nygren was commissioned as ensign and assigned to a destroyer, the USS Hughes in the Pacific Theatre. "I chased it around the Pacific for three months trying to catch up with it," remarked Nygren. He was in Pearl Harbor when the war ended.

With the war over, the Navy had other plans for the destroyer, as a target for the atomic bomb tests at Bikini in the spring of 1946.

"I was the damage control officer in charge of the deck force," said Nygren, "and it was my job to assess the damage caused by the bombing. The ship led a charmed life. The Air Force dropped the bomb too far off and the ship survived. We went aboard within a week or so to check the damage. She was still serviceable and we managed to get up steam and move her about the harbor for the next shot. The second blast almost sank her, but not quite."

Nygren spent the next few months minutely examining and reporting on the damage done to the ship by the A-bomb, until someone decided that because of the radiation she wasn't safe to go aboard. Then, his mission completed, Ensign Nygren wrote his own travel orders and went home.

Back in Seattle, he returned to the University of Washington for a degree in mechanical engineering, which he received in 1947. One day, while going to class, he saw three gray ships tied up to a pier. His curiosity aroused, he discovered they were Coast and Geodetic Survey ships. Capt. Henry Fortin, the watch officer, gave him a talk and an application and he signed up as a deck officer, with the understanding that he would report for work after he graduated.

"I had a 20-foot cabin sloop," Nygren recalled, "and I wasn't in any hurry to go to work as long as I had any money. When it finally ran out, after several months, I reported for duty."

In the spring of 1948, Nygren was commissioned an Ensign and assigned to the Explorer, which sailed for the Aleutians to conduct hydrographic surveys. Nygren has a special place in his heart for Alaska, for he spent more time there on assignment than anywhere else. Off and on, his assignments were to take him there for the next two decades until, in the fall of 1968, he relinquished command of the Surveyor and went to Rockville, Md., where he has been ever since.

Nygren is ambivalent about the nation's 49th state, its 50-below-zero temperatures, its raging winds, its mosquitoes, its choppy seas, and its charm.

The NOAA Corps Director and his wife, Norma, hold a summit conference over plants to be set out at their Virginia home (top). Below, Nygren and son Matthew discuss some of the finer points of baseball, with Pop offering a demonstration.

"At times, it was cold as hell," he recalled. "You don't ever forget having to repair a tractor on the ice when it's 50 degrees below zero. Nor having your shack burn down around your ears when it's about 35 below. Or having your launch explode. Or falling through the ice while hunting."

Offsetting that was some of the earth's most beautiful and awe-inspiring scenery, magnificent glaciers, great forests, and a place where the air is as fresh and bracing as it was thousands of years ago.

One of Nygren's most rewarding assignments, as he looks back at it, was the nautical charting he did above the Arctic circle from 1949 to 1952 along the Beaufort Sea which laps the northern shores of Alaska. Today, these nautical charts guide cargo vessels through treacherous seas as they pick their way among the ice floes to the camps on the oil-rich North Slope.

"The experience was rewarding in the knowledge that we played a key role in the development of these oil lands," said Nygren, "but it certainly wasn't rewarding to me financially. As an Ensign, I was the lowest paid member of our party. The Eskimos got more."

But Nygren got a pay raise in 1951 on being promoted to Lieutenant (j.g.). The Admiral leaned back in his chair and smiled as his mind went back over the years.

"Counting the time I spent in the Navy, I was an Ensign for six years," he mused. "That's a long time to be at the bottom of the ladder."

Nygren was in charge of one of the two parties which conducted the North Slope surveys out of which came 30 charts covering the coastal areas from Point Hope southwest of Point Barrow to the Canadian border on the east. Each party consisted of about 35 officers, Civil Service personnel and Eskimos, hired as temporary employees during each working season.

"We worked from 1949 to 1952, beginning in February or March, and continuing until Steptember, when the Beaufort Sea froze over completely," said Nygren. "The cold weather didn't stop us, the ice did. There were times, of course, when the temperature fell well below 50 and the wind howled, when we were unable to conduct our surveys, but many were the times we worked 12 hours a day in 40-below temperatures. The object was to keep moving. We surveyed hundreds of miles by triangulation on land and launch work off the coast. We worked on land until August, when the ice in the Beaufort Sea broke up. It didn't exactly leave. It just moved out to sea a little way and we worked among the ice floes with our launches, taking soundings and grab samples of the bottom and maintaining the tide gages."

After being stationed in Seattle for 6½ years, Nygren, by then a full Lieutenant, was assigned to geodesy. While working with a gravity party in Minnesota, Nygren received what he remembers as one of the most interesting assigments of his career, a special one-man mission for the military

The Nygrens enjoy an evening in the family library (top). The Admiral and Matthew inspect a fearsomely-decorated kite (left); Adm. and Mrs. Nygren pose with their dog, Muppet; below, Adm. Nygren confers in his Rockville office with his secretary, Mrs. Verna Mize.

Photos: Frank Oxley

making gravity surveys at home and abroad. His first mission took him to New Mexico, Hawaii and other Pacific islands. His second trip took him to England, Europe, Africa and back to Europe.

Since he was the chief of party and the disbursing officer for his group, he had to be back in Minnesota in time to sign the paychecks. Each trip was therefore limited to two weeks and when he reached Switzerland on this second trip, he flew from there direct to Minnesota to take care of his party's payroll. It was on this trip that he made an unscheduled visit to Paris. While flying over the city, his plane lost an engine and had to make a forced landing.

Nygren's next major assignment took him to Patrick Air Force Base, Fla., from which he conducted leveling, triangulation, astronomic and gravity surveys in Florida and the West Indies for some 18 months. He was relieved in this post by Lt. Cdr. Allen L. Powell, who later went on to become a Rear Admiral and Director of the National Ocean Survey.

Following completion of the special project at Patrick Air Force Base in September 1957, he was assigned to the Seattle-based ship Pathfinder.

"I landed in the same job and same room I'd had four years earlier on the ship," he recalled. Where did the ship go? To Alaska, of course, to the Aleutians and Bering sea, where his 18 months of service was punctuated by a murder aboard ship.

A year of graduate studies in 1958–59 at the Univeristy of Washington School of Oceanography landed him back in Alaska aboard the university's 30-year-old, 128-foot wooden ship Brown Bear.

"We worked in the Chukchi Sea, north of Point Barrow," said Nygren. "We just kept on sailing north until the ice stopped us."

In 1961, Nygren received another cold-weather assignment. He was detailed to the British Antarctic Expedition as the U.S. representative and spent four months visiting all British, Argentine and Chilean bases on the southern continent with the British research ships Shackleton and John Biscoe.

"I landed in Montevideo, Uruguay, on my way home," recalled Nygren, "and flat broke, because the home office in Washington had neglected to send my paychecks there. Luckily, I had a plane ticket home. I complained, of course, upon my return, and all my paychecks for the next three months were sent to Montevideo."

His assignment in Antarctica was followed by a four-year stay in Washington, where he served on the planning staff of the Environmental Science Services Administration.

"I finally asked them to send me back to sea," said Nygren. "I'd been behind a desk long enough. So in 1966, they assigned me to the Surveyor as executive officer."

In the next two years, during which he received command of the ship, Nygren was busy in the waters around Hawaii and, of course, Alaska.

Nygren left the Surveyor in 1968 to succeed Rear Admiral Don A. Jones, a former Surveyor skipper, as Associate Administrator of ESSA and was promoted to flag rank. Jones took over the Coast and Geodetic Survey as Director. In 1970, when NOAA was formed Nygren became Director of the NOAA Corps.

"After knocking about all over the world, I guess I'm here to stay now," said Nygren. He estimated that his travels took him "perhaps over a million miles" in just about every conceivable form of transportation, including planes, ships, survey launches, submarines, destroyers, aircraft carrier, helicopter, troop transport, train, bus, sailboat, outboard motorboat and rowboat. No canoes.

As NOAA Corps Director, Nygren has broken new ground. The Commissioned Corps, a male bastion for more than a century and a half, enrolled its first female officer in 1972. Of the 16 women who have since joined the corps, only one has left (she suffered from sea sickness). The number of minority group officers has also increased.

One of the achievements of which Nygren is proudest is the increase in the number of commissioned officers who have remained in the corps after completion of their initial tour of duty. The retention rate has increased from 20 percent to over 50 per cent in the past five years.

The NOAA Corps Director keeps in close touch with his officers. "One of the most interesting aspects of my job," he said, "is being able to go out in the field and see what our people are doing. Some of them are involved in fascinating projects."

Nygren makes it a point to speak to every officer training class at Kings Point, N.Y. "We tell our young officers," he said, "that we're going to overwork them and wear them out. They'll get hungry and thirsty on the job. They'll really get to know the environment in which they work, and in the process, find out what they're actually like and what they can do."

The size of the Corps has also increased during Nygren's stewardship. In Fiscal Year 1968, shortly before he took over, its authorized strength was 300. Today it is 360, and plans are to increase it to 390 next year and to 420 by the following year. "We're having no trouble filling our ranks," said Nygren.

"There is a tremendous demand throughout NOAA for the services of commissioned officers," he said, "because they are a productive group and are distinguished by their mobility, flexibility and versatility."

Half the Corps is now serving at sea. That's where much of the work has to be done, although Nygren would like to reduce somewhat the proportion on sea duty. But he regards the sea as tremendously important to the future of the United States. He feels, however, that if the potential of the oceans is to be fully realized, the educational approach to the problems of the seas that now face the country must be revised.

"We need a more intensive study of the oceans all the way up, from the grades through the colleges," said Nygren. "We need broader programs in oceanography in college. The schools keep on producing people who are compartmentalized.

"People should be more broadly educated in the problems of the oceans and less specialized. The oceans cannot be left to the scientists, including oceanographers. They are too important for that. Oceanic courses should cover the history of the ocean, the law of the sea, the economics of the ocean and a greater appreciation of the oceans' importance to our daily lives.

"Too many people have only an intellectual understanding of the oceans and never experience what the oceans are really like. Just as you can't leave the conduct of wars to generals and admirals alone, so you can't leave the oceans just to the experts."

Nygren is married to the former Norma M. Grobey of Everett, Wash. The couple lives in Vienna, Va., and have four children, Eric, Ernest, Peter and Matthew.

If you can believe Admiral Nygren, once he leaves his office he's under his wife's thumb—her green thumb, that is.

"My wife is quite a gardener," he said, "of flowers, vegetables and trees. I help her out and I want to emphasize that that's exactly what I do. One day she was away for a while and I was trying to cope. A neighbor came over, pointed to what I thought was a rather handsome plant and asked: 'What are you saving that ragweed for?'"

The NOAA Corps Director is a history buff, especially marine history, and has a library of about 2000 books. He does a great deal of reading. He's also strong on home repairs. "I don't send out much to be repaired by someone else," he remarked.

One of the things he repaired recently was a 20-year-old Bolsey camera produced by a firm no longer in existence. "I fixed the flash and found it still takes beautiful pictures." With that and another camera, Nygren likes to pursue this hobby together with another one, sailing, a pursuit which goes back to the days he was 12 years old. Some day, when he finds the time, he's going to build a sailboat.

As for sports, he's fond of golf. "I'm not good at it and I don't take it seriously," he said. "If I did, I'd be in trouble." But while he doesn't take it seriously, he likes it well enough to pursue the sport in winter.

Admiral Nygren and Mrs. Nygren can often be found looking at old houses. "The history attached to the place interests me," he explained. "Sometimes we'll buy a few antiques, but we don't go in strongly for that."

Nygren is also a "battlefield buff." He likes to visit battlegrounds and attempt to reconstruct in his mind from what's physically present the drama that once occurred there.

Life at the Nygren home is quieter now than it used to be. Of his four boys, only one, Matthew, 12, is at home. The others are now living on the Pacific coast. Matthew belongs to two bands and a Little League baseball club. Nygren helps out on Little League activities, but is not involved with the bands.

"My bugling days are over," he remarked. "Its a sure thing it won't get me another stripe."

What lies ahead?

The New York Bight: Nature Under Stress

BY CARL A. POSEY

The concept was irresistible: take an agency like NOAA and focus the considerable ocean-bent talents of its major components on the marine environment and life-forms in some crucial corner of America's offshore world. Develop an ecological context for man's roles as neighbor, exploiter, and custodian of this world, measure what has happened thus far, and see what can be done about the future. In 1972 the concept took a name—MESA, for Marine Ecosystem Analysis—and NOAA scientists laid plans for testing their idea in an oceanic crucible called the New York Bight.

Strictly speaking, a bight is a body of water edged on one side by a curved coastline. But add "New York" to almost anything and the meaning shifts to a higher energy level. So that the New York Bight is more than the roughly pentagonal 15,000-square-mile area running from an apex between Sandy Hook and Rockaway Beach out to the edge of the continental shelf 100 miles offshore. It is also a living thing that reacts with the humanity massed along these dark waters, the hazy towers of Manhattan and the brick suburbs and all the transportation and industry and subsistence and services that constitute this incomparable metropolitan area. There is no separating the Bight from the people and activities which use it.

The MESA New York Bight project was conceived to view these offshore waters and their life, the environmental impact of some 20 million human neighbors, and the particular consequences of ocean dumping of sewage sludge, dredge spoils, and industrial wastes—whole. To do this, an impressive variety of talent and equipment was applied. Current, sediment, and remote-sensing specialists from the Environmental Research Laboratories' Atlantic Oceanographic and Meteorological Laboratories in Miami. Ships and oceanographers from the National Ocean Survey. Submersibles provided by the Manned Undersea Science and Technology program office. The biological expertise of the Middle Atlantic Coastal Fisheries Center of the National Marine Fisheries Service. The special observational abilities of the National Environmental Satellite Service. The ability to move a mountain of data, from the Environmental Data Service. And participation by scientists in universities, industrial research institutions, and other organizations.

NOAA assembled a NewYork Bight MESA Advisory Committee, to coordinate scientific studies already underway in the Bight area, and to improve communications among and with these efforts. The committee and its advisory panels also provide a means by which officials responsible for public service and for environmental management, citizens concerned with resource conservation and the quality of life, and others can contribute to project planning and operations.

This national capital for arts and finance is also the nation's leader in disposing of wastes at sea. In an average year, boats and barges lay down nearly half a billion cubic feet of material at dumping sites out beyond Ambrose Light. This material includes dredge spoil (rich in organic matter and heavy metals), waste acid (high in iron compounds), some miscellaneous other materials (fly ash from powerplants, for example), and sewage sludge, the byproduct of cleaning wastewater, containing potentially toxic heavy metals and pathogenic materials.

Management of sewage sludge and other wastes is one of the disagreeable realities of operating a metropolis. Some cities burn it, others bury it, others recycle it as fertilizer. Milwaukee exports fertilizer and so is able to dispose of its sludge by spreading it around the country. In the New York area, sewage sludge is work for boats and barges, and the dumping sites are in the great plenum of the sea.

The Environmental Research Laboratories' New York Bight MESA project got underway in mid-1973. Meanwhile, there was growing suspicion that sewage sludge dumping had created a massive lens of material characterized as "black mayonnaise" at the dump site, that, with its germs, was stalking Long Island beaches. Because of NOAA's and EPA's ocean dumping responsibilities under 1972 legislation the New York Bight studies have focused on what ocean dumping was doing to the life and environment of the Bight.

Not much was known about the Bight then. People had examined it in several different ways over the years, and a general understanding of what lived there, currents, sediment transport, and other factors was available to the very curious. But no one had ever drawn a definitive picture of the Bight, and so there was little context in which to assess the effects of dumping.

Two years later, a more detailed likeness is emerging, along with some answers about what dumping is doing (and has done) to the Bight, and what should be done about it. This is the picture presented by the first MESA report on ocean dumping:

- The area of the New York Bight in which present dumping sites are located is swept by gentle currents along the seafloor, some of them part of an intermittent clockwise gyre which moves water northward toward Long Island, then seaward, then to the southeast across the continental shelf. Little sediment or dumped material is transported over the ocean floor in the dumping site areas except during the passage of major storms, when movement of as much as 1,200 feet has been observed over periods of several days. (In this regard, EPA points out that as much as 9000 million gallons per day of raw sewage is washed into the Bight during heavy storms.)

- Water circulation in the area appears to be dominated by tidal currents, freshwater discharges from the Hudson and Raritan Rivers, and seasonal effects which tend to stratify Bight waters. Only in winter is there much vertical mixing in the water column.

- There has been essentially no buildup of sewage sludge at that dump site. Sewage sludge is about 95 percent water, and much

Photography by Friedrich Hoelzl

The NOAA Ship Rorqual at mooring at the Sandy Hook, New Jersey, laboratories of the National Marine Fisheries Service, one of several NOAA elements involved in the pioneering study of the New York Bight.

of its solids content is dispersed, mixed, and diluted as it joins the other suspended sediments which cloud Bight waters. Also, biological and chemical processes continually break down dumped materials.

- At the dredge spoil dump site, however, a mound of material some 30 feet high has accumulated over about a generation of dumping.
- Levels of nutrients (nitrogen, phosphorus, and silica compounds) are generally high near the sewage sludge dump, and slightly above "normal" around the dredge spoil dump site. Beyond these localized increases, nutrients in the Bight appear to be controlled mainly by the outflow of the Hudson and Raritan Rivers.
- The unsightly black mud popularized as "black mayonnaise" does not indicate the presence of sewage sludge. In fact, the existence of muds in some topographic lows off Long Island is typical of transient muddy patches found along much of the Atlantic coast.
- There is a small admixture of what appears to be sewage sludge in mud samples taken off Long Island; however, it is not possible to say whether these materials came from the dumping site or from sewage outfalls.
- There is no evidence that a front of sewage sludge is stalking Long Island beaches, or that ocean dumping in the New York Bight has created an immediate threat to the public health.
- A crucial area of uncertainty, according to Charles Gunnerson, director of the MESA program office, has to do with determining the presence and source of sewage sludge in materials taken from the Bight.

"There is no way at present to measure sewage sludge in a given bottom sample, or to determine whether the sludge is from the dump site or some other source. There are still important questions as to when sewage sludge becomes something else in the sea. We are using a variety of measurements—trace metals, total organic carbons, and the ratio of total organic carbons to carbohydrates. This last shows some promise as a sludge indicator. Probably we will have to make a number of analyses and take our conclusions from where the results of different tests converge."

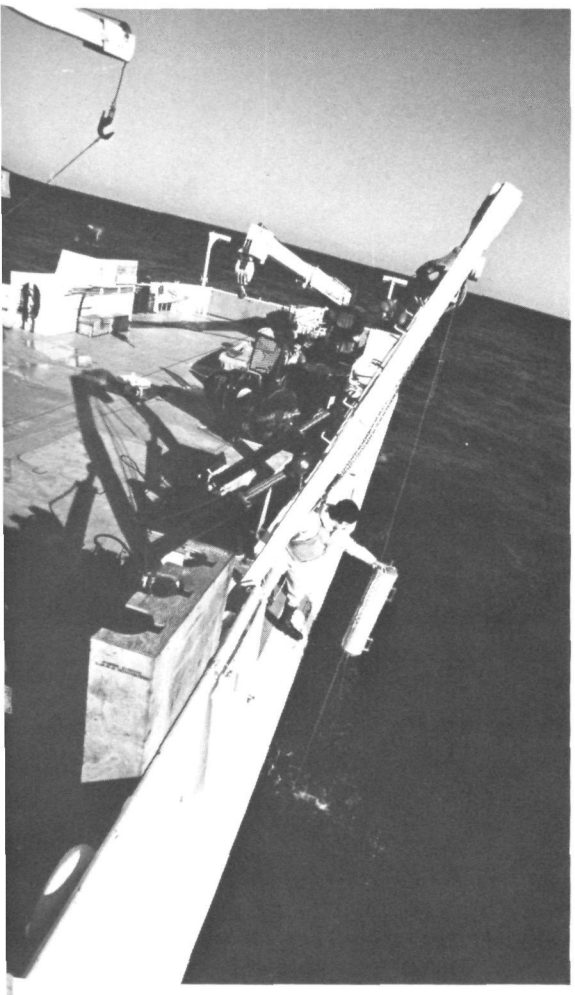
The absence of an immediate threat to public health or Long Island beaches does not mean that ocean dumping has been kind to the New York Bight. There is ample evidence of environmental stress, and ample suspicion that much of this derives from what is being dumped in the Bight.

Shellfish near the dump sites contain unacceptably high concentrations of coliform (intestinal) bacteria. In 1970, a circular area with a six-nautical-mile radius around the sewage sludge dump site was closed to shellfishing by the Food and Drug Administration. Last year, the closed area was extended to include virtually the entire portion of the Bight landward of this circular area.

Fish taken from the Bight apex have a higher incidence of fin rot—a disease in which the fin rays and epidermis are progressively eroded from the outer edges inward to the bases—than specimens taken from surrounding areas. Crabs and other crustacea in the dump areas show some shell deformities that could be pollution-related.

The growing use of antibiotics over recent years is also reflected in samples from the Bight. Antibiotic-resistant strains of normally harmless coliform bacteria have been found there, suggesting that this acquired resistance, or "R-factor," is transmitted interchangeably between harmful and harmless bacterial species. The public health significance of this last discovery is not yet known.

Tests continue to try to isolate cause-and-effect relationships between observed damage and ocean dumping. For example, NOAA fisheries scientists at the Sandy Hook laboratory are deliberately stressing



The NOAA Ship Ferrel takes water samples from the New York Bight while, ashore, Linda Ritter analyzes a biological sample at the Mid-Atlantic Coastal Fisheries Center. The study provided information on which rational management decisions can be based; much, however, remains to be done.

captive fish with materials found in sludge and dredge spoil, to determine whether the observed fin rot is really caused by dumping.

But project scientists have seen enough to make some recommendations.

"All our information points to some ecological damage from present dumping practices in the New York Bight," explains Dr. R. Lawrence Swanson, who manages the project from its Stony Brook, New York, headquarters. "We think that ocean dumping as it is practiced in the Bight should stop. Alternatives could be either disposal ashore or additional cleansing of present wastes before dumping them at sea."

Meanwhile, NOAA has agreed to help the Environmental Protection Agency by recommending two sites for study for alternative dumping sites offshore, should the decision be to move present dumping farther out to sea. Also, under contract to EPA the Interstate Sanitation Commission is studying alternatives to dumping of sewage sludge in the Bight.

These alternatives will not be available overnight," Swanson says, "and because there appears to be no evidence of an immediate health problem or threat to Long Island beaches from dumping, we have recommended that the present dumping sites be kept active until alternatives can be developed.

"But we also want to be sure that any decision to move present dumping farther out into the Bight is guided by solid scientific data. That is why we are looking at alternative areas for the Environmental Protection Agency."

NOAA has urged that any move to alternative dump-site areas be preceded by at least a year of intensive study. In that interval, NOAA and EPA scientists hope, a clear picture of the currents, life forms, water chemistry, and bottom composition would permit them to identify new dump sites which would result in the least ecological damage. Any new site designation would have to be accompanied by an environmental impact statement.

The effects of ocean dumping are only one facet of the ecological picture NOAA scientists hope to get of the New York Bight. "If dumping stopped today," Gunnerson says, "we would still have a heavily stressed environment there. We're working in a corner of a bathtub. We know some of what we see here is influenced by what goes on elsewhere in the Atlantic. But we don't yet know how to assess the importance of observed effects, whether we should be thinking parts per million or parts per billion.

"Next year we'll be emphasizing studies of possible public health impacts. We'll also begin measuring petroleum hydrocarbons in the Bight and try to determine whether 'fallout' from polluted air is a significant contributor of contaminants."

The pendulum has begun its swing back toward a comprehensive view.

As the New York Bight project has moved forward, authors in NOAA and other organizations have been using MESA data in preparing a series of monographs for the Sea Grant Program of the State University of New York. This series of state-of-the-art summaries describing specific, important aspects of the Bight—beach forms and coastal processes, demographic patterns, sand and gravel, and so on—will be published as some 30 separate titles by the end of 1975. The project is supported by special program funding from NOAA's Sea Grant Office. Eventually, the thirty titles will become chapters in what the SUNY people call "the big book," a New York Bight Atlas.

This will be one of the important tools the MESA program will provide managers of this highly stressed portion of America's marine environment. Another is a conceptual model of the New York Bight ecosystem, which will match research resources and specific problem areas.

Words for summer living

COOL IT!

BY NATHANIEL GUTTMAN

Summer is here again and temperatures are rising. Across the country, people are bracing for the inevitable heat wave.

Scientists are not yet able to modify the oppressiveness of summer on a large scale. They can, however, provide some measures of the impact of summer weather on our daily activities.

One such measure is the cooling degree day, summer sister of the more familiar heating degree day used to estimate fuel consumption in winter. The cooling degree day serves as an index of air conditioning requirements, and is computed by subtracting 65°F from the daily mean temperature (one-half the sum of the high and low temperature for a given day). For example, if today's high temperature 82°F and the low temperature is 60°F, the daily mean temperature is 71°F (82 + 60 = 142; one-half of 142 = 71). This equals six cooling degree days (71 − 65 = 6). If the daily mean temperature is 65°F or lower, the cooling degree total is zero.

As temperatures increase, more cooling degree days accumulate, and more energy is required to maintain indoor temperatures at a comfortably cool level. Utility companies use cooling degree days rather than temperatures when they determine how much power they need to generate. The weather forecasts for the next day, the next week or the next month can be turned into an equivalent accumulation of cooling degree days for the period. From this, they compute, and plan for, the power supply.

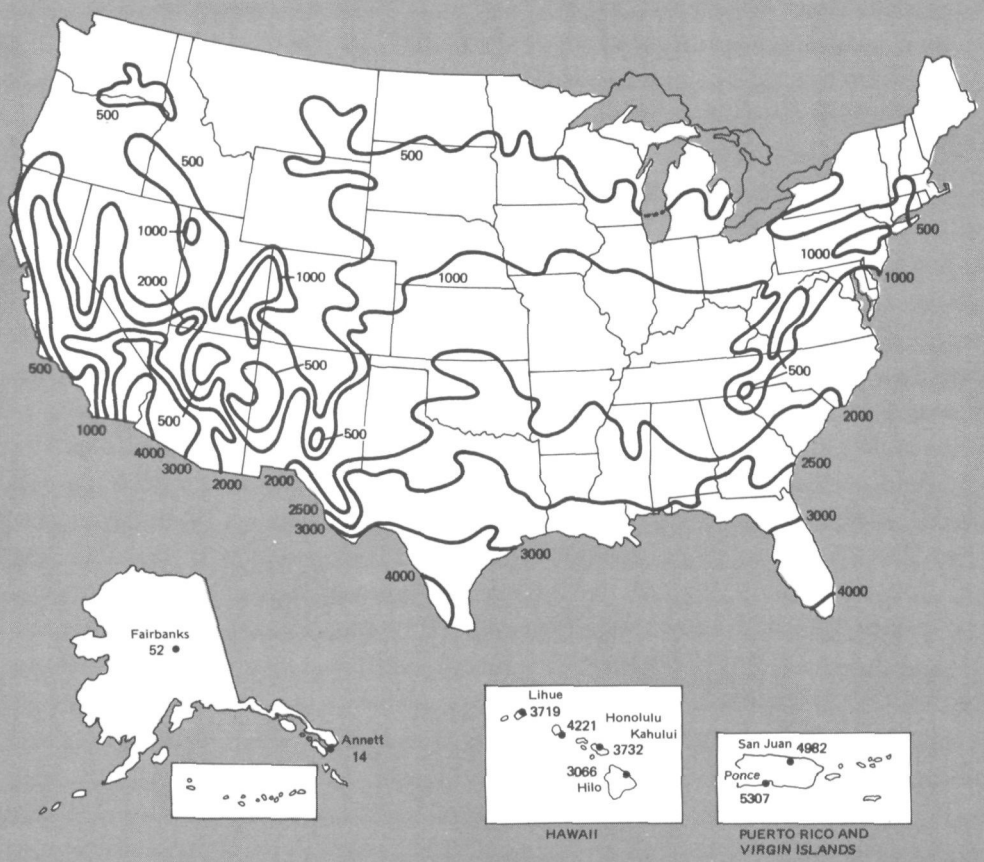
Unfortunately, the relationship between cooling degree days and energy consumption is less precise than the one between heating degree days and energy consumption. Controversy exists among meteorologists and engineers as to which atmospheric parameters are most directly related to energy usage by air conditioning systems. Some think that air temperature alone is a good indicator; others think that air temperature combined with humidity is the best indicator, and a few believe that wind speed and solar radiation should also be included.

You may have heard your local weathercaster mention the Temperature-Humidity or Discomfort Index. This index takes into account temperature and moisture and is a modification of the Effective Temperature. The Effective Temperature was developed in 1923 by The American Society of Heating, Refrigeration, and Air Conditioning Engineers to determine the degree of warmth experienced by the body on exposure to different combinations of temperature, humidity, and air movement. A Discomfort Index of 70 or below, for example, means that few people will be uncomfortable. About half the population will be uncomfortable when the index reaches 75, while almost everyone will be uncomfortable when it reaches 80.

The Effective Temperature and the Discomfort Index are attempts to quantify the subjective problem of how a person reacts to heat. Because the problem is personal, these measures have not gained widespread acceptance as an indication of air conditioning needs. Some people have suggested that "comfort" be used as the index title since the word "discomfort" may trigger a negative reaction and make one feel warmer.

Each index has its disadvantages, but everyone agrees there is a need for an objective unit of measurement of the effect of weather variables on cooling require-

Normal Cooling Degree Days (Base 65°F) 1941-1970



Cooling Degree Day Data Sources

The following publications may be ordered by writing to: Director, National Climatic Center, Federal Building, Asheville, North Carolina 28801. (Please make checks payable to Commerce, NOAA, NCC).

LOCAL CLIMATOLOGICAL DATA is issued monthly and annually for about 300 major locations in the United States. The monthly summary includes daily cooling and heating degree days, monthly totals, and departures from normal (if computed). The annual summary includes monthly and annual values for the current year, and normal monthly values (if computed). The subscription rate is $2.00 per year per station (including annual). Single copy prices are 20 cents for the monthly and 15 cents for the annual summary. Distribution is normally 30 days after the end of the month for the monthly issue, while the annual is usually published in March.

CLIMATOLOGICAL DATA NATIONAL SUMMARY is issued monthly and annually. Included are cooling and heating degree days for about 300 stations in the U.S. The subscription rate is $5.50 per year (including the annual). Single copy prices are 40 cents for monthly and $1.00 for the annual summary. Distribution is normally four months after the end of the month for the monthly issue, and six months after the end of the year for the annual.

CLIMATOGRAPHY OF THE UNITED STATES NO. 81, Monthly Normals of Temperature, Precipitation, and Heating and Cooling Degree-Days, is published decennially for each state or combination of states. Data are shown for all cities in the state, or combination of states, which have sufficient temperature data available for computation of a normal. The cost is 25 cents per issue. Data for the period 1941–1970 were published in August 1973 and the normals will be in effect through 1980. Corrections will be made as necessary to reflect changes in location and instrumentation of stations.

CLIMATOGRAPHY OF THE UNITED STATES, NO. 84, Daily Normals of Temperature and Heating and Cooling Degree Days is published decennially. The cost is 10 cents per station. A bound set of all stations is available for $6.50. Data for the period 1941–1970 were published for 325 stations in September 1973 and the normals will be in effect through 1980. Corrections will be made as necessary to reflect changes in station location and instrumentation.

ments. Power companies must plan far in advance to provide adequate electricity to run air conditioners without causing brownouts or even blackouts during peak load periods. On the other hand, the generation of too much power is wasteful, particularly today.

The cooling degree day concept, while far from perfect, is the most widely accepted means of anticipating summertime energy usage.

The accompanying map depicts normal seasonal cooling degree day totals for the United States and is based on data for 1941-1970. It shows what to expect in an average summer for a given location. You can also use the map to compare areas. You can see at a glance, for example, that the Southeast is much warmer (more cooling degree days) than the California coast and, therefore, requires more power to keep cool. This type of comparison is useful if you have a choice of areas to live in and are trying to estimate the relative needs for air conditioning.

Even if you live in the cooler northern states, you can expect at least a few days this summer when the heat will make you uncomfortable. There are some commonsense steps you can take to make life more bearable and save energy at the same time.

If you have an air conditioner operating, prevent the excessive entry of outdoor air by weather-stripping windows and doors and caulking cracks. Keep windows and doors shut and leave storm windows and doors in place (a few windows should be easy to open for ventilation). Make sure fireplace dampers are tightly closed, and seal off all spaces not air-conditioned. Also, select the proper size cooling unit, clean the filters, and keep the system in good operating order.

Your house will remain cooler if you shade windows from direct sunlight. Blinds and draperies can reduce heat gain through windows by as much as 50 percent. External awnings, sunscreens, overhangs and trees, if placed properly, are very effective in cutting solar heat. Thick insulation in ceilings and walls and around heating and cooling ducts will also keep the hot air outside and the cool air inside.

A light colored, smooth textured roof will absorb less solar energy and keep your house cooler than a dark colored roof, while an attic fan is often effective in removing unwanted heat collected by the roof. It should be run on the exhaust cycle during the day and on the intake cycle at night, when the outside air temperature is cool.

Limit the use of appliances during the hottest portions of the day. Light bulbs, television sets, radios, stereo equipment, irons, hair dryers, and other appliances all generate heat. Use them only when necessary. Try cooking and using shower facilities during the cooler morning and evening hours.

Your National Weather Service Office can provide cooling degree day data and accumulations for your area. More detailed local and national data are available in several of the publication series of NOAA's Environmental Data Service.

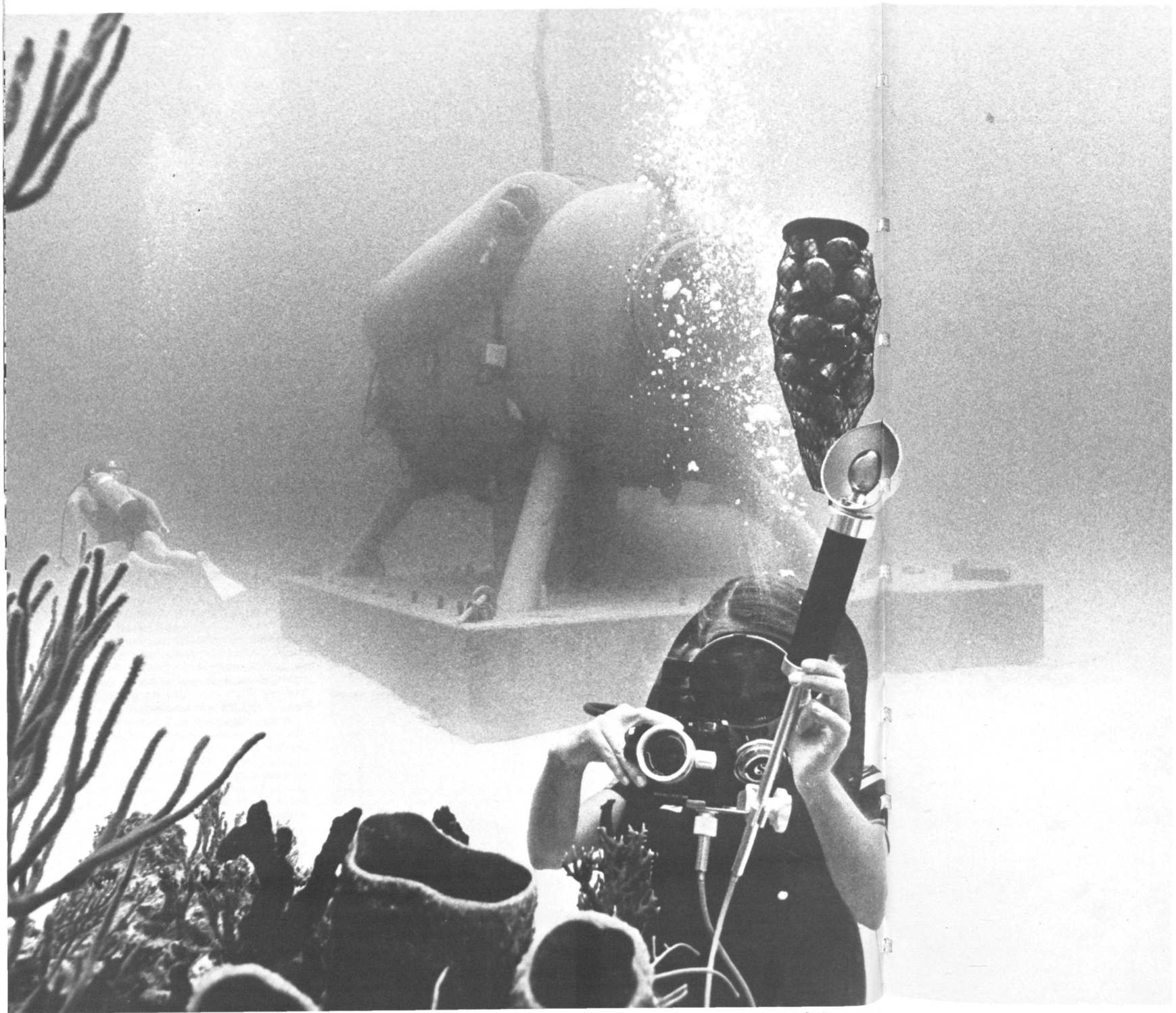


Photo: Dick Clarke

Over the wall and down to 250 feet

PROJECT SCORE: BREAK-THROUGH IN THE BAHAMAS

BY ROLAND PAINE

With a small habitat as hotel and a submersible to provide taxi service to their research sites, four teams of scientists have explored the dropoff and deep sidewall of a coral reef with great detail. Using this unusual combination of scientific support facilities for week-long missions during the month of April, they enjoyed the luxury of comparatively long working periods on the scene in their underwater laboratory. And as a result of the time available to them on these scientific swims, they have already reported:

- discovery of a previously unknown tiny, mushroom-like green alga (seaweed);
- collection of four species of fish not yet identified that may also be new to science;
- most significantly, a much more profound understanding of the remote but important ecological community of a deep reef and the interactions of the living organisms that make up that community.

Dubbed Project SCORE (Scientific Cooperative Operational Research Expedition), the effort was carried out by NOAA, the Harbor Branch Foundation, Inc., of Fort Pierce, Fla., and the Perry Foundation, Inc., of Riviera Beach, Fla. SCORE proved to be the capstone of a three-year Bahama Banks Research Program supported by NOAA's Manned Undersea Science and Technology (MUS&T) office, and it added a new capability to undersea scientific operations.

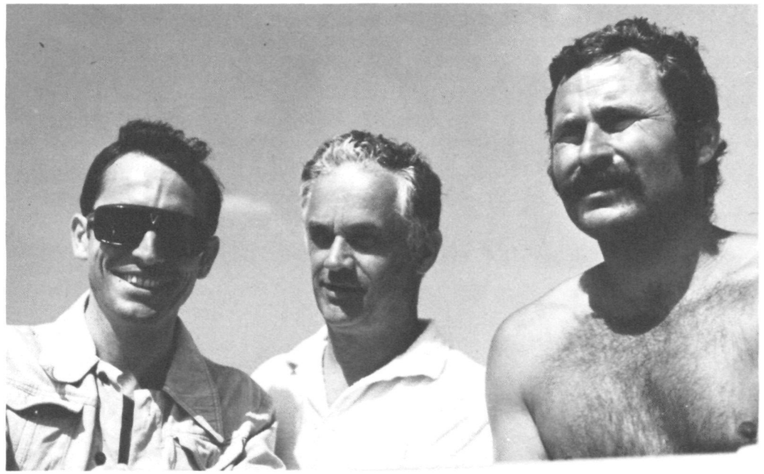
"Project SCORE was clearly the highlight of our whole three-year program on the Bahama Banks," said Dr. Morgan Wells of MUS&T, SCORE scientific director. "In the early days we rarely went to 100 feet, and then only for short times. We gradually increased depth and time underwater as new diving tables were evolved, and now our divers are able not only to live under water, but can make extended excursions to deeper areas. The scientific results are the payoff, and they are exciting.

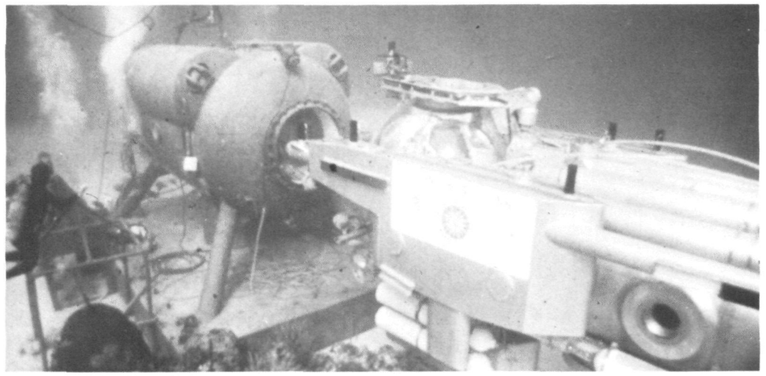
"We have found, for example, that on this reef there are five zones of life between shore and drop-off, each quite distinct—as distinct as zonation on land. We have detailed knowledge of the animal and plant life of each zone, and of those that overlap zones. We can make generalizations that begin to tie our findings together—for example, that light appears to be the single most important variable affecting abundance of life.

"One result of the overall program that should prove most useful will be a detailed atlas of this reef, with the zones delineated, life forms mapped out and described, and such characteristics as light quality and reef metabolic rates included. Publication of the atlas—still well in the future—will sum up

With a sack of flash bulbs floating upward on its tether, scientist photographs sponges and other coral reef life near Hydro-Lab, the small "hotel" used during Project SCORE.

Photography by Friedrich Hoelzl (Others as credited)





(Top photo) French biologist Jean Jaubert (l.) joins NOAA's James Miller and Morgan Wells in SCORE operations. (Center photo) Johnson-Sea-Link approaches Perry Hydro-Lab; photos from sub (below) show "Sea Shell" stations (l.) and Sub-Igloo (r.), containing air and diver communications.

Artist's conception shows Project SCORE activity. Submersible anchors below overhang of coral reef wall as scientist descends to 250 feet for research. Other team members are in Sub-Igloo (center) communicating with Perry Hydro-Lab (upper left), while support divers from surface approach the habitat. Tall cylinder on edge of reef is Undersea Instrumentation Chamber housing oceanographic sensors; Sea Shells are located along routes used by divers for decompression and resting.

all the available knowledge of the reef and could provide a model for studies of undersea environments all over the world."

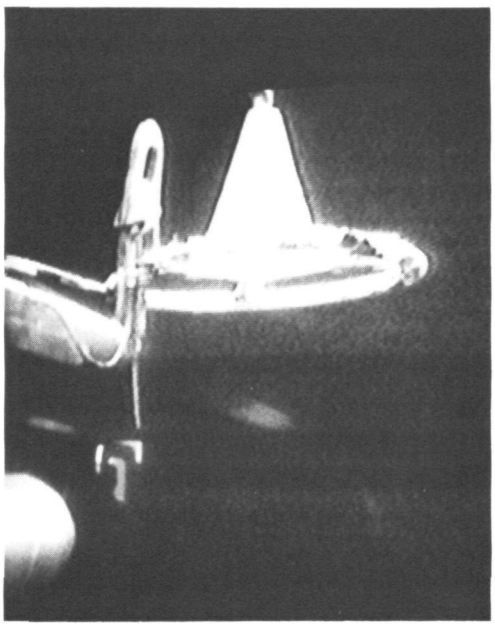
The relatively long periods of time that the scientist-divers were enabled to stay at depths resulted from the unique combination of the habitat-submersible duo, and the use of newly developed vertical excursion diving procedures (sponsored by MUS&T) that incorporate the use of air rather than the so-called "exotic" gas mixtures (such as those incorporating helium). With the new procedures, SCORE scientist-divers could spend up to 45 minutes at 250 feet depth, and a full hour swimming around at 200 feet. By way of comparison, if a diver goes from the surface to 250 feet for 45 minutes of work, he must undergo five hours of decompression upon his return to the surface.

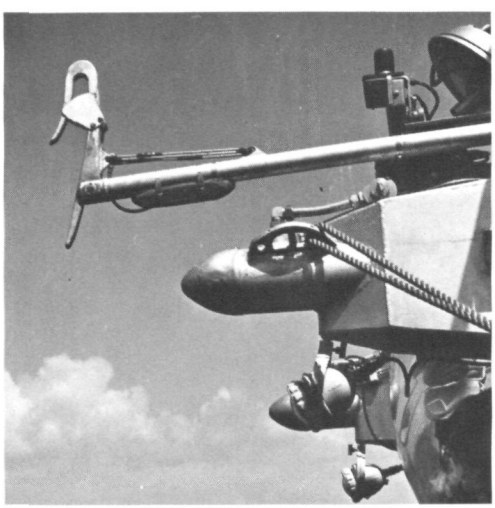
"This is a significant advance in diving technology," said Dr. James Miller, Deputy Director of MUS&T and Project Coordinator of SCORE. "Although exotic gas mixtures provide long periods at depth, they are expensive, they can make speech almost unintelligible, they increase body heat loss, and they require special equipment. With the new air tables we avoided all these problems, and the extended working time made it possible for aquanaut scientists to work thoughtfully rather than frantically while making their observations and collecting specimens."

Home port for Project SCORE was Freeport on Grand Bahama Island, and home base was the Hydro-Lab quarters at the Underwater Explorers Society. As the tourist season drew to a close on the sunny island, scientists and technical support people from private, public, and academic institutions in the United States and three other countries settled down to a weekly rhythm that gave each of the four teams three or four days of training, five days in the Hydro-Lab "hotel" punctuated by excursions either in Harbor Branch's Johnson-Sea-Link submersible or in Scuba gear to research sites, and then one day of decompression.

NOAA's Dr. Wells arrived on the scene in March and acted as liaison between the scientific teams and the operational support groups. His job was to ensure that the project ran smoothly and that the scientists were able to accomplish as much of their planned work as possible. A biologist with a Ph.D. from Scripps Institution of Oceanography, Wells is also an active field scientist who has spent more time in underwater habitats than anyone else in the world. This time, with the exception of occasional dives to support the scientific program, Wells stayed on land, at the base.

The Perry Hydro-Lab had been the basis of MUS&T's coral reef research program in the Bahamas for three years. Week after week for most of that time, teams of scientists and supporting personnel had lived in the small undersea structure for six to fourteen days at a time, studying all aspects of the coral reef—the kinds and distribution of the coral itself, the fish and plant life that inhabits the reef, the effects of pollutants on reef life, the metabolism of the individual living organisms and of the reef community, and a host of other problems. All this work was carried out on the gently sloping top of the reef, from the tide line down to perhaps 100 feet, and the Hydro-Lab was situated at a depth of about 40 feet. For SCORE, Hydro-Lab was moved to deeper water, 60 feet, which put it 600 feet closer to the sudden sharp drop-off at the edge of the reef, at a depth of about 130 feet. SCORE scientists studied the reef from this depth down to 250 feet, along the side wall and overhang of the cliff.





Special underwater anchoring system was devised whereby Johnson-Sea-Link submersible hooked onto suspended ring and backed off until it "hung" motionless in water. Diver-scientists could then swim out in safety for research. Top photo shows hook on arm extending from sub. Bottom photo, of closed circuit television screen in surface ship R/V Johnson, shows view from inside sub as hook engages the ring during actual dive. Television inside sub permitted support personnel to monitor every operation, thus adding back-up safety measure.

Perry Hydro-Lab is a cylindrical chamber 16 feet long by eight feet in diameter, containing two bunks (two of the team members slept on the floor), air conditioner, dehumidifier, communications equipment, fresh water shower, and other minimum necessities. Dr. David Olson of the Bureau of Fisheries and Wildlife, Government of the Virgin Islands—a member of the second SCORE team—likened living in it to "camping underwater." But if its accommodations are spartan, its efficiency as a scientific support habitat is unmatched. It has had the longest continuous useful life of any underwater habitat anywhere in the world.

The necessary support to keep Hydro-Lab operating consists of an unmanned life-support buoy at the surface of the water above, and two imperturbable and extraordinarily dedicated men, Robert Wicklund and Richard Clarke of Perry Oceanographics, Inc. Wicklund and Clarke ensure that the life support systems operate, they man the radio, they buddy dive with scientists down to the Hydro-Lab, they swim safety missions, they repair delicate scientific equipment, they advise scientists new to underwater work on problems ranging from instrumentation difficulties to personal apprehension, and they carry out their own research and photography projects in conjunction with the long-term program.

To make the deepest dives, to 250 feet, SCORE scientists left the habitat and climbed aboard their underwater taxi, Johnson-Sea-Link. The little submarine holds a pilot and observer in the forward compartment and two "passengers" in the rear compartment. And it has a highly important capability that most undersea research craft lack—just like its terrestrial brothers, it can let the passengers disembark where they wish. The rear compartment is a lock-out chamber that can be pressurized to ambient pressure.

For each SCORE excursion, Johnson-Sea-Link picked up one scientist and one Harbor Branch technician from the habitat, transported them to the edge of the cliff and over the wall, and then anchored—with a special deep-sea anchor from which the submersible "hung" over the cliff—at a depth of 229 feet. The scientist would then swim from the rear compartment and make his observations while the support diver watched over him and tended the combination air hose and communications line from inside the submarine. Had there been any problems—and there were none—the support diver could have left the submersible to assist the scientist.

After 35 minutes (the longest time actually spent in the water) at a maximum depth of 250 feet, the scientist re-entered the rear compartment and the submersible made its way back to the habitat.

Submersible operations director, and director of training for Johnson-Sea-Link, was Roger Cook of Harbor Branch Foundation. Under his careful guidance training dives were conducted for all scientists who were to use the sub, and whenever weather permitted the scientific lock-out dives were

Photo: C. Lavett Smith

(Top photo) Dr. Sylvia Earle, outside Hydro Lab, "talks" by hand signals with team member Dr. Thomas Hopkins during dive to examine marine algae and soft corals. (Above) Fishery scientist Dr. Robert Jones and buddy diver search reef during fish census. (Right) German scientist Gerd Schriever swims out with collecting sack.

accomplished with smoothness and efficiency.

The four teams—each consisting of three scientists and one technician from Harbor Branch—"saturated" in the Hydro-Lab for five days at a depth of 60 feet. Saturation means that after about 24 hours under the pressure of 60 feet of water—almost three times atmospheric pressure—blood and tissue absorb all of the gas that they are capable of absorbing. Once saturated, a diver can safely stay at that depth for an indefinite period of time. To go back to the surface, a slow period of decompression is required that permits the gas to be released from the body without forming bubbles in blood and tissues. If bubbles form, they can cause what is commonly referred to as the "bends." Decompression time in SCORE from the 60-foot habitat depth was approximately 19 hours.

Both the scientists who made excursions from Johnson-Sea-Link to 250 feet, and those who swam out from Hydro-Lab on missions to 200 feet, required decompression prior to returning to the habitat, to compensate for the additional pressures under which they had worked. Scientists returning from 250 feet accomplished their 45-minute decompressions in the submersible. Scientists who swam out from Hydro-Lab required 19-minute decompressions, which they accomplished by swimming slowly back to the habitat, remaining at fixed depth for planned periods of time.

For diver safety, the Canadian underwater station Sub-Igloo—an air-filled plastic dome, on legs, with communications to Hydro-Lab—was situated near the edge of the cliff dropoff, and smaller breathing stations were placed near the areas where the scientists were to work and carry out their decompression stops. The safety system had to be put into use only once, and it worked perfectly. Early in the project one of the technician-divers had difficulty, was escorted by his buddy diver and the safety diver hovering overhead to Sub-Igloo, where he rested, was provided with air, and later transported to the surface by the submersible.

Teams in Hydro-Lab decompressed in the habitat at the end of each 5-day mission. A back-up decompression chamber was located aboard the support ship R/V Johnson. A second back-up decompression chamber was located at the Hydro-Lab base.

Most of the scientists who participated in SCORE had been part of MUS&T's Bahama Banks Research Program during the previous two or three years. Several had also participated in other NOAA-sponsored undersea work, such as FLARE—the Florida Aquanaut Research Expedition that MUS&T and Sea Grant mounted in 1972 on the Florida coral reefs. All had had extensive work in the shallower depths, and were looking forward to extending their knowledge to the deep areas that they had visited only briefly, if at all.

NOAA's Wells explained it. "We had three overall scientific objectives," he said. "First, we wanted to extend our scientific knowledge of the reef environment so that we could describe it better from the standpoints of oceanography, geology, chemistry and biology. Second, we wanted to supplement the shallow-water studies, to find out more about what kinds of plants and animals there are down deep, how many of them there are, where they are located, and what they are doing with and to each other. Scientists call such studies species composition, distribution, abundance, and dynamics. The third objective was to find out how the whole coral reef community reacts to stresses caused by nature and by man."

Wells, together with Wicklund, Clarke, and Cook, spent the last two weeks of March getting equipment installed on the bottom, setting up a laboratory in the base camp, and training the first scientific team to work in Hydro-Lab and Johnson-Sea-Link. They were joined by the first group of support divers, students from Seneca College of Applied Arts and Sciences, Ontario, Canada. These young men paid their own way down to participate in the operation, for which they received credit in their diver training program at the college.

On April 1 the first mission began, as a team of fisheries experts were taken out to the site in a small motor launch, donned their Scuba gear, slipped over the side and dove down to the habitat. Meanwhile R/V Johnson, with Johnson-Sea-Link in her cradle on the stern of the ship, made her way out and prepared for the first scientific dive.

Dr. C. Lavett Smith of the American Museum of Natural History (New York) was one of the scientists on that mission, along with Dr. Robert Jones of Harbor Branch. They were assisted by Dick Clarke of Perry and Jeff Prentice of Harbor Branch.

Smith had spent several days in the movable habitat Edalhab during FLARE, taking a fish census of a small portion of a coral reef off Key Largo. He had also worked on Tektite, and had participated in MUS&T's Bahama Banks Research Program on two previous occasions in Hydro-Lab. An experienced diver and underwater scientist, he found the deepwater excursions in SCORE intensely interesting and scientifically useful.

"We found that there is a very sharp break in the kinds and abundance of fish species that occur on the face of the wall as opposed to those found on top," he said. "This was not a completely new discovery, but we were able to see it very clearly, and corroborate that it is a regular and continuing characteristic of fish populations there. This was the great advantage of the long time that we could spend at depth."

He also reported a discovery of possible commercial interest. "At two hundred feet, just over the dropoff, there is a very large population of black snapper," he said. "This is a species of great market potential—not as well known as its cousin the red snapper, but very tasty. At that depth, black snapper are very abundant, in commercial quantities. They are just waiting there for somebody to come and take them."

From a systematics viewpoint, perhaps the most interesting find for ichthyologist Smith was the trapping of four species of fish that, back in his laboratory at the American Museum, he has not yet been able to identify. "We've done a lot of work with these four," he said, "and so far nothing like them has turned up in the literature. Of course, one of them poses a particularly tough problem, as we obtained only a juvenile specimen. But it may be that we have four species of fish that have never before been identified."

In addition to the deep excursion work, Smith made a three-day visual census near the habitat, at 65-foot depth. He saw two species only at night, and believes that they hide very deep in holes in the coral during the day. "At 65 feet," he said, "there are the same number of species as I had previously observed when the habitat was at 40 feet—but there are far fewer numbers of individual fish of each species."

Dr. Jones of Harbor Branch worked with Dr. Smith on the deep excursion census, and during the periods at shallower depth in and around the habitat, conducted a fish census using a technique he had developed for working in the Trust Territories of the Pacific for assessing damage to fish populations caused by Crown-of-Thorn starfish predations on coral reefs. "We feared that as the reefs disappeared under the impact of the star," he said, "the fish populations, deprived of a habitat, would also be seriously affected. We didn't have the time or the equipment to conduct definitive scientific surveys. What we needed was a fast way for a biologist with minimum equipment and time to make a rough comparison of stressed and non-stressed areas, to get some idea of the effects on the fish."

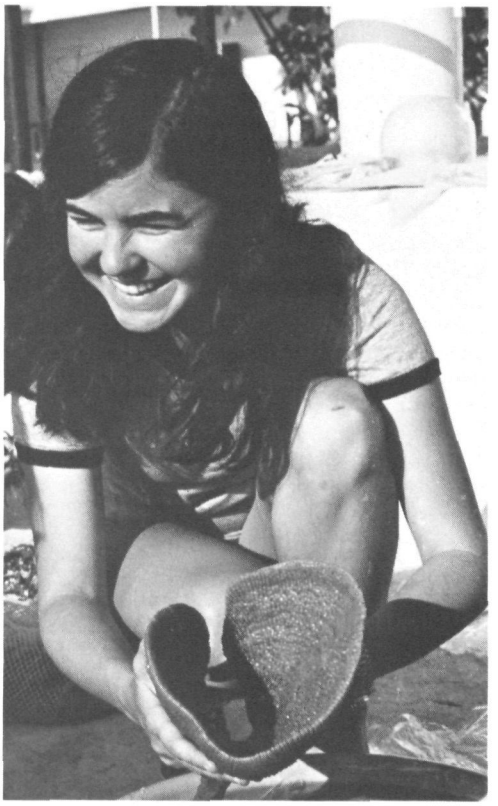
He calls his method one of "relative count." It consists simply of swimming a given time, perhaps 50 minutes, divided into 10-minute blocks. During each ten minutes he counts every species he sees. He can swim in any direction, and at any speed, and obtains at the end of his five 10-minute blocks a cumulative species count. A numerical value is assigned to each block—five for the first, four for the second, and so on—and the species counts in each block are multiplied out, giving a relative count of most of the species in the area.

"Obviously, I'm not going to get the nocturnal species, and there will be species missing from the tabulation," he explained, "but I will have a handle on probably 70% of the species, and can get a baseline against which a later rough baseline study using this technique can be compared. I used this technique in swims around Hydro-Lab when we were not on deep excursions. With John Thompson of Harbor Branch I am going to use this technique on the Pennekamp reef in Florida, comparing a protected and a non-protected area, to obtain the same kind of rough measure of environmental stress."

The two scientists counted more than 120 species of fish in the shallower waters, and in their deep water excursions counted and obtained specimens of about 20 species.

On April 5 they underwent the 19-hour decompression, and then came to the surface and were transported back to the base.

Photo: Roland Paine



(Top) Dr. Sylvia Earle, Los Angeles Museum, just returned from Comoro Islands research on "living fossil" coelecanth fish, begins work in SCORE laboratory. (Below) Susan Brawley, University of California biologist, displays large specimen—sponge or hard coral—sent up by Dr. Earle from undersea collecting excursion.

Arthur Ley, Scripps Institution of Oceanography, examines algae samples collected by scientist-divers and sent to surface for preservation and classification.

Dr. David Youngblood of Harbor Branch, Medical Officer for SCORE, examined them as he did each team before and after saturation, to ensure that there were no problems, and after a prescribed waiting time at the base they returned to their institutions.

Meanwhile the second team had arrived at the base and underwent training. Dr. David Olson of the Bureau of Fish and Wildlife, U.S. Virgin Islands, Walter Jaap of the Florida Department of Natural Resources, and John Halas of Harbor Branch were the three scientists on the second team, all working on characteristics of the stony, reef-building corals. They—with Harbor Branch technician Bill Meinert who accompanied them in the habitat, tended their lines, and provided safety back-up during submersible lockouts—began their mission April 8, shortly after the first team had completed their work.

Two of the team, Olson and Jaap, have worked with Wells on a long-term project to determine the community structure of hard corals and how this changes with water depth. The three men had carried out this work during two previous Hydro-Lab missions and in the Puerto Rican habitat La Chalupa. These and other missions from Hydro-Lab had mapped the distribution and diversity of stony corals from the shoreline to a depth of 210 feet, and identified 45 species, but information for depths greater than 100 feet was very sparse. On the second SCORE mission, Olson and Jaap carried the project into deeper water with much greater detail than had been obtained before.

"People have thought that shallow-water corals would be light-starved at depth," Dr. Olson explained, "and so probably would not grow in deep waters. We found that at that site, there were about 12 species of coral at 20 feet, increasing to a peak of about 18 species at 50 to 60 feet depth, and then decreasing to 10 to 12 species at 120 feet. From 150 feet on down, there were only about six species to be found. But all of the deepwater species also grow in shallower water."

The duo on SCORE worked with a statistical technique that they had previously used, developed by Israeli scientist Yoffi Loya of Tel Aviv University. Loya, in turn, had perfected the technique during a NOAA-sponsored dive in the Puerto Rican habitat La Chalupa many months earlier. A valuable tool as an environmental indicator of the health of coral reef communities, the technique consists of making measurements of the abundance of hard corals along a transect line, from which is calculated a statistic of species diversity. The result is a simple numerical expression of relative abundance and consequently of relative health.

Taken as a single measurement, it shows the local depth where conditions are optimum for hard coral growth. Taken in the same place over time, the series of calculations will show by increase or decrease in value an improvement or deterioration in environmental conditions for hard coral growth.

The technique can also be used easily to compare different areas. At the Freeport coral reef site, Olson and Jaap found that there was a statistical peak at a depth of about 60 feet—meaning that this was the depth of greatest relative abundance and number of species of coral. This was 10 to 15 feet deeper than the peak that the Puerto Rico work had shown. As Olson explained, "The Puerto Rico site was in an area where the water contained much more sediment than did the Bahama site. Since the sediment prevented sunlight from penetrating so deeply, it is an apparent conclusion that the light-loving coral cannot thrive in such deep water at the Puerto Rican site as it can at the Bahamian site."

The scientists were struck with another result that came from their observations. "On land," said David Olson, "a northern climax forest will typically have one or a few species of trees that dominate the ecosystem—oak or pine, for example. A tropical forest, on the other hand, typically contains many species, none of which are dominant. We found that for corals, there are generally a great number of species of coral in shallow water, and a few species tend to dominate. As we go deeper, we find less dominance apparent—and at the considerable depths down to 250 feet, none of the few species we found dominated the site."

A related investigation of interspecies domination was carried out by John Halas of Harbor Branch on that mission. He studied the populations of two species of stony coral at varying depth. Using photography and direct observation, he recorded a little-known process whereby one coral interacts with another, competing for space in their underwater realm. When the two species occur at sufficiently close range, one may send out slimy filaments that cover the other, inhibiting the latter's growth and inflicting sometimes fatal injury.

The Mission II aquanauts accomplished their decompression on April 14, in time to chat briefly with a group of newsmen who were visiting the project. While in the Hydro-Lab they had had a distinguished visitor, Prime Minister Lynden Pindling of the Bahamas. An experienced Scuba diver, the Prime Minister had been escorted down to the habitat, where he inspected the operations and discussed the progress of the work with the aquanaut-scientists. The following week, Prime Minister Pindling returned and was given an overall briefing of the whole project by scientists and operational personnel.

The third team started work on April 15, with research carried out by Dr. Sylvia Earle of the Los Angeles Museum of Natural History, Dr. Thomas Hopkins of the University of West Florida, and Dr. Gerd Schriever of the University of Kiel, Federal Republic of Germany. Steve Nelson from Harbor Branch assisted in the submersible and the habitat.

Dr. Earle has become a recognized authority on marine algae, or seaweed, and has participated in many undersea programs including serving as team leader on one of the 1970 Tektite II missions off the Virgin Islands, participating in dives on the submersible Deep Diver off the Bahamas, and leading a team on the FLARE expedition to the Florida coral reefs.

German scientist Gerd Schriever had participated in previous Hydro-Lab work supported by MUS&T, and worked in the German undersea laboratory Helgoland in the Baltic Sea.

"Marine plant life is as important to the overall ecological system of this earth as plant life on land," Dr. Earle explains. "We know far less about it, of course, but we do know that it serves as the basis of the food chain in the sea, just as terrestrial plant life is the basis of the food chain on land. So far, most of the studies of marine algae have been in relatively warm tropical waters, and at relatively shallow depths, simply because that is where it is easiest to study them. We have learned a great deal about the kinds and varieties of seaweeds in these regions—some of which are harvested regularly for various commercial uses—and SCORE gave us the opportunity to extend our studies into greater depths.

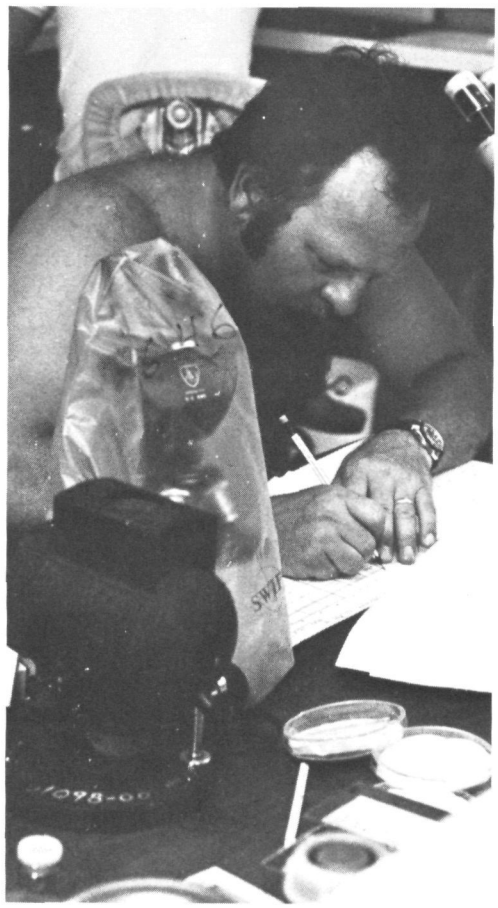
"In particular, the team was interested in finding out how deep the marine plants grow along the reef, and what their relationships to herbivorous fish might be. We wanted to correlate the quality and quantity of light at these depths with distribution of the plants, and collect deepwater plants for cultivation and analysis in laboratories at home."

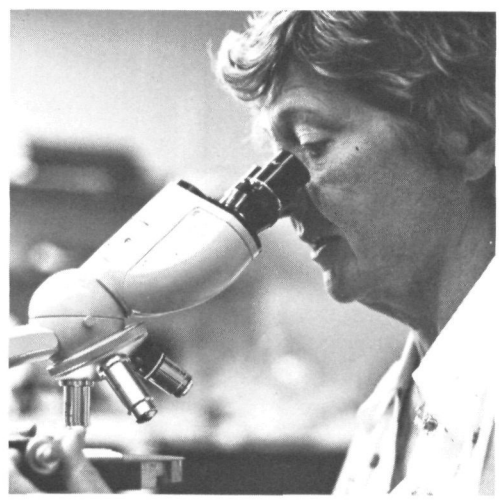
It was during one of her deepwater excursions that Dr. Earle came upon the tiny, light green mushroom-like alga that is new to science. "We know it is a new species," she said, "and we think it may be a new genus. It was very exciting to see it—I obtained specimens on my lockout dives from the submersible, at a depth of 250 feet. Later, the geologists observed the same plant to depths of 500 feet from inside the submersible."

Her assistant on the project, Susan Brawley of the University of California, collected and classified the specimens at the surface as Sylvia Earle sent them up in collecting bags. Doctoral candidate Brawley is cultivating the tiny plant, along with others that Dr. Earle collected, in a laboratory at Berkeley in collaboration with Dr. John West. The scientists are intensely interested in the nature of pigments in the plant, and how it—and other deepwater plants—can live in such low light intensity, at a temperature of about 74° F.

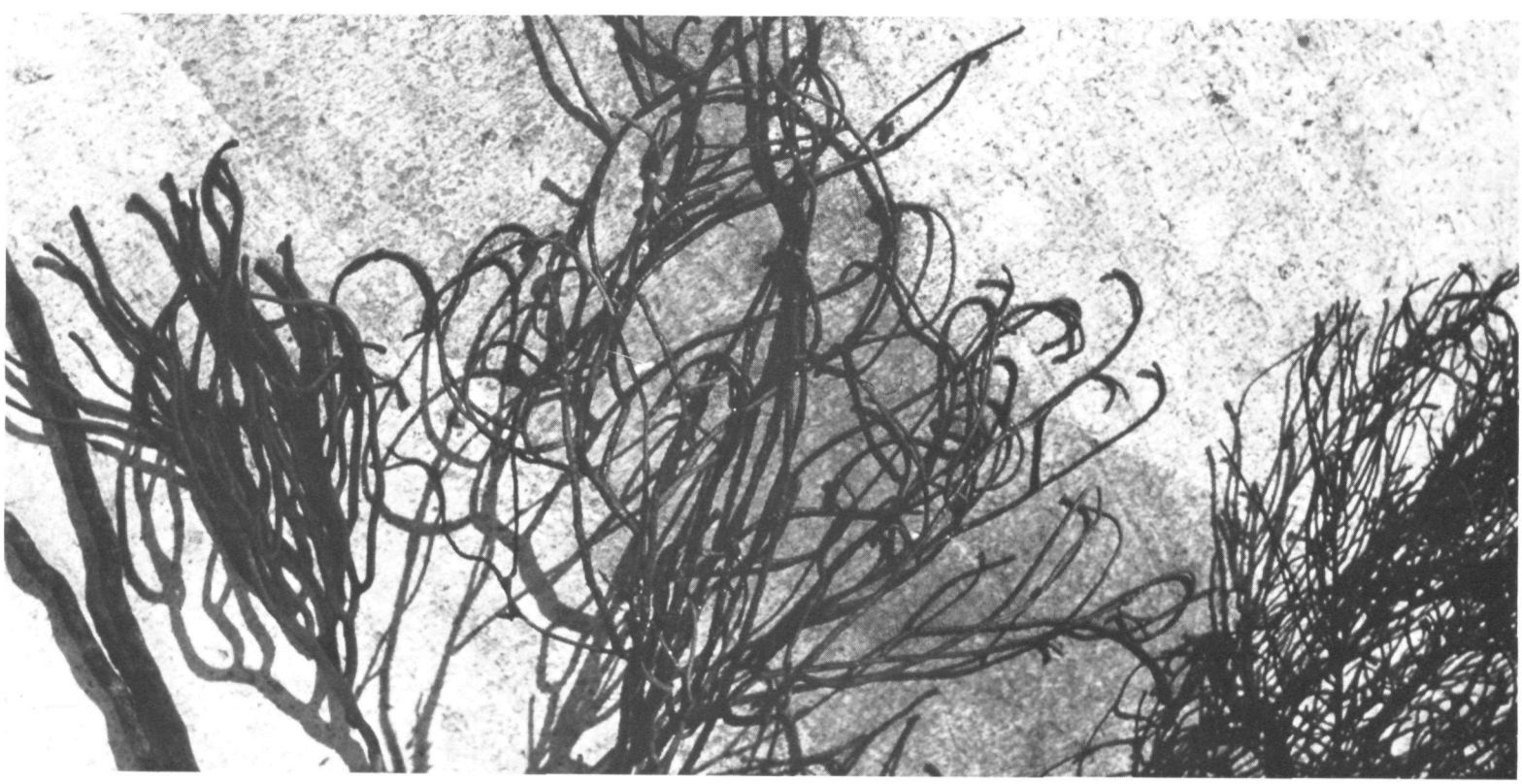
"We would like to determine the maximum depth at which sea plants can grow," said Dr. Earle, "and extend our overall knowledge of the diversity and distribution of the reef plants down to the greatest depths at which they occur."

She was pleased with the time that the new air tables and submersible lockout capability gave her at depth. "We gain new insight into the vegetation of the deep reef when we can observe it for a longer period of time," she said. "Also, we can follow through with an idea that occurs on the spot, and observe relationships among plants or between plants and animals that hadn't been apparent to us before.





Potpourri of SCORE surface scientists: Dr. Richard Philp (above) and Jill Francey (rt.), University of Western Ontario, work on aquanaut blood hematology; Diane Grimm (upper rt.), University of West Florida, examines hard coral; Dr. Francis Haxo, Scripps Institution, studies algae that live inside coral. Below, pattern is formed by sponges, soft corals and algae laid out in the sun to dry.



"Studying the vegetation of a coral reef in 10-minute segments is like studying a forest by visiting it for 10 minutes at a time once a day—you can make collections, and learn quite a bit, but there is a tremendous amount that you miss. You just don't have the time to reflect on what you are seeing."

The team found that some of the algae are very specialized as to the areas where they will grow, while others are quite versatile. "Some algae grow only in deep water—such as the new one, that begins at about 200 feet and goes deeper," she explained. "Others are found only in even deeper areas, or in areas where they are shaded by overhanging coral abutments or cave entrances—areas where our light meters showed extremely low or 'no' light at all. Some of the seaweeds, on the other hand, occur all the way from intertidal areas down at least to 150 feet."

The team also collected red algae for study in the laboratory, seeking better to understand the process whereby red accessory pigments absorb light energy at depths that green cannot. The red pigments then pass the energy along to chlorophyll to facilitate photosynthesis.

Although she is not a specialist in fish, Dr. Earle is interested in the relationships between grazing fish and marine plants. She reported large numbers of grazing fish at the lip of the reef and would be interested in making night dives to find out if there are other grazers there, and to try to determine if the fish live at that depth or primarily go down to forage.

Thomas Hopkins of the University of South Florida, another member of the team, has long been interested in the behavior of a sea creature known as the basket star, as a pollution monitor. Because the basket star feeds only at night, and eats essentially everything—fish eggs, small fish, phytoplankton—his digestive tract contains a good sample of the biological and chemical material of the area. So, Dr. Hopkins reasons, if you know the health of the basket stars, you have a clue to the environmental health of the area. If there is an environmental problem, such as a spill, you can use the basket stars to monitor the effects.

On SCORE, he looked for kinds of soft corals, known as sea whips and sea fans, that are used by basket stars as perches from which to feed. He was interested in the zonation of these animals, as clues to the distribution of basket stars.

"It might be," he speculated, "that when we know enough about the habits of the basket star, we could collect some of the animals, move them to a selected area in 'cages' that would permit them to live but not escape into the environment, and monitor the effects of environmental change by monitoring the health of the starfish."

The fourth team consisted of two American geologists and another scientist-aquanaut from abroad, Jean Jaubert, who is a biologist from the Laboratory of General Biology, Nice, France. The U.S. scientists were Dr. Richard Slater of the University of Northern Colorado and Dennis Hubbard of the University of South Carolina. Jeff Prentice of Harbor Branch did a second stint as habitat technician.

Purpose of this final SCORE mission was to complement the biological studies of the reef-building organisms with a geological study of the reef-building process. The scientists took advantage of the deep-diving capabilities of Johnson-Sea-Link and of deep excursions from the habitat to collect samples of the rock. In the laboratory, they are analyzing the stony skeletons of calcareous algae, corals, and other plants and animals whose skeletons go to make up the reef.

"We wanted to pin down the geological history of the area," said Dennis Hubbard, "and we went about it in three ways. First, we looked at the morphology—the form and appearance—of the wall itself. We can infer a great deal from how a structure looks. Second, we looked at the sediment transport—how much was coming out of the reef, which should be in rough balance with how much is going into the reef. Third, we tried to determine the growth rate, if any, on the face of the reef itself."

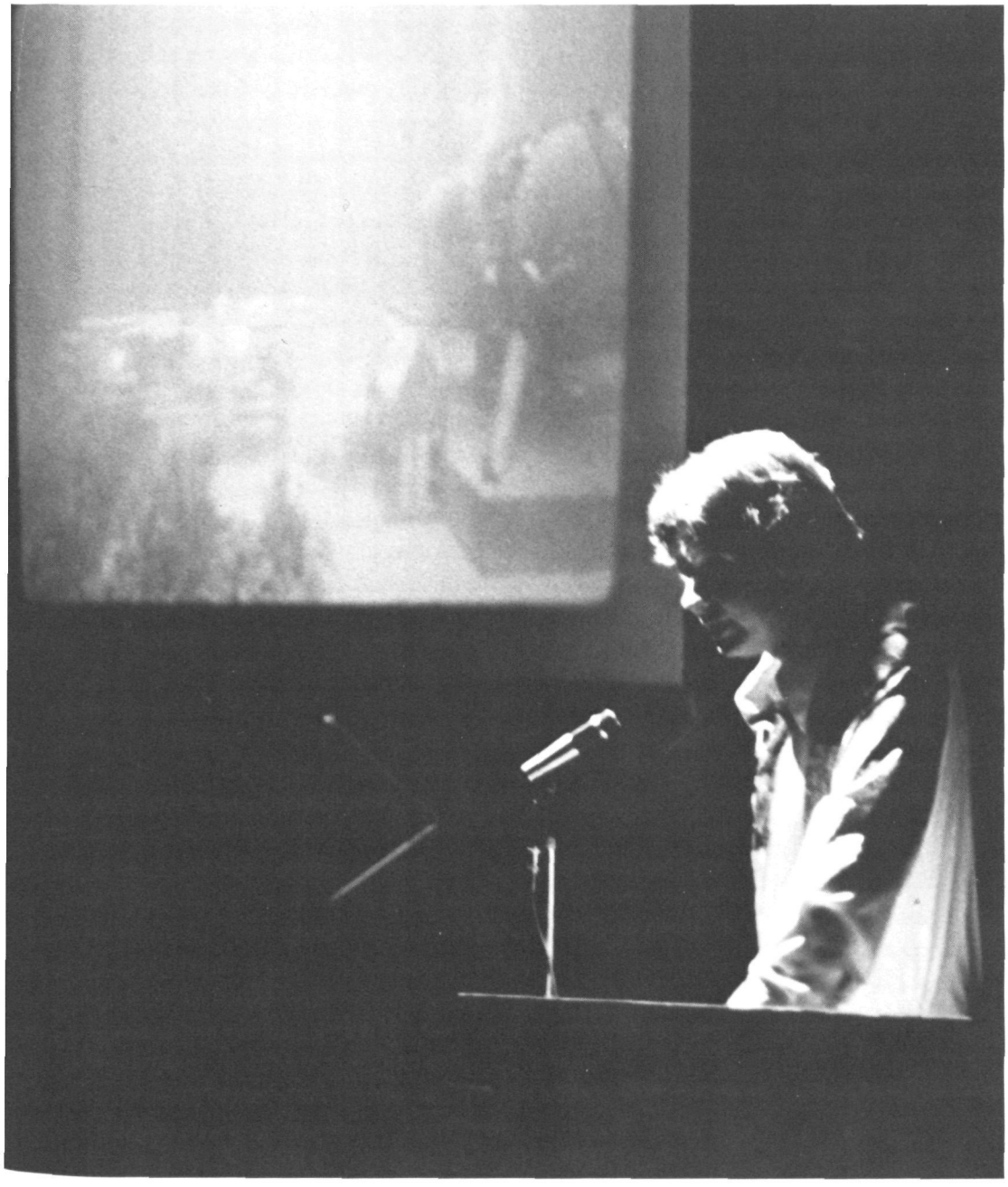
A major point of interest in the geological history is the present-day status of the reef wall—is it eroding away, or is it still growing outward? They collected evidence that leads them to believe that the reef wall apparently is still a live, growing feature.

"We found that there is apparently more sediment going over the wall from the top of the reef than can be found at the bottom of the talus (rocky debris) slope at the base of the wall," said Hubbard. "By putting out sediment traps, we obtained a rough measure of the amount of sediment outfall over the wall. There wasn't enough collected at the bottom to account for all that going over the top. Where might the surplus be going?

Photo: Roland Paine

First there is a strong current there, and that doubtless removes a lot of sediment. But also we found evidence that much of the sediment is becoming cemented on the slope."

This process, called submarine lithification, is a relatively recent discovery of geologists. Dr. Robert Ginsburg of the University of Miami, working with NOAA assistance, has done pioneering work on this process, and found implications for oil prospecting on old reefs on shore as a result of his work at sea. Slater and Hubbard believe that they have found confirmation that this



Harbor Branch operations chief Roger Cook briefs Bahamian Prime Minister Lynden Pindling, other officials, on submersible work.

◁ *Prime Minister Pindling (pointing) discusses SCORE with M. P. Kendal Nottage and party. Below, NOAA's Dr. James Miller talks with Lloyd Bridges, star of TV series "Sea Hunt," during filming of SCORE movie.*

same process is taking place on the Grand Bahama reef, both along the wall and on the talus slope below.

From the standpoint of morphology, they found along the reef wall many platy coral skeletons stacked one on another, strong evidence of an outbuilding or "live" area, rather than of an eroding dead reef.

The rock dating will take time, and they do not yet have the results. If the rock dates from the surface of the reef wall are very old, it will be evidence that the reef is not expanding. "We don't yet know the dates, but we think they will be very young," said Hubbard. "If so, the dates will confirm our other observations on this mission."

The geologists were also pleased by the length of time available to them on the excursions from the habitat. "Geologists need to get back and look at the landscape, and think about its form and shape," said Hubbard. "When you have only 18 minutes at depth, as was true on my earlier missions, you spend a lot of time looking at your watch. With 45 minutes or an hour, you can make careful observations and think about what you are seeing, about what it implies in terms of the reef building processes."

With the termination of that mission at the end of April, the operational phase of SCORE came to an end. Work is continuing in the laboratories to identify, to analyze, and eventually to collate and report the information in definitive form. Not only is this work being undertaken by the aquanauts, but in other laboratories, scientists are benefitting from the SCORE work.

At the University of Western Ontario, for example, Dr. Richard Philp is working with the hematology and blood chemistry of blood samples taken from all the aquanauts, before, during, and after their dives. He and assistant Jill Francey had a corner of the laboratory at the base, where they were investigating the effects of saturation diving on blood cell production and destruction. He is following up on previous work with platelets, which are tiny particles that are present in the blood, where they serve to help prevent bleeding and also form clots that cause thrombosis. In divers, these platelets tend to disappear for a few days after saturation, and he believes that they collect around microbubbles in the blood.

A pharmacologist, Dr. Philp is looking for a drug that will control or reduce this effect. In a previous mission in Hydro-Lab, working with three groups of divers and using placebos and drugs in a double-blind study (where neither subjects nor experimenter knows who is getting the drug and who is getting the placebo) he found evidence of a drug that is useful for this purpose. He is now analyzing the results of his SCORE work for further proof.

At the Scripps Institution of Oceanography Dr. Francis Haxo is working with deep water plants collected for him by the aquanaut teams. He is examining the effects of light quantity and quality on types and abundance of photosynthetic pigments in these plants. He too worked in the shore laboratory on SCORE.

Finally, Dr. Mario Pamatmat of Auburn University, who was present on shore early in April, has been studying the metabolic rates of bottom communities and individual organisms on the reef.

The science of the project is thus well in hand, and SCORE appears to have been successful in bringing together the many pieces of research, from various fields of science, into a comprehensive and interrelated whole, just as is the environment of the coral reef community. As Dennis Hubbard said, "Because of SCORE I don't have two separate and complementary studies of different parts of the reef, I have one overall study of the reef as a whole."

The technology that was used in SCORE represents another step forward in the development of underwater procedures and diving tables that are especially devised for the benefit of science. FLARE, in 1972, first tested the notion of a movable habitat. The Bahama Banks Research Program has consisted of a long-term, thorough analysis of a portion of a coral reef using a basic, austere facility. SCORE has contributed new diving tables using air, a combination of habitat and lock-out submersible, and thus deeper dives for longer periods on air than was previously possible. The next step, to be undertaken in the fall of 1975, will build on some of these advances, and will extend diving technology into a cold-water environment. In every case, the advances in diving technology are made to provide for further advances in scientific knowledge. SCORE was one step forward in this science-technology partnership.

It's in the great tradition

Coastal Zone Management: The Town Meeting Approach

BY MILTON E. SLOANE

John Q. Citizen, long subject to the vicissitudes of local ordinances and private decisions about coastal use, is now finding a forum for expressing his own views about whether a coast should be used for real estate development (above), industry and recreation (right), or other purposes.

An ambitious program to bring about wise and balanced use of the nation's coastal areas—coordinated by NOAA's Office of Coastal Zone Management—is showing promise of having an equally significant side benefit: getting the public involved in government decision-making as epitomized by the New England town meeting.

As coastal states, with the guidance and assistance of OCZM, develop programs to balance competing uses of the nation's seashores, they concurrently are creating opportunities for the broad public not only to make their voices heard, but to take an active role in the actual planning of programs and the making of hard decisions.

Today, more than one-half of the U.S. population lives within 50 miles of the seashore, and the number is rising. During the last quarter of this century, the figure is predicted to swell to four of every five Americans, or 225 million people. Their needs and desires have brought about the need to manage better the use of the coast, for such things as beaches and beach homes, highways, harbors, power plants, oil refineries, wildlife refuges, commercial establishments—and plain everyday living.

As a result of the Coastal Zone Management Act of 1972, OCZM has been charged with assisting coastal stages in developing a program for managing the coast. The Office is headed by Robert W. Knecht, Assistant Administrator for Coastal Zone Management, and provides financial and technical assistance to 34 states and territories. Each state is eligible to receive three annual grants to develop its program and supplemental funds to implement it. The "implementation" funds, however, are made only after the management program has been approved by the Secretary of Commerce.

In developing programs, states must allow the public to participate. The Coastal Zone Management Act declares, "it is national policy to encourage participation of the public, of federal, state and local government and regional agencies in the development of coastal zone management programs." Outlined in federal regulations governing the Act are two key provisions involving public participation. The first calls on states to exchange information among citizen groups, local agencies, and the general public; and the other requires states to establish a procedure that allows the public to review program elements.

In NOAA, the Office of Coastal Zone Management is actively urging citizen involvement in decisions that affect their coastline through a systematic program of public information, education, and participation. The aim, of course, is to determine the public's views and desires on such matters as: How should the coastline be used? What do you like or dislike about the area at present? How should the plan be developed? Who should have management responsibility?

The citizen involvement program, as perceived by OCZM, entails helping states inform their citizens about coastal zone problems through news releases, brochures, and other mass media; to interpret the problems for the public decisions that could change their lifestyles.

The advantages are manifold in allowing citizens to participate in the development program because it enables individual needs to be identified and included in the plan; prevents one interest group from dominating the planning process; allows conflicts to be resolved through broader understanding; and generally results in a better plan.

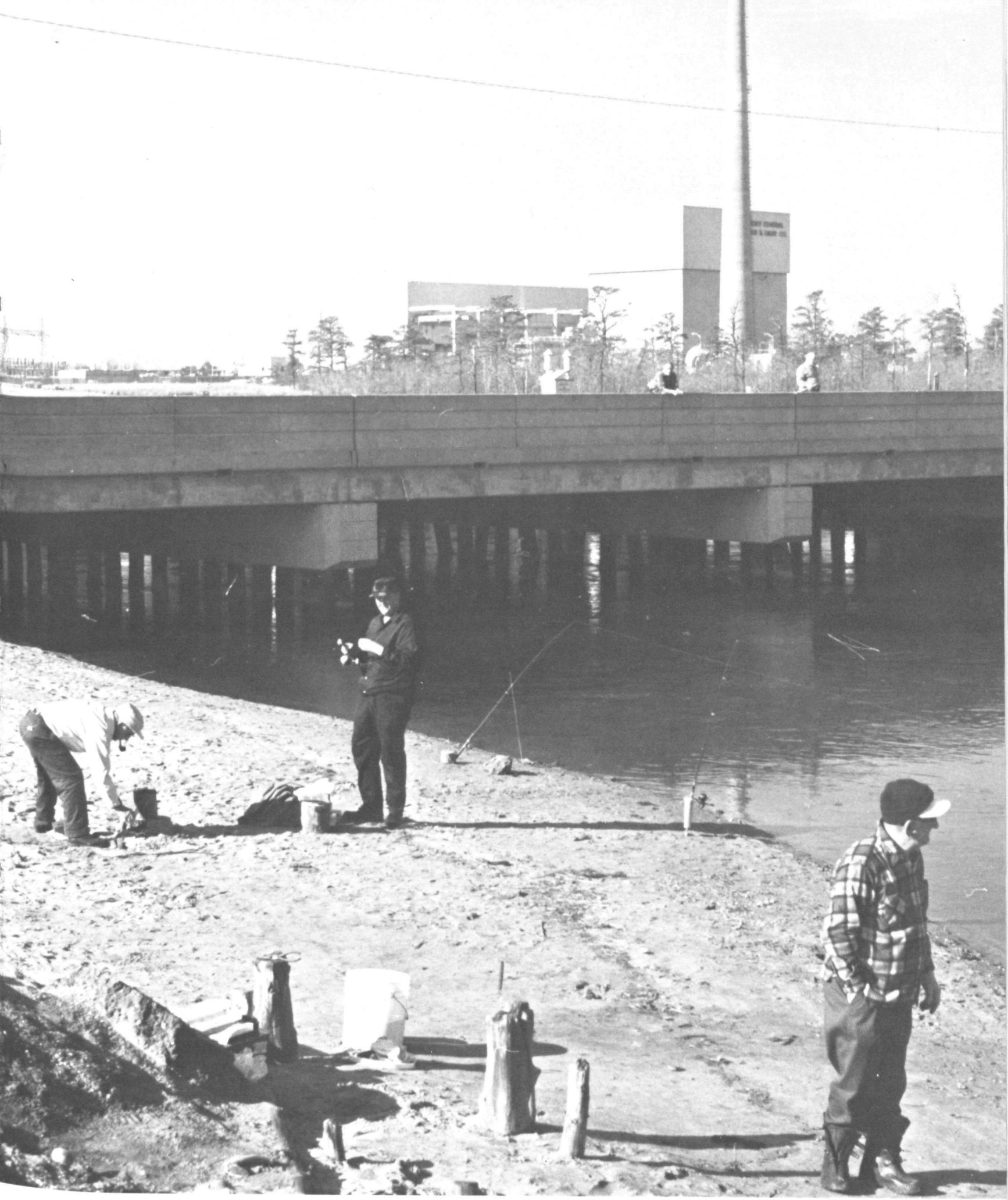
Through NOAA's Public Affairs Office, public informational materials of a general nature—including brochures, film, and radio and television spots—are being provided to coastal states, while states are producing more specific materials that strike at the very heart of citizens' concerns.

In North Carolina, for example, state officials are pursuing two basic steps in arousing citizen participation. According to North Carolina's public participation handbook, "The first is information—making sure that the individual understands the problems and the procedures. The second is involvement—getting the individual to take an active part in evaluating present land uses and planning for future uses.

"In order to secure effective and widespread public participation, it is necessary to give equal emphasis to both steps on a continuing basis, for it accomplishes little to inform the citizen without encouraging him to participate in the planning process, and even less to get him involved if he is not informed."

To do both, North Carolina is using a wide variety of mass media techniques, including radio and television, newspapers,

Photography by Friedrich Hoelzl (Others as credited)



magazines, direct mailings, handouts, meetings, exhibits, fairs, and personal contacts. It's also using opinion-sampling techniques to get the view of a cross section of citizens, who represent each geographical area of the state as well as various economic, social, ethnic, and cultural interests.

Under production, or in the planning stage, are radio spots and newspaper columns presenting citizen questions on coastal land uses; printed notices on the need for citizen involvement; a documentary showing past and present coastal land uses; discussion programs on radio and TV with opponents of shoreland uses; and a series of weekly interviews with citizens regarding the coastal management program.

One suggestion for an interview segment would feature state health department officials discussing sources of the local water supply, with emphasis on coastal zone problems in meeting the growing demand. The officials might also discuss current methods of disposing of coastal residents' sewage and trash, the limits on increased use of these methods, and the problems in providing acceptable alternatives if the coastal population continues to rise.

North Carolina is also using agricultural extension agents to expose the CZM program to civic groups and local leaders using visual presentations. To provide additional information, the state has established a telephone "hotline" which citizens can call collect, and is printing a regular coastal newsletter. In addition, the state is distributing a pamphlet of coastal management, has several specialized reports available on coast-related subjects, and has created a speakers' bureau to offer to civic and service clubs.

To arrange for a speaker, all the head of a group has to do is call the Coastal Resources Commission or fill out a request-for-speaker form. The commission will schedule a speaker based on the group's choice of topics, which range from "The Provisions and Impact of the Coastal Area Management Act (CAMA)" to "CAMA and Areas of Environmental Concern."

The speakers' bureau consists of commission members, advisory council staffers, extension service personnel, and state government officials—including CZM Public Affairs Director Stephen L. Meehan.

About the state's public program, Meehan had this to say: "In North Carolina we are using every means possible to inform and involve the public in preparation of the coastal management plan. We see this program as an opportunity to create the participatory type of government that existed in the early years of our country."

To the extent possible, North Carolina hopes to involve high school students in making those decisions with which they will have to live in the future. Regularly scheduled slide shows will be presented in junior and senior high schools by qualified individuals involved in the planning process. Direct contact will be made with student leaders, and all students will receive printed materials distributed by the state. Students will also be encouraged to develop ecological posters and exhibits to display in government buildings, local businesses, and other prominent establishments.

Photo: Bob Williams

Three Skipjacks—part of a fleet of the last sailboats used in America as commercial fishing vessels—tie up in Market Slip, Annapolis, Md. The state capital is on Maryland's estuarine coast, Chesapeake Bay.

Other methods which the state is considering using to publicize its program are township meetings, neighborhood discussions, personal surveys, and citizen advisory panels.

For the record, local governments are required by the state to outline the methods used to gain public participation and to summarize the extent of citizen involvement. To meet the requirements, the state suggests that counties:

1. define the responsibility and role that citizens will have in developing the plan:
2. identify and develop methods to contact public interest groups;
3. determine each group's attitudes toward land use and environmental problem solutions.

The biggest problem North Carolina has discovered in exposing its coastal program is that the press does not have enough staff to do indepth reporting for the average citizen. So, the state is using professional writers from its Natural and Economic Resources Department to provide the media with general information.

Next door to North Carolina, meanwhile, South Carolina has been putting together its own campaign to promote public involvement. The four-phase campaign is one of the most ambitious the state has ever conducted.

Under Phase One, which began last summer, the state is surveying existing attitudes and perceptions along the coast; identifying special interest groups; establishing commu-

Industry, agriculture, commerce, and a host of other uses—such as recreation—vie for space on America's increasingly crowded coastlines.

nication with the public; acquainting the public with state and federal coastal management laws; explaining coastal zone problems; and obtaining agreement on the coastal boundaries.

Phase Two will focus on collecting, analyzing, and disseminating information about the coast; understanding the public's views of the coastal problems; and expanding the list of public contacts. Phases Three and Four will concentrate on explaining alternative coastline uses; achieving acceptance of the CZM plan by residents and the Secretary of Commerce; and laying the groundwork for implementation.

The media approaches the state is using vary from direct mailing to television and radio, newspapers, magazines, public hearings, and personal interviews. South Carolina has had little difficulty targeting an audience to receive its "message" or finding someone to prepare it. The entire state population is the audience, and the state's Information and Public Affairs Division will handle most of the publicity. That division was honored recently at an awards banquet in Annapolis, Maryland, as "the best of its kind in the nation."

Public Affairs Director Louis Hern, commenting on the state's program, said: "South Carolina's public participation efforts are geared to the use of a media plan to reach the population on a graduated basis. We have directed our efforts first through the media to heighten public awareness, and then to convert that awareness into active participation." So far, he added, "our program is well on schedule."

In Louisiana, the theme is the same, only the approach is different. The public participation program there is based primarily on a regional approach to focus attention on the political, cultural, economic, and demographic diversity present in the coastal area. According to the proposed program, both the plan and the planning participants have been divided into groups and stages. At each stage of the process, each group of participants will be involved to varying degrees.

In Stage I, for example, the state will conduct a broad media campaign to provide information to the public as well as to state and federal agencies. The campaign is designed to inform the public about coastal zone management, what it means to them, and ways in which they can participate. The campaign will consist of all the conventional media techniques, including a speakers' bureau and informational site visits.

Midway through the first stage, the state will contact local meeting sponsors to set up several public information/participation workshops. According to Louisiana's timetable, Stage II will focus on planning information seminars to familiarize the public with components of the plan and to gain their support. The media campaign will continue during this stage, and alternatives to coastal uses will be described.

The third and final stage of the Bayou State's program will be directed mainly toward holding public hearings on the overall coastal management plan among various concerned "publics." At critical points in each program phase, an evaluation will be made to determine:

1. if the public has had ample chance to participate
2. if conflicts have been resolved
3. whether public support has been generated
4. whether citizen groups have become better informed
5. if a better plan has been developed.

Joel Lindsey, director of public affairs for Louisiana's Coastal Resources Program, explains: "Our approach in Louisiana is to get local people to invite us into the community to explain the coastal zone management program and to help us disseminate information through the mass media. At present, we are working through established statewide organizations—such as the Louisiana Municipal Association and the Police Jury Association—to set up regional meetings with their members, to explain the program and to tell how they can get involved."

Across the Pacific, the state of Hawaii recently contracted for and received a 28-page consultant's report—financed in part through a coastal zone grant—outlining common approaches to a citizen's involvement program. Other states, too, have developed and begun public participation programs, including Wisconsin, Texas, Georgia, Maryland, Virginia, Delaware, and Massachusetts, among others.

No two states have identical public participation programs, nor should they. The character of each state differs, in its people, its problems, its needs. But one element remains constant in all of the state programs: the commitment to encourage people to take part in making decisions which may determine for generations to come how the coasts of this nation will be managed and used.

They call it Sea Echo

A Thousand Leagues Over The Sea

BY JOAN VANDIVER FRISCH

While seagulls circled gracefully against a backdrop of jagged cliffs and windblown clouds, an immense spiderweb-like structure recently took shape on an uninhabited and rocky beach at San Clemente Island, California. The new resident, a powerful skywave seascatter radar designed to monitor sea conditions up to 2,000 miles away, began tests this summer. The high-frequency radar is part of Project Sea Echo, a cooperative research study conducted by NOAA, the Institute of Telecommunications Sciences, and the Naval Research Laboratory.

"During the project's Phase I, we are remotely sensing a large sector of the North Pacific, collecting sea echo data and interpreting the radar's echoes in terms of wave heights, velocity, and direction," explains Dr. Donald E. Barrick, chief of sea state studies at the Wave Propagation Laboratory, one of NOAA's Environmental research Laboratories in Boulder, Colorado.

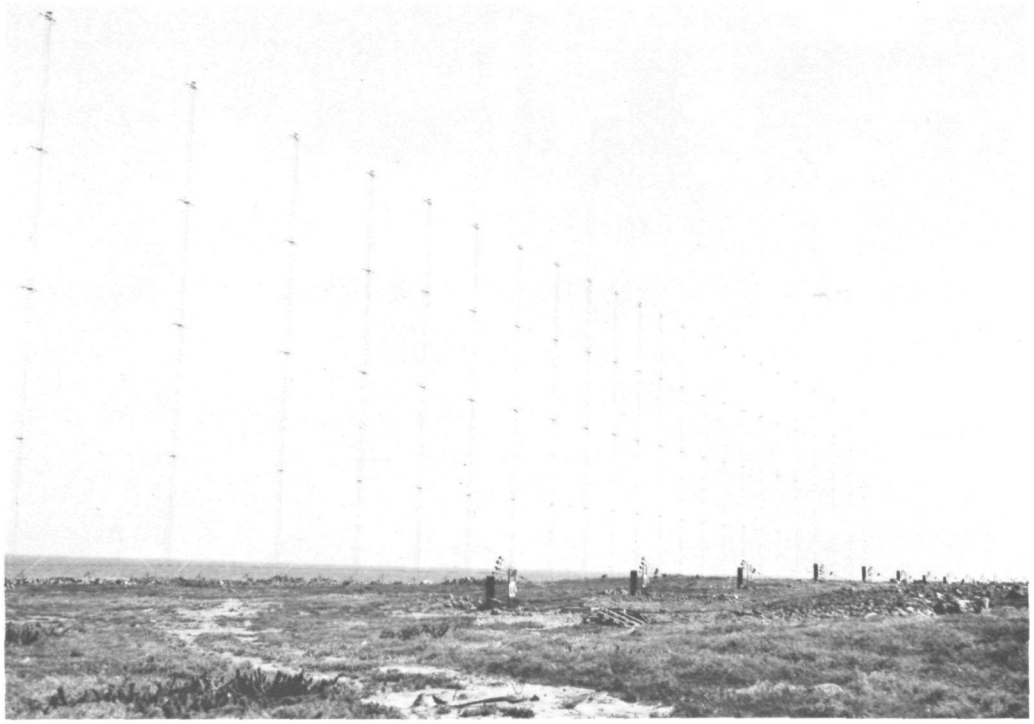
According to Jack Snider, the Sea Echo project leader, the data will be compared with known on-site sea state observations gathered by Canadian weather ship and two NOAA environmental buoys, permanently stationed at three points in the North Pacific.

"Within a year, we hope to begin Phase 2 of Sea Echo—converting the research phase of the project to a quasi-operational mode in which the radar will be ready for routine monitoring of the North Pacific by January 1, 1978."

Phase 2 is a team effort between the Environmental Research Laboratories and the users of the data—NOAA's National Weather Service and the U.S. Navy's Fleet Numerical Central at Monterey, California.

Until now weather forecasters have been limited in their ability to predict accurate wave conditions and wind speeds at sea. Fishermen and helmsmen of cargo ships and pleasure craft often have had to assume the role of amateur weathermen, and guess from past experience what may be happening beyond the ocean's horizon.

To plug this gap of sea state knowledge, the U.S. Navy has been using sophisticated computer models to predict ocean surface conditions from meteorological information. And NOAA's National Weather Service has routinely issued sea-state information on a global scale for approximately a decade by mathematically modeling the atmosphere and sea-air interactions. Surface winds over the oceans are first estimated by the weather scientists from mathematical "building-block" models of the atmosphere.



Scientists with NOAA, the Naval Research Laboratory, and the Commerce Department's Institute for Telecommunication Sciences are monitoring distant sea conditions in the North Pacific for the first time this summer with a specially designed skywave radar (above) which resembles a monster radio station, and consists of a quarter-mile-long row of 150 foot towers and a spider-web of antenna wires; (right) green seas on deck.

These estimates are used, in turn, to determine the approximate wave conditions of the oceans.

Even with the advent of space-age tools like SMS/GOES*, which can monitor large maritime storms and other weather systems as they develop, fishermen, ship routers, and a host of others still need real-time information on what the ocean and atmosphere are doing at smaller scales of time and space. NOAA and Navy models of the atmosphere are limited by the sparseness of accurate meteorological data over the open sea, and by gaps in basic understanding of the energy exchange processes between the atmosphere and ocean, and within the sea. Thus far, the computer models of these processes have had to be simpler than the environmental processes they try to simulate.

But the San Clemente skywave radar antenna will enhance that view. By remotely sensing wave heights, lengths, and direction over larger areas of ocean surface, the radar will permit much of the North Pacific to be

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* *From Synchronous Meteorological Satellite, NASA's designation for the development spacecraft; and Geostationary Operational Environmental Satellite, NOAA's designation for the operational system.*

observed with a continuity in both space and time never before possible. By feeding this information into computers hooked up to the radar, Sea Echo scientists can more precisely estimate the direction and velocity of the ocean surface wind fields. This information will provide the basis for improved forecasting of new wind and wave conditions, and routinely supply a comprehensive description of the present and future marine environment over large areas.

The target area of Project Sea Echo—the Gulf of Alaska—was selected for its severe and changeable weather, and its role in America's energy plans. The Gulf will be crossed by the sea leg of the Trans-Alaska Pipeline, and includes proposed oil leasing areas on the Alaskan Continental Shelf which are the subject of an intensive environmental study being conducted by NOAA's Environmental Research Laboratories for the Interior Department's Bureau of Land Management.

Specifically, the radar-scanning technique employed at San Clemente Island during Phase 2 will be capable of helping scientists:

- predict destructive wave activity along the northwest coast of America,
- infer average wind conditions near the ocean surface for the prior 6-to-24-hour period,
- improve warnings to coastal areas and ships likely to be damaged by the waves,
- predict where and when high waves will reach other regions.

While Barrick and his colleagues have been ironing out the technical problems associated with construction and operation of the skywave seascatter radar, the scientific research has been accompanied by a thorough probing of the system's possible economic implications.

R. S. Rhodes and Dr. R. B. Chadwick, both of the Wave Propagation Laboratory, have estimated potential savings of tens of millions of dollars annually to U.S. interests when a twin-site seascatter radar system scanning both the Atlantic and Pacific Oceans becomes fully operational.

According to their comprehensive study*, the greatest potential economic savings from improved sea-state data would be realized by the commercial shipping industry. Faced with average daily operating costs of between $10,000 and $20,000 for transoceanic crossings, American shipping interests could save millions of dollars per month if full advantage cuold be taken from improved ship routing and steering when underway.

Better knowledge of sea state conditions would also have a significant impact on the U.S. commercial fishing industry with even modest improvements in operating conditions.

"Since a large fraction of at-sea time is spent in transit to and from the fishing area, labor and fuel costs are needlessly incurred each time a boat reaches a fishing area only to find sea conditions too rough for fishing," the report explains. "About $8 million could be saved nationally each year from improved environmental data by this $600 million per year industry."

Offshore petroleum operations, including drilling and ship loading and unloading, are another segment of the U.S. economy which depend upon quality and timeliness of forecasts of sea conditions and the surrounding environment, especially in the hostile waters of the Gulf of Alaska. As proposals to construct deep water offshore terminals for unloading petroleum products from supertankers flow in, the need for greatly improved statistical data and sea-state forecasts for each site increases. Rhodes and Chadwick estimate an annual benefit to the petroleum industry nationally of at least $14 million from accurate sea-state information.

Offshore mining is directly affected economically by potential use of over-the-horizon skywave radar. While its growth in the immediate future is very uncertain, the rate of new investment into the field would accelerate if the environmental risks were better known.

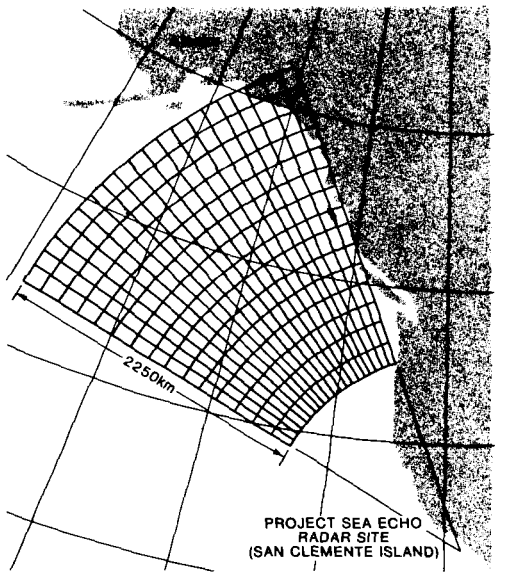
According to the Rhodes and Chadwick report, the industrial, recreational, and private facilities along America's coastline sustain over $500 million damage annually from high tides and waves spawned by severe storms. While scientists can do little or nothing to reduce the severity of these natural occurrences, considerable reduction in property damage and loss of life could be expected from better knowledge of the character, location, and timing of the injurious storms. The Wave Propagation Laboratory study estimates an annual reduction of losses of over $4 million in property damage and a number of lives saved through improved sea-state forecasting along the nation's coastlines. And an additional $8 million could be saved each year by ocean-related recreational facilities.

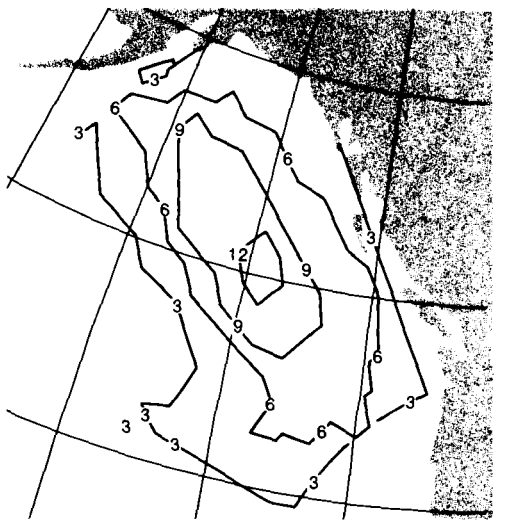
While economic benefits can be attached to various segments of the American economy, several users of sea-state information would benefit in other than economic terms. For example, the ability to observe oceanic conditions continuously and remotely would have great impact upon the effectiveness of U.S. Naval operations and surveillance systems. Even in routine peace-time operations, the Navy uses automated computer global weather models for optimum ship routing for savings in transit times and fuel costs, recommended ditch headings along selected air routes, and underwater and surface surveillance systems.

Search and rescue operations of the U.S. Coast Guard vary, depending upon the location of the accident and the weather conditions. While a dollar value cannot be attached to such operations, accurate sea-state information would benefit search and rescue operations through improved operational efficiency and effectiveness.

"The San Clemente radar's use is not intended to locate ships in distress, but rather to aid the Coast Guard in determining whether to send a helicopter or a cutter to the rescue scene, based upon the radar's ability to assess the sea state in the emergency area," says NOAA's Barrick. However, he points out that it will require two or three years of skywave radar operation to achieve such indicated levels of benefits, and for people to learn to use and trust the information supplied by the newly developed instrument.

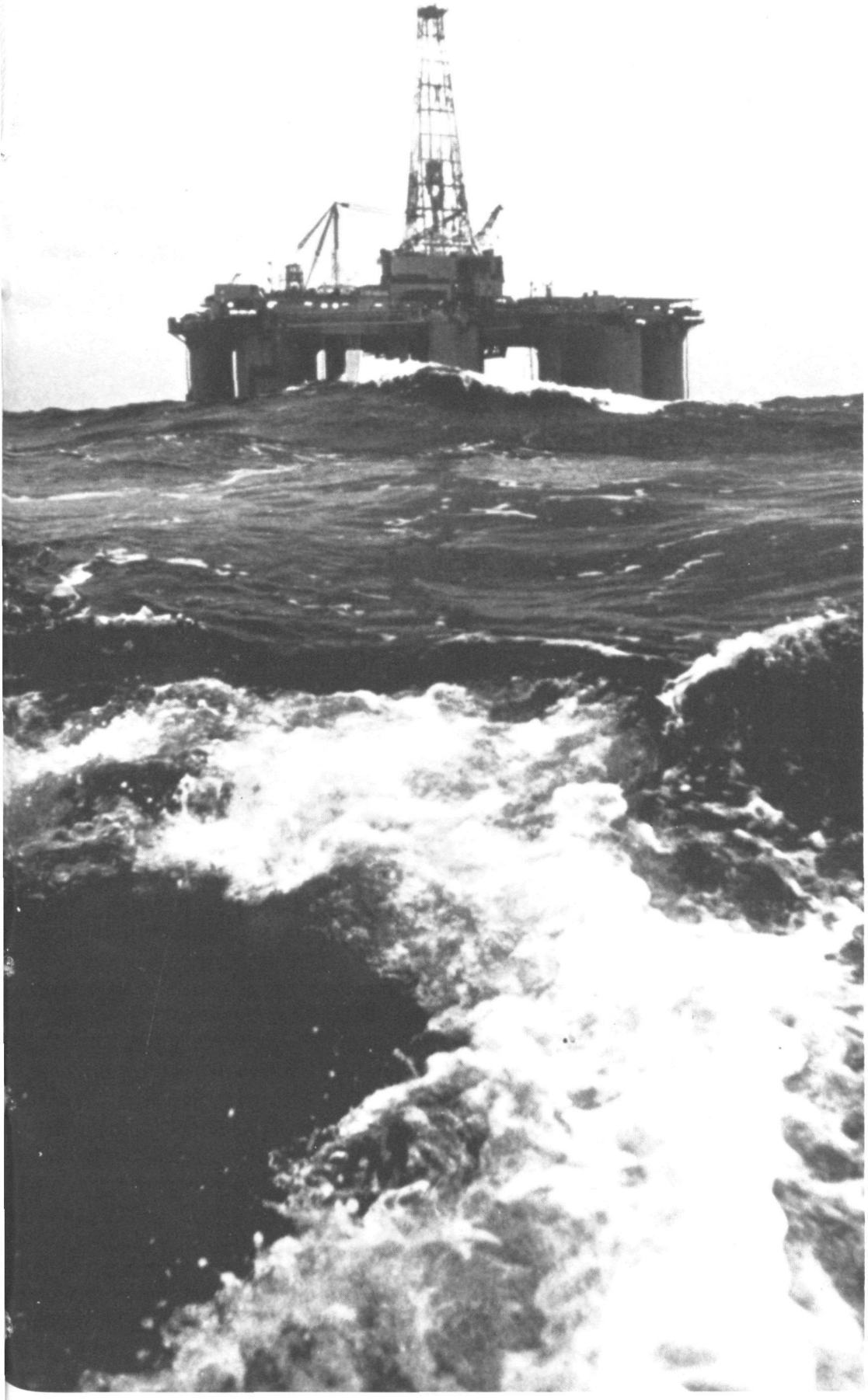
Project Sea Echo is guided by an interservice group consisting of NOAA's Barrick, Douglass D. Crombie, Director of ITS, Dr. Robert W. Bogle, research physicist for the Naval Research Laboratory, and James H. Headrick, manager of the Naval Research Laboratory's high frequency radar branch. Crombie is credited with the discovery in 1955 that long wavelength radar had a unique capability to sense the character of the sea. A group of engineers at Crombie's





Skywave radar (top) scanning a 1,550 nautical-mile-long sector of the North Pacific Ocean, will be able to "zero in" on any of 400 designated 80-by-80-mile patches of ocean shown on this computer-generated display; (above) a computerized map showing regions of differing wave heights within the North Pacific; (right) offshore petroleum drilling depends upon high-quality and timely sea conditions.

* Economic Appraisal of Real-Time Synoptic Sea-State Measurements by Over-the-Horizon Radar, *NOAA Technical Report ERL 299-WPL32, May 1974.*



Commerce Department laboratory under Lowell Tveten built and installed the sophisticated Sea Echo System.

Headrick and his group have performed extensive long range sea measurements with their powerful MADRE radar, located on the Chesapeake Bay. Theoretical and computer-oriented analyses are being done in his organization.

While other government-sponsored and university groups have explored the technology of remote ocean radar sea sensing, the NOAA and Navy team, by pooling their resources, have been able to put together the only high-frequency radar expressly designed for this purpose.

The Sea Echo radar, resembling a monster radio station more than a typical radar, stands on a rocky shoreline at the north end of San Clemente Island, a test facility operated by the Naval Undersea Center in San Diego, 90 miles off the California coast. The prominent antenna consists of a quarter-mile-long row of 150-foot towers and a spider-web of antenna wires. The sophisticated electronics and a full-size computer are housed in trailers. Because of the remoteness of the site, power is supplied by three diesel generators.

From its perch on the north end of the island, the 1,200 foot (366 meter) long by 400 foot (121 meter) wide antenna scans a 1,550 nautical-mile-long (2,500 kilometer) sector of the North Pacific Ocean and Gulf of Alaska. The radar's signals will be able to observe the coast of California, Oregon, Washington, and British Columbia as well as a wide section of ocean in the Gulf of Alaska. The Sea Echo radar will also be able to "zero in" on any of 400 designated 80-by-80-mile patches of ocean within the antenna's range as far away as the westernmost tip of the Aleutian Island chain.

Unlike the familiar microwave radars operating with short wavelengths and "dish" antennas, the novel radar employed in this project uses very long wavelengths. At these long wavelengths signals are reflected by the ionosphere to great distances over the horizon. (This phenomenon is familiar to motorists whose AM radios can pick up far-distant stations, particularly at night.) However, the most important aspect of the long radio wavelengths used is that they exactly match the wavelengths of the ocean waves. The use of this effect makes the Sea Echo system very sensitive to the conditions of the sea. Some of the sea-scatter radio energy returns to the radar over the same path. A computer at San Clemente records the time delays for the echo return as well as the echo frequencies, and analyzes the way the returning echo has been scattered at the ocean surface. From this information the computer produces contour line maps showing differing wave heights, directions, and periods within the region scanned with as little as an hour and a half of echo observations.

Thus, Navy and NOAA scientists are learning how to sense the changing moods and motions of distant regions of the ocean, and monitor them with a radar beam that reaches a thousand leagues over the sea.

Building a data base for international management

The Watch On Our Fisheries

*BY KENNETH SHERMAN

It was June 1974 in Halifax, Nova Scotia, and the discussion was heating up. The delegation from Poland strongly defended its recommendations for relatively high quotas for the catch of mackerel off New England and had scientific data to back up its recommendations. The delegation from the U.S. pushed for lower quotas, and it, too, had scientific data to back up its position.

Both sides had come to the meeting of the International Commission for the Northwest Atlantic Fisheries (ICNAF) with estimates of the total annual catch level required to maintain the stocks and maximize catches, but their estimates differed appreciably. Finally, Dr. Bradford Brown of the National Marine Fisheries Service, Northeast Fisheries Center, suggested that both sides calculate their estimates of population size together, using a portable computer terminal that the U.S. delegation had brought to the meeting. Via commercial phone link to their data bank, Dr. Brown and two other Center scientists, Dr. Vaughn Anthony and Dr. Emory Anderson, programmed population analyses of the most recent mackerel data from assessment surveys and catches of the Soviet, German, Polish, and U.S. fleets. Working with them were Dr. Andrew Paciorkowski of Poland's Sea Fisheries Institute, Dr. Albrecht Schumaker of the Institute of Sea Fisheries in Hamburg, FRG, and Dr. Emilio Cadima of the Food and Agriculture Organization, Rome.

The joint analysis headed off an impasse that could have lead to serious difficulty in the setting of mackerel catch limits. Ultimately the group came up with acceptable recommendations for total allowable catches which were approved by the Commission and should protect the resource from excessive overfishing.

Similar deliberations take place on the west coast. Recently Dr. Dayton L. Alverson, Director of the Northwest Fisheries Center, led a U.S. delegation to bilateral meetings with Soviet scientists to discuss the conditions of fish resources off our northwest coast. Attempts were made to reduce the fishing on several stocks that are overfished. Based on available stock assessment information, scientists of the two countries agreed to recommend that the total annual catch of Pacific hake not exceed 150,000 metric tons per year. The estimate will be revised annually based on changes in fishing effort and the condition of the stock as measured by Soviet and U.S. scientists.

Discussing protocols for plankton sorting at NMFS Narragansett laboratory are (l. to r.) David Kramer, NMFS; Dr. Leonard Eyzemont, Plankton Sorting Center, Szczecin, Poland; Robert Marak, NMFS; Dr. Thomas McKenney, NMFS; Dr. Francis Ferrari, Smithsonian Oceanographic Sorting Center; Dr. Idzi Drzycimski, Plankton Sorting Center, Szczecin, Poland.

More such quotas are needed for fish stocks on a worldwide basis. Concern over the depletion of food resources reflects a crisis of global proportion. The world's present crop of commonly used fish and shellfish is about 70 million metric tons a year. At the present rate of increasing harvests the maximum sustained yield, now estimated at about 120 million tons of conventional species annually, could be reached by 1980. Clearly, the era of rapid expansion of global fisheries is coming to a close. We now need to focus on improving systems for management and allocation of the global fish resource, bring those stocks now overfished back to former abundance levels, and carefully assess the condition of other stocks now subjected to increasing fishing effort.

Fish stocks of the U.S. coast are a vast renewable resource. The annual harvest by U.S. and foreign fishermen currently averages about seven million metric tons, valued at $9.0 billion retail. The potential catch has been estimated at 10 to 20 million metric tons worth at least $15 billion retail. These resources are subject to competitive harvesting by foreign and domestic fishermen; 14,000 U.S. vessels over five gross tons and up to a thousand foreign vessels, most over 250 tons, fish off the U.S. This situation has led to overfishing of at least 10 major commercial stocks (Alaska pollock, California sardine, haddock, halibut, herring, ocean perch, Pacific mackerel, sablefish, yellowfin sole, yellowtail flounder), resulting in serious economic consequences. For example, overexploitation of the California sardine and the haddock off New England has resulted in an accumulated loss to fishermen in excess of half a billion dollars as of 1974.

International agreements are becoming increasingly necessary to allocate resources fairly among the various nations while preventing overfishing. For these agreements to be successful, they must be based on sound data. NOAA's Marine Resources Montoring, Assessment, and Prediction (MARMAP) program conducted by the National Marine Fisheries Service, is able to provide

**Mr. Sherman is Chief of the National Marine Fisheries Service's Resource Assessment Division*

much of the necessary information.

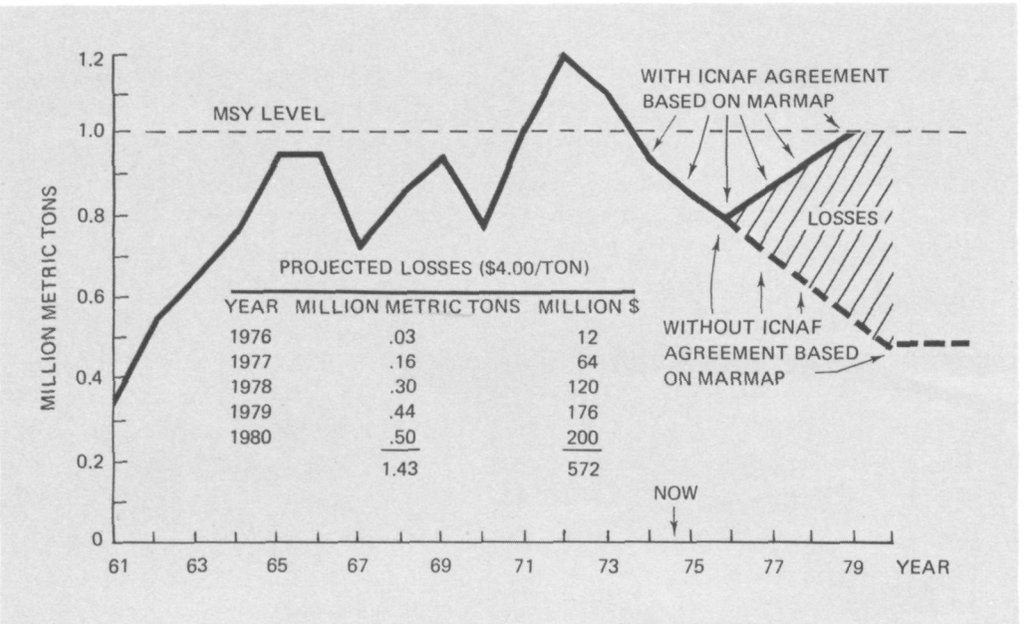
MARMAP is a nationwide resource assessment system that annually provides forecasts and warnings of changes in fish and shellfish stocks. In addition to domestic fishery management uses, MARMAP stock forecasts support the United States in negotiations for management and allocation of fishery resources under the terms of six international commissions and 10 bilateral agreements.

To prevent damage to fish and shellfish stocks, the United States makes assessments to establish catch quotas in complex fisheries taking many species. ICNAF uses MARMAP assessments in regulating major international fisheries off the northeast United States. Regulations in this area are based on concepts developed by U.S. fishery scientists at the Northeast Fisheries Center for treating the resource as a whole rather than on a stock-by-stock basis.

Prior to 1960, the area off New England managed by ICNAF yielded less than half its estimated maximum of about one million metric tons per year (excluding menhaden, shellfish, and underutilized species). In the late 1960's, total U.S. and foreign catch began to approach a million tons a year and by the early 1970's had exceeded a million tons. ICNAF countries agreed to limit their catches beginning in 1974 to forestall an inevitable collapse of the fisheries. The objective of the three year program is to stabilize the stocks and initiate recovery during 1976. Without this type of agreement in the future it is likely that losses from 1976 through 1980 could reach about 1.5 million metric tons and $600 million, with about half of the loss borne by U.S. fishermen. MARMAP stock assessments, including fishery analyses and surveys, were used to support U.S. recommendations in negotiating this agreement.

Regulation of fisheries in one area often tends to increase pressure in another area. For example the regulation of fisheries for restoration of the stocks in the ICNAF area in the Atlantic is forcing foreign fishing vessels to turn to fishing grounds off the U.S. in the Northeast Pacific. In another instance, the catch of yellowfin tuna in the Eastern Tropical Pacific is now regulated, and as a consequence skipjack tuna stocks in the Pacific and yellowfin stocks in the Atlantic are being subject to increasing pressure.

At present, the means for requiring other nations fishing off the U.S. to provide population estimates for stocks they are exploiting is limited. Off the northwest and Alaskan coasts, in the Northeast Pacific and the Eastern Bering Sea, stocks of salmons, and other species are being subjected to increasing fishing pressure from Japan, the Soviet Union, and Korea. The situation is expected to change in the near future with extended jurisdiction over U.S. fishery resources, perhaps out to 200 miles. At that time the U.S. will be required to insure that foreign fleets which are allowed to continue fishing do so in a manner that will not conflict with U.S. fishermen nor be prejudicial to continued optimal yields.



PROJECTED LOSSES ($4.00/TON)

YEAR	MILLION METRIC TONS	MILLION $
1976	.03	12
1977	.16	64
1978	.30	120
1979	.44	176
1980	.50	200
	1.43	572

Photo above: US-USSR bilateral scientific meeting discussing fish stocks in North Pacific. Dr. Dayton L. Alverson, NMFS (third from left) headed U.S. delegation.

Graph below: Trends of catch decreases and projected recovery in ICNAF regulation areas off the New England coast 1881-1979.

The principal elements of the MARMAP system are resource surveys, analyses of catches by commercial and sports fishermen, fishery oceanography, and fishery engineering. Updated stock assessments are produced from analyses of resource survey results, catch statistics, biometric data (age, growth, fecundity, recruitment, and mortality rates) plus information on environmental and food chain conditions. The seven NMFS Fisheries Centers—Woods Hole, Sandy Hook, Beaufort, Miami, Galveston, La Jolla, and Seattle—carry out MARMAP's surveys and analyses.

Fishery scientists, oceanographers, and technicians at these facilities work closely together to make the program successful. For example, Fred Nichy and Joseph Devenny, fishery scientists at the Northeast Fisheries Center, endured the slashing and cutting spines and tails of the spiny dogfish while tagging some 2,000 specimens on a recent MARMAP assessment survey. This effort contributed to the first assessment of the dogfish population off New England; Dr. Marvin Grosslein of the Center estimated the total biomass at 200,000 tons. Under the guidance of Dr. Robert Edwards, Center Director, a number of other major fishery investigations are underway, collecting and analyzing data that are used to provide the assessment information needed for setting Total Allowable Catch (TAC) levels for flounders, cod, haddock, herrings, mackerels, and other species now regulated by ICNAF. The TAC's are set with an overall objective of maintaining the productive capacity of the fish biomass off the northeast coast. The Center uses the R/V Albatross IV on MARMAP surveys that are conducted annually in spring and autumn to measure changes in the abundance of important fish stocks inhabiting the continental shelf from Nova Scotia to Cape Hatteras. The Albatross IV is joined by Soviet, Polish, German (both Germanys), Canadian, and French vessels that survey the shelf jointly off New England and

Large Japanese factory trawler Yamato Maru with pollock catch in East Bering Sea. Huge catches by ships such as this are reducing stock of several species. Management protocols for returning overfished stocks to former abundance are being developed with aid of MARMAP information provided by NMFS scientists of Northwest Fisheries Center.

northward to West Greenland. The resulting survey data has application not only to ICNAF and other management agencies, but is also used widely by the fishing industry, universities in taxonomic and ecological studies, recreational fishermen, by pollution control agencies, the offshore energy industry, and educational groups.

Incidental observations made during survey operations are often as significant as planned observations. John Colton of the Northeast Fisheries Center recently reported extensive contamination of surface waters by tiny plastic spheres one to five millimeters in diameter from samples collected on an extensive MARMAP survey of the Northwest Atlantic. At first he thought they were fish eggs, but close examination showed them to be polystyrene beads used in plastic manufacturing. He reported that significant numbers of these plastic beads are introduced into estuaries from manufacturing plants along the mid-Atlantic coast. They are carried seaward by the currents and concentrated offshore by surface eddys, where they remain indefinitely in the surface waters.

At the Middle Atlantic Coastal Fisheries Center, Sandy Hook, a survey of the fish resources of the mid-Atlantic Bight is conducted under the direction of Dr. Carl Sindermann. The Center uses the R/V Delaware II to map annual changes in abundance of important near-shore stocks of flounders, surf clam, bluefish, mackerel, sea trout, and others. These species have been included in the catches of foreign trawlers off the mid-Atlantic coast. The impact of these foreign catches on the stocks is the subject of extensive analyses by Center scientists.

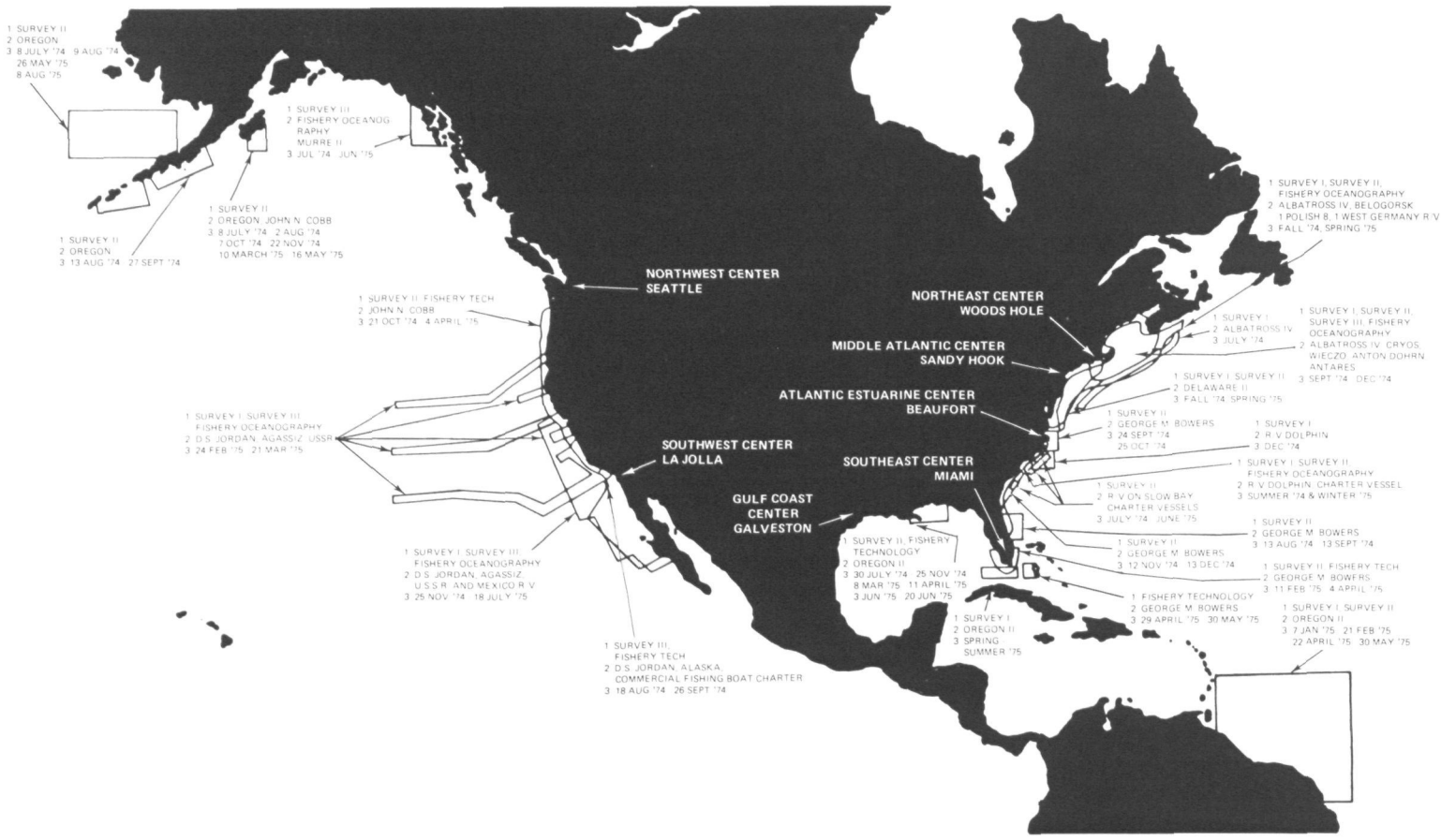
Dr. Merton Ingham, Chief of the Atlantic Environmental Group, heads up a staff at Narragansett, Rhode Island, engaged in processing thousands of bits of oceanographic data to better understand the effects of current, temperature, and other oceanographic changes on fish abundance in the northwest Atlantic. Sharing the Northeast Fisheries Center facility at Narragansett is the MARMAP Field Group, led by Robert Marak. The Field Group coordinates MARMAP survey operations for larval fish within NMFS, and with cooperating universities and other countries. Mr. Marak recently spent a month providing instruction in plankton sorting and identification methods to collaborating scientists at the newly established Polish Plankton Sorting Center, at Szczecin. As part of a scientific exchange program Drs. Idzi Drzycimski and Leonard Eyzemont of Szczecin recently spent two weeks at Narragansett becoming familiar with Northwest Atlantic plankton groups.

Up in the North Pacific, fishery scientists Martin Nelson and Thomas Dark of the Northwest Fisheries Center, Seattle, have been experimenting on the R/V John Cobb with an underwater sound system for locating schools of fish and counting them. Their assessments aid in keeping a watch on the condition of the fish stocks off Washington and Oregon, British Columbia, and Alaska. They use a submerged "flying-wing" equipped with electronic sounders that bounce signals from fish schools to receivers mounted on the hull of the COBB. Mr. Nelson and his staff are making progress in assessing fish stocks using hydroacoustics as a substitute for trawling in surveys of pelagic fish aggregations off the northwest coast, working jointly with a Sea Grant team from the Applied Physics Laboratory, University of Washington.

The fish resources in the Gulf of Alaska and East Bering Sea are among the most productive in the world. The Center staff is concerned with the need for returning presently overfished stocks to former abundance levels. MARMAP assessment activities at the Center under the direction of Dr. Frank Fukuhara include the use of the R/V Oregon in spring and summer groundfish and crab surveys in the East Being Sea, pollock surveys from the Cobb, in autumn, and shrimp and ground-fish surveys in the Gulf of Alaska in spring through the use of chartered vessels. The Center also conducts joint assessment studies with U.S.S.R. on Pacific hake stocks and with the Fisheries Research Institute of the University of Washington on North Pacific salmon stocks. Americans are allowed to observe fishing operations in the East Bering Sea on board Japanese and Soviet commercial fishing vessels as part of a cooperative program with the Japanese and Soviets.

Dr. Fukuhara and his staff provide stock assessments and serve as scientific advisors to the U.S. representatives on several international commissions and bilateral fisheries agreements with U.S.S.R., Korea, Japan, and Canada. Effort is also directed to the development of trawl nets that will reduce the incidental catch of non-target species. This is a problem that results in the annual wastage of millions of pounds of halibut and crab caught incidentally by the Japanese and Soviet fleets fishing for Alaska pollock.

South along the coast in La Jolla, California, Dr. Brian Rothschild, Director of the Southwest Fisheries Center, conducts



Locations of NMFS fisheries centers, and areas of MARMAP survey operations taking place during fiscal 1975.

MARMAP investigations on global tuna stocks, monitoring changes in their distribution, abundance, and condition. Center scientists provide stock assessments for international management bodies concerned with tuna conservation. Reports prepared by the Center staff provide information to improve the management of tuna stocks. Drs. William Lenarz, William Fox, Brian Rothschild, and Gary Sakagawa recently completed a study of the yield-per-recruit as a basis for minimum size regulations for Atlantic yellowfin tuna stocks. Drs. Rothschild and Fox, along with Harvey Bullis and Dr. Grant Beardsley of the Southeast Fisheries Center, provided tuna assessment information to a meeting last November of the Council of the International Commission for the Conservation of the Atlantic Tuna in Madrid. This information played an important part in the agreement reached for limiting the catch of bluefin tuna to recent levels for a period of one year, and the setting of minimum size regulation of 6.4 kilograms. Consistent with the terms of the Convention, the Council is now proceeding to recommend formally the measures to the Commission for approval by member countries through a mail vote.

Assessing the condition of fisheries resources and making forecasts requires analyses of data collected from commercial and recreational fisheries and resource surveys. Three types of MARMAP ship surveys are conducted. One type of survey assesses eggs and larvae (ichthyoplankton) when they are concentrated near the surface and can be sampled with a single kind of net. Fish are sensitive to environmental changes and pollutants during their early life stages, and the mortality for each year-class directly affects future harvests. These survey operations are conducted cooperatively with U.S.S.R., Poland, France, Canada, the Democratic Republic of Germany, and the State of South Carolina in the Atlantic, and with the State of California and the U.S.S.R., and Mexico in the Pacific.

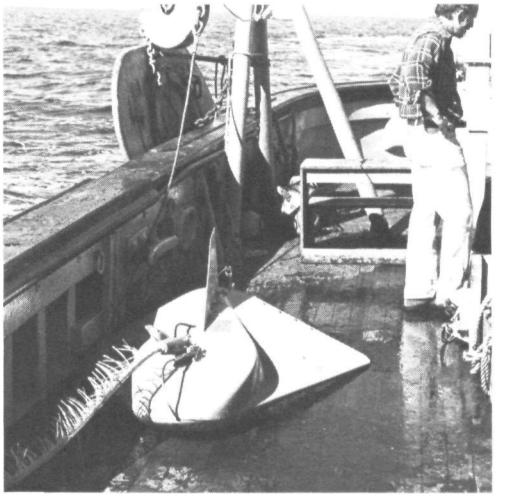
A second type of survey focuses on the abundance and distribution of groundfish and shellfish species which live at or near the bottom in their harvestable stages (e.g., cod, flounder, scallop, lobster, crab, and shrimp). Bottom survey operations are conducted with ICNAF nations in the Northwest Atlantic from Greenland to Cape Hatteras, and with the State of South Carolina from Cape Hatteras to the Florida Keys. Surveys are also conducted in the Mississippi Delta region, and there are surveys of small areas in the Northeast Pacific off Alaska and in the East Bering Sea.

A third type of survey assesses pelagic fish species that live in the upper water layers (e.g., herrings, mackerel, tunas, squids, sharks, menhaden, and others). Surveys of pelagic fish pose special problems. Effective assessment of these fast moving migratory species will require the application of acoustic techniques.

Analyses of data collected on surveys and from commercial and recreational fisheries, by skilled scientists trained in biometrics, statistics, population dynamics and ecology, make possible the measurement of fishing and natural mortality, and of annual changes in abundance caused by fishing or environmental changes. With these measurements in hand, NMFS scientists construct yield curves, population models, make stock abundance forecasts, and produce status of stock reports as backup for management decisions. Some 400 reports are issued each year—about a third are published scientific papers, and another third are reports to international fisheries commissions and meetings concerning international bilateral agreements. The balance is divided among reports to interstate fisheries commissions, the State regulatory agencies, and other Federal agencies.

The first nationwide status of stocks report was produced by the MARMAP program in 1974. It provides a synthesis of all available assessment information on the principal stocks off the U.S. coasts. Several recent MARMAP reports provided warnings of serious stock depletions, including yellowtail flounder and silver hake in the Northwest Atlantic, and ocean perch, crab, and flounder in the Northeast Pacific. MARMAP survey findings also resulted in

(Above) Fred Nichy (l.) of Northeast Fisheries Center, Woods Hole, Mass., tags spiny dogfish on board R/V Albatross IV; Joe Devenny records tag number. (Right) MARMAP tests new system for scanning ocean bottom with acoustic "eyes" to measure fish stock size, on board R/V John Cobb in North Pacific.



the issuance of two Red Flag Reports describing extensive contamination of western Atlantic surface waters with tar clumps and plastic particles.

The physical and chemical properties of the ocean (currents, temperature, nutrients) directly or indirectly affect fish and shellfish resources, but only rudimentary knowledge of controlling mechanisms and rate processes is presently available. The impacts of man's activities (fishing, pollution, environmental modification), and of natural environmental processes on the production of annual fish crops need to be accurately predicted. MARMAP oceanographic activities provide descriptions and analyses of marine organic poduction systems and of oceanographic conditions, and define the influence of environmental factors on the distribution and abundance of fish stocks. Activities include the analyses of physical, chemical, and biological oceanographic data collected during MARMAP surveys and from oceanographic research activities of other agencies (e.g., commercial ships of opportunity, Navy, Coast Guard, States, and universities). Special MARMAP studies are conducted with the U.S.S.R. to obtain organic production and larval survival data and for the development of ecosystem models for specific areas (Northwest Atlantic, Northeast Pacific).

Recent MARMAP accomplishments in oceanography include: the development by Andrew Bakun, Pacific Environmental Group, Monterey, of an annual seasonal ocean upwelling index for the U.S. west coast which is an important contribution to understanding the biological productivity of this region; the application by Dr. Michael Laurs, Southwest Fisheries Center, of environmental data, including oceanic boundary features, to forecast the migration of albacore into the U.S. west coast tuna fishery; and the development by Dr. Merton Ingham, Atlantic Environmental Group, and Walter Nelson, Atlantic Estuarine Fisheries Center, of a correlation between the wind/current index and menhaden catches that indicates onshore-offshore currents can directly influence menhaden year-class survival. This index, if proven valid, would improve annual forecasts of menhaden abundance.

Prior to the 1960's significant depletion of fish stocks was measured in decades. Stocks now may be overfished only two to three years after a fishery begins. Consequently real-time assessments are critical, and they depend upon applying advanced engineering and technology for collecting resource information. Engineering and technology developments are also needed to reduce waste of non-target species taken during fishing operations, and to devise the means for conducting more rapid and less expensive surveys. Projects now underway include improving a system for realtime estimates of the abundance of groundfish and pelagic fish stocks through hydroacoustic and other remote sensing methods, improving the sampling efficiency of trawl nets, and the testing and evaluating (in cooperation with the United Kingdom) of an automated plankton and enviromental recorder to be deployed from ships of opportunity.

MARMAP engineering tasks also include the development and introduction of selective fishery systems to eliminate the wastage of incidental catches, particularly in the shrimp and pollock fisheries where thousands of tons of non-target species are discarded at sea annually as incidental catch. Studies are being conducted to define the magnitude of crab and lobster loss due to derelict traps and pots lost by fishermen, and to develop remedial measures. MARMAP technical advances include: development of a hydroacoustic assessment system, development of an automated plankton sorting system, improvements in shipboard data logging, application of chemical autoanalyzers, development of a selective shrimp trawl, and the adoption by a number of European countries and FAO of a standardized paired net system ("Bongos") for use on cooperative larval fish surveys.

Initial progresss in MARMAP has shown it to be considerably more cost-effective than previous methods. Domestic and international cooperation has resulted in standardized stock assessment methods with subsequent exchange of comparable data, while reducing individual costs. For example, foreign countries contributed approximately $2 million in ship time in FY 1974–1975 for MARMAP surveys. Promising developments in the application of hydroacoustic technology for more rapidly assessing stocks are being achieved.

While progress has been made, present resource assessment efforts are not sufficient to meet all the needs for management and allocation of fish stocks. For example, efforts are inadequate for recommending optimal quotas for 70 of 100 important stocks off the U.S. coast. In addition, the data base is inadequate for developing latent stocks, particularly in the Gulf of Mexico, where evidence suggests potential for expanding fisheries on croakers, tunas, mullets, and other species. Present information is inadequate for developing and protecting marine recreational fishing. If there is a seaward extension (to 200 miles) of U.S. fisheries jurisdiction through Law of the Sea negotiations or domestic legislation, the need for fishery resources assessment will become even more urgent, to meet the needs of the 70's and 80's for improved assessment and better management of vital fish and shellfish stocks.

NOAA Profile

It's very exciting...

Rita Colwell's Small World

BY ANN K. COOK

"It's a very exciting time to be in environmental microbiology—microbial ecology, I would call it," says Dr. Rita R. Colwell, Professor of Microbiology at the University of Maryland.

Dr. Colwell has been on the trail of microscopic marine organisms since she was a doctoral candidate at the University of Washington, and much of her detective work has been sponsored by NOAA's National Sea Grant Program, as well as by the National Science Foundation and other government agencies.

She prefers to term herself a microbial ecologist, rather than a microbiologist, because of her special interest in the important ecological role that microorganisms play in nature.

Speaking in her small, bright office on the University's College Park campus, she enthusiastically sprinkles her conversation with the adjectives "exciting" and "fascinating."

In microbial ecology, the present is exciting, she feels, because "new things are constantly being discovered. Microbiologists, biochemists, and ecologists have given us tools that we can put together and use to develop some theories about microorganisms . . . and to learn how to harness them to do things for us. We might, for example, be able to use microorganisms to clean up oil spills, although I have reservations about that. But now at least we can understand their effects and their potential better than we did in the past."

Some of the important new tools she refers to are the result of her own work. "I went to the University of Washington, where I studied microbiology. I just happened to get interested in marine bacteria. At that time, there was no great public concern or much support for the field. It was just something I did because it interested me.

"I wrote a computer program to handle the data for my Ph.D. thesis, because it wasn't possible to do it any other way. So I found myself a pioneer in marine microbiology and a pioneer in computer applications of microbiology. Today, the field is burgeoning, and I find the problems we've worked on are almost classic. It's been fun . . . lots of fun."

"For Sea Grant, we've been working on several aspects of the microbiology of shellfish and marine animals." The "we"—in addition to Dr. Colwell herself—now includes five postdoctoral fellows working in her laboratory, five graduate students, about six technicians, and two part-time computer programmers.

Although much of her work focuses on the organisms and physical processes that produce disease in Chesapeake Bay shellfish and marine animals, Dr. Colwell stresses her confidence in the Bay as a healthy shellfish growing area. "It's a very good area, and I'd be the first to support it."

One of her major Sea Grant-sponsored projects is a study of *Vibrio parahaemolyticus*, a saltwater organism that has been found to be associated with mortalities in shellfish and crabs and causes gastroenteritis in humans. It was completely unknown to scientists until 1950, when a number of Japanese became ill and some died after eating partially boiled young sardines.

In 1968, Dr. Colwell's team found this organism in Chesapeake Bay, which, she says, "was sort of a surprise. Why should it be there? At that time, we didn't understand its ecological role. We assumed that there must have been an external source. Now we know that because of the organism's salinity requirements it grows best in an estuarine environment. We did a whole lot of studies with Sea Grant support, showing that it's found in the Bay and in areas where the salinity is optimum for its growth. It is not found off the coast; it is not found in the deep ocean, because it cannot survive the high pressure and low temperatures there.

"The interesting point concerning *Vibrio parahaemolyticus*," Dr. Colwell continues, "is that it's an organism with a fundamental role in mineralizing molecules like chitin—the material that forms the outer shell of many minute planktonic animals, as well as of crustacea such as lobsters, shrimp, and crabs. It has the ability to digest the chitin, so *V. parahaemolyticus* is abundant in the warm summer months when there's lots of chitin around. We found that it is actually associated with copepods—minute forms comprising a major portion of zooplankton—'animal plankton'—and that it attaches itself to them. It is also found occasionally in shellfish. We believe that, in Chesapeake Bay, it survives the winters in the sediments."

Vibrio parahaemolyticus breaks down the chitin in shells, and thus its ecological significance is to recycle chitinous material, Dr. Colwell postulates. "Its attachment to planktonic animals is perhaps the most important factor in determining its distribution in nature."

Her hypotheses on the nature and ecological role of *Vibrio parahaemolyticus* are the outgrowth of more than 10 years of studying microorganisms in Chesapeake Bay. She began her research there in 1964, when she was an assistant professor at Georgetown University.

Initially, she undertook comparative microbial ecology analyses of seasonal and regional differences between two areas of the Bay—one suffered serious annual shellfish mortality and was no longer commercially productive, and the other was a thriving oyster-harvest area. She and her colleagues found that at the non-productive site various species of *vibrio* were the predominant bacteria in water, sediment, and animals during the months from June to September.

Dr. Colwell's research team first discovered *Vibrio parahaemolyticus* on the Bay in 1968—in dying blue crabs. Other investigators, before and since, have identified the

Giants in Rita Colwell's small world—Chesapeake Bay zooplankton.

organism in Puget Sound, and in waters off the Oregon coast, along the Gulf Coast, in New Hampshire bays, and around the coast of Hawaii. "The distribution of this organism in estuaries and coastal regions apparently is widespread, very likely global," she believes.

From December 1970 through August 1971, Dr. Colwell and her associates examined the ecology of *Vibrio parahaemolyticus* and other vibrios in the Rhode River area of Chesapeake Bay. During the winter months, they could not detect vibrios in the water column, although they found them in the sediments. From late spring to early summer, as water temperatures warmed, vibrios which had overwintered in the sediments were released from the bottom communities and rose to attach themselves to animal planktons, their numbers increasing as the temperatures rose. In fact, the team found, during the summer months vibrio species and related organisms comprised the total bacterial population associated with the planktonic animals.

Immediately after completing the study in the Rhode River, the group sailed on Duke University's R/V Eastward to the waters of the continental shelf off Georgia and South Carolina. There they collected water, sediment, and plankton samples, and fish, and found no *Vibrio parahaemolyticus* present, even in samples gathered as close as four miles from shore.

The computer program Dr. Colwell had written as a student was one of the earliest applications of numerical taxonomy to microbial ecology. Taxonomy classifies animals and plants according to common characteristics. In much the same way, Dr. Colwell's programs identify and classify bacteria, by means of a computer. "We're now putting all our data accumulated over the past decade into the computer at the National Microbiological Data Center at the American Type Culture Collection. We plan to develop a model of the bacteriological populations in Chesapeake Bay and off the East Coast. It's the first time any laboratory has been able to do this, because of the volume of data we have. We have full annual cycles of petroleum-degrading bacteria, chitin-digesting bacteria, and various genera for Chesapeake Bay and data from a full series of cruises off the Atlantic Coast and near Puerto Rico, as well as in the deep ocean trenches. We're putting together all of the microbiological data, along with salinity, nutrient, and temperature data, to see whether we can predict which genera of bacteria will be dominant at given times of the year—whether for example, you could expect petroleum-degrading bacteria to metabolize oil spilled at a particular site or whether the bacteria would not be the types required for that at that particular time.

"We think our approach has great potential. Most of our support has come from Sea Grant and the National Science Foundation. They seem to have seen at an early stage—not now, when it's obvious—that there was some promise in our work and a need for fundamental research in bacteriology and virology, basic work for which the applications couldn't then be foreseen. Now, 10 years later, the results of this work are proving to be important and useful in aquaculture and in fish harvesting and seafood processing. It's kind of a fun situation to be in, to have had the initial support for basic research, and now to be able to implement the basic knowledge in a very practical way."

Through Dr. Colwell's numerical taxonomy techniques and DNA investigations, along with data provided by other scientists, *Vibrio parahaemolyticus* was positively identified in 1970 as a separate species of the genus vibrio. *Vibrio parahaemolyticus* samples obtained from various sources—blue crabs, infected humans, water, and sediment—showed a striking similarity. Their DNA (deoxyribonucleic acid) base composition was remarkably alike.

"We're very interested in the molecular genetics of marine bacteria," says Dr. Colwell. "We've extracted the nucleic acid and compared the DNA of Chesapeake Bay bacteria with that of Japanese isolates. The *Vibrio parahaemolyticus* strains from Chesapeake Bay showed more than 80-90 percent correspondence in molecular structure with the Japanese strains. You can separate the DNA double strands, and get the single-stranded form of the DNA from the Chesapeake Bay *V. parahaemolyticus* strains. This DNA will reassociate with the single-stranded DNA from the Japanese strains and form a duplex—that is, a biologically active polymer. So we have proven on a molecular-genetic level that these Japanese and Chesapeake Bay strains are practically identical.

Dr. Colwell and her associates are engaged in, or have completed, several other Sea Grant projects.

"After hurricane Agnes, it was discovered that shellfish in the Bay were contaminated with coliform bacteria. We had some ideas concerning this problem but needed to know why this happened," she says. "So we studied the bacteria associated with softshell clams and oysters over a full annual cycle. We found a seasonality of the microorganisms that had been suspected but never proven before. Now we know that at certain times of the year, certain bacteria predominate. Microorganisms and viruses that may potentially cause disease often are transported by sediments, and when there is a heavy influx into the Bay from, for example, the Susquehanna River or other fresh water containing terrestrial runoff, there is then a greater possibility that the shellfish will take up potentially pathogenic bacteria."

"We are also examining the effects of pollutants on the microbiology of shellfish," Dr. Colwell continues. "Do pesticides in high concentrations—in the spring months, for example, when farmers are spraying the fields—affect the ability of shellfish to pump, or circulate, water? Impaired metabolism could result in an accumulation of bacteria in the shellfish and thereby cause a bacteriological problem. If one doesn't suspect there might be other agents causing such effects, it might be concluded to be strictly a bacteriological problem.

"With Sea Grant support and assistance from the State of Maryland, we are now constructing and using aquaria in which we can do dosing experiments with different levels of pesticides and other pollutants. Then we'll do bacterial counts and find out which bacteria, if any, the shellfish tend to accumulate."

"We are also interested in pathogens . . . bacteria and viruses that cause disease, not only in man, but also in animals," Dr. Colwell notes. "We've investigated some mortalities of clams and shellfish, and we hope to investigate fish kills as well, to see if there are certain bacteria always associated with these kills. I think this will provide some important information useful for other projects supported by the Sea Grant program.

"One of the very exciting things we've done is to determine what kinds of organisms are associated with mortalities in aquaculture. Because we're funded by Sea Grant, we feel a responsibility to assist those people doing Sea Grant aquaculture studies. We've been getting cultures from Texas, Florida, and Oregon, for example, and we've been able to make some rather interesting discoveries. We've found that, interesting enough, *V. parahaemolyticus* and other vibrios are problems in shrimp culture. They can cause the mortality of as many as a hundred thousand shrimp in a matter of few days, and that can be a disaster.

"In the last few weeks, working with researchers at the Biomedical Center in Galveston, Texas, we found that some of the commercial sea salts used in aquaculture contain *V. parahaemolyticus* and other vibrios. So it looks as though aquaculturists ought to autoclave sea salt mixtures before preparing such mixtures for culturing shrimp.

"We feel that we're providing a service to the aquaculture people by our bacteriological studies: directly, by accepting cultures and identifying the cultures using our computer techniques; and indirectly, by doing basic research in the field and in the laboratory in order to understand the microbiological processes involved."

In addition to her research, Dr. Colwell teaches marine microbiology at the University of Maryland. She and her students take short scientific cruises on the Johns Hopkins University vessel R/V Ridgely Warfield every six weeks in Chesapeake Bay, collecting water, sediment, and plankton samples. At least twice a year, they participate in an expedition aboard the Duke University R/V Eastward. "Also," she adds, "we have a collaborative project with the Ocean Research Institute, University of Tokyo. We've been on one of their oceanographic vessels, and in May the Japanese spent some time with us in Chesapeake Bay. It's part of a U.S.-Japan cooperative program."

"I have one student," Dr. Colwell notes, "who is interested in the interrelationships of ciliates—protozoans—and bacteria. Ciliates are, of course, microorganisms, but to a bacteriologist they're elephant-sized. This student has found that some of the estuarine

Rita Colwell's research aboard R/V Ridgely Warfield of Johns Hopkins University: making a sediment grab (top); diluting sediments in preparation for making bacterial counts in ship laboratory (right); assistant empties zooplankton net (left).

ciliates feed specifically on certain bacteria. Therefore, we can 'label' these bacteria with radioactive material, such as tritium or C-14, and follow the labeled bacteria as they're digested by the ciliates to learn how the bacteria contribute to the nutrition of the ciliates. More than that, this technique provides a tool for detecting a mechanism by which some pollutants—such as mercury, pesticides, or oil—reach higher levels in the food chain. Bacteria metabolize the pollutants—concentrate mercury, for example—ciliates feed on the mercury, and the ciliates are then fed on by higher forms. Now we have a mechanism for tracking—fingerprinting, as it were—some of these pollutants and following them through the food chain by following the radioactive bacteria. This all comes out of the work we do under Sea Grant.

"Another student has found that many bacteria in Chesapeake Bay are drug-resistant and that the genetic information for the drug-resistance is coded in the DNA of transmissible plasmids—an extra-chromosomal DNA like an extra 'doughnut' of DNA in bacterial cells—that can be transmitted from one bacterium to another. There are a number of laboratories doing very exciting work on this topic, but we're interested in ecological aspects. Drug-resistant bacteria come into the Bay in sewage, and one can hypothesize that, because these plasmids can be transmitted from one cell to another, they might confer drug-resistance to the indigenous *V. parahaemolyticus* by this molecular-genetic mechanism.

"Another student, whose thesis work was partly supported by Sea Grant, has shown that drug-resistant bacteria can easily be isolated in Chesapeake Bay and also in the deep sea. This leads us to conjecture about the origin of the plasmids. If you find them in the deep ocean away from land, where do they come from? That's a hard question at the moment. It may be that the bacteria in the gut of fish carry these plasmids. Perhaps they are excreted in the deep water of the oceans. But we don't know that yet. This is one of those exciting basic research problems that has an ultimate, pragmatic, practical application in the future, but right now is classified as basic research. Again, this is where Sea Grant is very important in supporting fundamental research in marine microbiology."

Her bacteriological expertise and her concern for the environment often combine to plunge Dr. Colwell into the center of controversy.

"One of my hobbyhorses," she admits, "is the public health problem associated with water. We know that there are live viruses in drinking water. I think we've reached the point where we should be pasteurizing water, at least drinking water.

"Certainly, discharging live pathogenic bacteria and viruses into our coastal waters, rivers, and estuaries is not very wise, because of such problems as drug-resistance transferred by way of plasmids and because of living viruses which may attach to the surfaces of fish and concentrate in shellfish. This is a problem that has to be faced in the immediate future . . . not the distant future. I feel strongly about it. I feel that the public ought to be informed. They ought to have all the evidence, be told the hazards, and then be allowed to make decisions. If the public chooses not to expend funds for pasteurization or for renovation of sewage plants to eliminate this hazard, then at least the decision ought to be an informed one." She also thinks bottled water should be sterilized by the purchaser.

With all her research and teaching duties, memberships and offices in scientific societies, and appointments to editorial boards and advisory committees, Dr. Colwell also is married and the mother of two children, nine and twelve years old. "I kept on working after I had children, because a scientist can't stop. Five years out, and you may be obsolete. Those of us who persevered in the face of past societal directives against having a family and also working are, unfortunately, a minority. Many opportunities come to those of us who persevered, because attitudes have changed and now there aren't very many women to take positions of responsibility."

As a result of her perseverance and her own innate ability, Dr. Colwell now is recognized by her peers as one of the world's foremost authorities in the field of marine microbiology.

Small boat skippers join with Lake Survey Center pros

Cooperative Charting, Great Lakes Style

BY JOHN HANNA

Shorelines, estuaries, lakes, and bays are often fickle—changing shape and changing depth as tides, currents, storms and floods push and scrape at them. Chartmakers learned long ago that they cannot keep up with all the changes—and only through the willing cooperation of private organizations such as the U.S. Power Squadrons can they stay about even with nature's whims. NOAA's National Ocean Survey and its Lake Survey Center have maintained the USPS-NOS Cooperative Charting Program for 13 years.

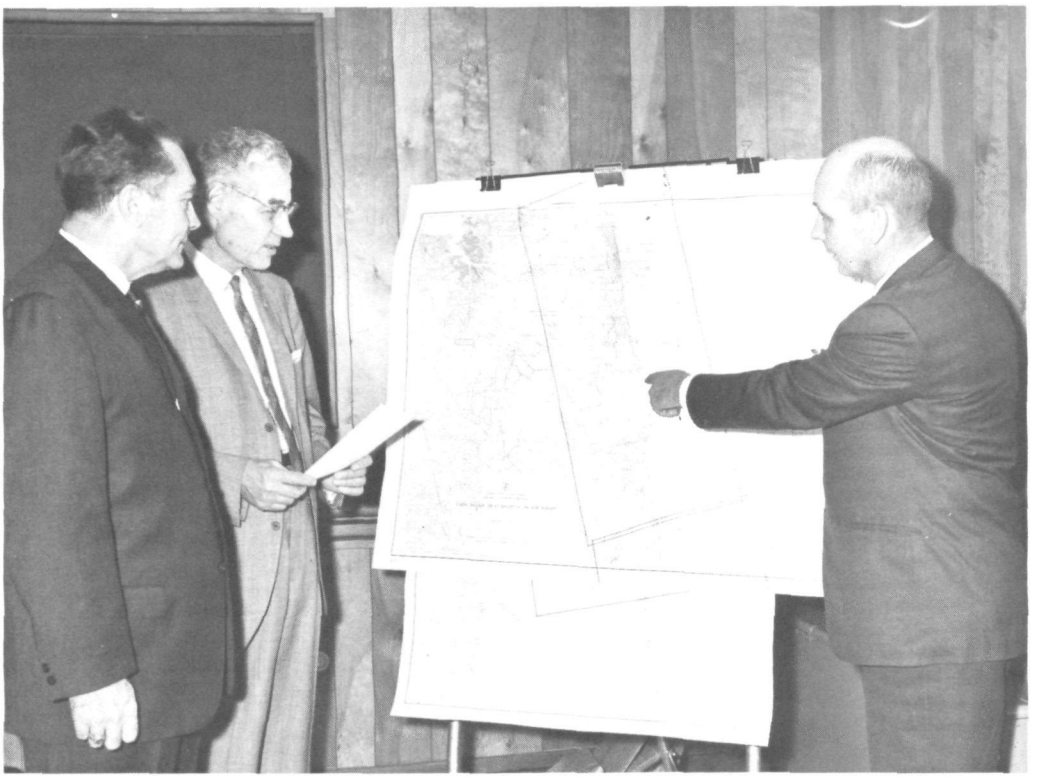
The U.S. Power Squadrons were formed in 1914. This broad-based group of dedicated mariners is involved in a variety of projects. Next to education, cooperative charting is their largest effort. Article II, "Objects," of the USPS Constitution describes their aims.

ARTICLE II
Objects

The objects of the United States Power Squadrons shall be to establish a high standard of skill in the handling and navigation of yachts; to encourage the study of the science of navigation and small boat handling; to cooperate with the agencies of the United States Government charged with the enforcement of the laws and regulations relating to navigation and to stimulate interest in activities which tend to the up-building of our Army, Navy, Coast Guard, and Merchant Marine.

Many Power Squadron members are active in cooperative charting. What they do essentially is 'field check' the charts for accuracy. Discrepancies are reported on a standard form and forwarded to NOS or its Lake Survey Center through Power Squadron channels.

Communication is an essential ingredient and the Power Squadrons have established an outstanding network for cooperative charting. There are 32 Districts in the U.S. Power Squadrons and each District has anywhere from six to 18 or more Squadrons, for a national total of 426. Membership runs from 50 or 60 to several hundred in each squadron. Each District and each Squadron has a Cooperative Charting Chairman. They report to a member of the National Cooperative Charting Committee who usually represents from two to four Districts and who, in turn, reports to the National Chairman. The 80,000 members provide input of inestimable value to those responsible for producing and distributing accurate, up-to-date nautical charts.



Cooperative charting at midstream: Some years after the formation of the USPS Cooperative Charting Program, R.Cdr. (USPS) Robert Schmidt—largely responsible for the program's success—meets with VCdr. Emery E. Ellis (l.) and Capt. Lorne G. Taylor, NOAA (r.), then Chief of NOS Marine Chart Division.

The U.S. Coast Guard Auxiliary has a similar program, and policies and procedures of the USPS Cooperative Charting Program usually apply to the Auxiliary's Chart Updating Program.

The idea of reporting chart errors is certainly not new. For years the Navy has accepted Merchant Marine reports on their charts, as has the National Ocean Survey. Those comments ordinarily come from commercial shipping interests, and are usually confined to conditions at large, deep-draft harbors. With the upsurge in recreational boating—which began slowly after World War II, accelerated rapidly in the late 50's and early 60's and continues to show significant growth—there came a need for more accuracy and greater chart detail in the shallow canals, channels and bays frequented by pleasure craft.

One of the National Ocean Survey's major responsibilities is that of providing nautical charts of U.S. coastal waters and the Great Lakes. Both NOS and its Lake Survey Center have had considerable experience in that specialized field; NOS since 1807 and LSC since 1841. The concept of 'cooperative charting' surfaced one quiet day in 1962 at NOS's Marine Chart Division. Then-Cdr. Marvin T. Paulson was Division Chief at the time. One of his assistants, James Richardson, was instrumental in the implementation of the Cooper-

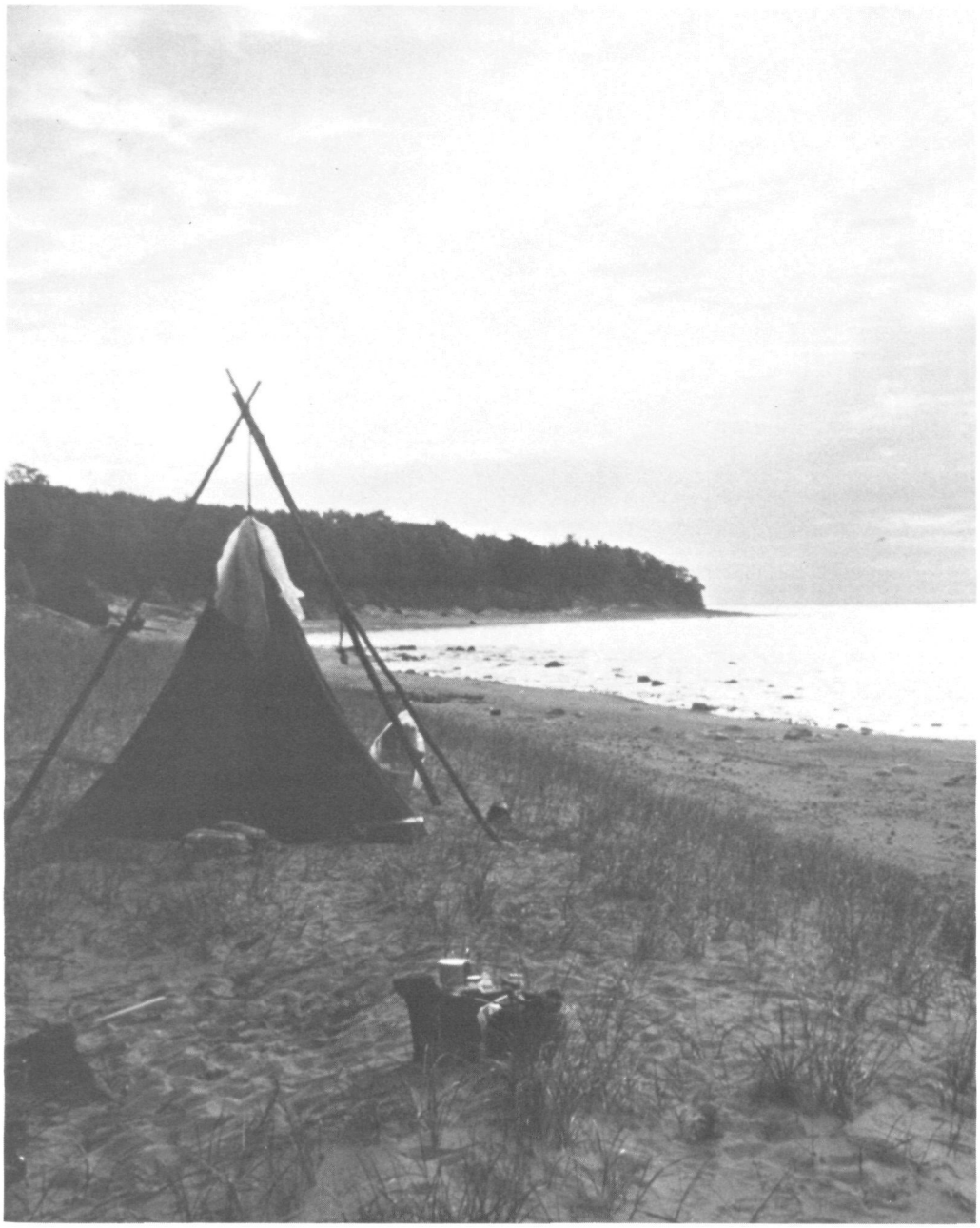


Photo: Great Lakes Foundation

ative Charting Program in its formative years. The idea was first publicly proposed by Cdr. Paulson at a U.S. Coast Guard Auxiliary National Convention in May of 1962. The U.S. Power Squadrons expressed interest and a formal agreement was signed the following year by U.S. Coast & Geodetic Survey (now NOS) Director, R.Adm. H. Arnold Karo, and the U.S. Power Squadron's Chief Commander, Charles M. Bradley. Robert T. Schmidt JN was given the assignment of getting the fledgling program off the ground for the Power Squadrons. One of his early acts was to contact the U.S. Lake Survey, then a District in the U.S. Army Corps of Engineers, now the Lake Survey Center under NOAA's National Ocean Survey, whose responsibilities included charting the Great Lakes. With the encouragement and active assistance of the Chief of Civil Works for the Corps, Maj. Gen. Jackson Graham, the Lake Survey-USPS part of the Cooperative Charting program was formalized in 1964 and the first tangible results appeared in 1965.

The efforts and dedication of many people have led to the high level of productivity enjoyed today. The prime mover, however, was USPS's Robert T. "Bob" Schmidt. His gentle prodding and pushing, and his unique writing skills, served to catalyze the interest and desires of many others. His memos to others in the program were always stimulating and encouraging. Schmidt also had a unique talent for judging people. He invariably selected or recommended the right person for the right job.

Bob Schmidt stepped down as National Chairman in 1971, but—to illustrate how others felt about him and the job he had done—he received two distinctive honors. The Power Squadrons dedicated 1970 to him and called it "Bob Schmidt Year" to recognize his contribution. Then to top it off, he got a personal, warmly-worded letter of commendation from the President of the United States.

His very able and capable successor, Rear Commander William T. Casey, N, continues at the post today. Casey, a former Merchant Marine officer, is highly knowledgeable in nautical matters and holds the designation of 'Navigator,' the highest in the USPS. Under his leadership the program has continued to grow and prosper. For example, in 1963 less than 500 credit points were given for cooperative charting reports received, a figure that soared to 20,000 in 1974. Some of the early reports, obviously the work of amateurs, occasionally drew chuckles from professional chartmakers. No one is laughing now. Not only has the volume of reports increased but the quality

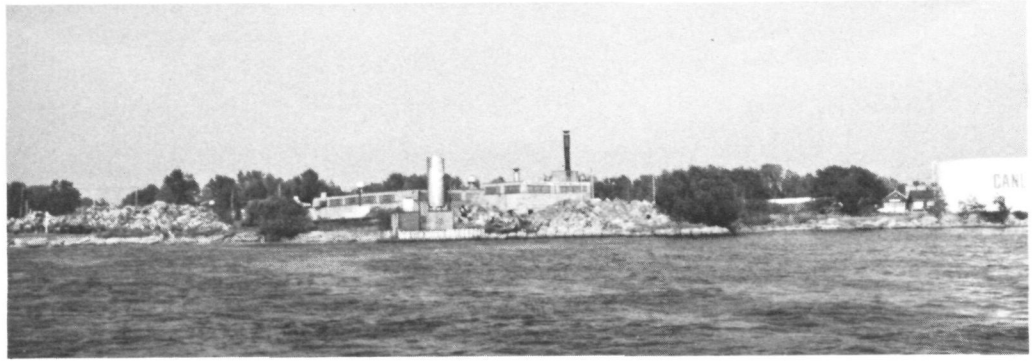
From long, quiet stretches of shoreline and open water areas where campers can find solitude, to congested urban waterways used primarily for commerce, the Great Lakes offer countless challenges to the men and women who make the charts that assure the safety of boaters.

today is nearly on a par with what could be produced by an expert field team. Occasionally reports, because they are so well-documented and carefully prepared, are used directly in the compilation of a new edition without field checking by NOS. If a report concerns a serious hazard it is frequently issued as a Notice to Mariners by NOS or the Lake Survey Center.

Until 1970 the USC&GS-USPS and USLS-USPS programs were separate, but for all intents and purposes, identical. While the formation of NOAA and the transfer of the Lake Survey Center to the National Ocean Survey, the Federal portion of cooperating charting was smoothly unified with no loss of efficiency. Standardization of the procedures for assigning report credit points, the determining of national winners and other matters were achieved with no adverse effect on the overall program.

There are nine U.S. Power Squadron Districts, comprising 120 Squadrons in 'Great Lakes country.' Part of District 2 extends into the Lakes region. Those nine Districts and part of District 2 cover not only the Great Lakes but many other inland waters, including Lake Champlain, the New York State Barge Canal System, the Ohio River, the upper Mississippi River, Tennessee Valley Authority Lakes, Fox River and Chain-O-Lakes in Illinois. Not all these areas are charted by the National Ocean Survey. However, all reports concerning these waters are forwarded to NOS' Lake Survey Center. If a report does not apply to a NOS Great Lakes chart, it is forwarded to the responsible agency after appropriate credit points are awarded. Any time the Cooperative Charting Program receives media publicity, newspapers, magazines, radio and TV, the USPS member reporting such coverage receives credit points. Anything that encourages participation in the program and favorably mentions NOS and USPS benefits the effort and warrants recognition.

At the end of the reporting year, November 1, all credit points are tabulated by District, Squadron and individual. After adjustments are made for length of boating season, requirements based on District enrollment and other considerations, a blue ribbon panel of senior USPS and NOS members gather to determine national winners in a number of categories. Awards are made by both USPS and NOS. Other criteria also have to be met before a unit or individual becomes eligible for an award. For example, to get a national award, a District must have participation by all its Squadrons. In 1974, for the first time, a Great Lakes District won the award for the best District. District 20, Chicago, edged out the winner of the three previous years, District 27. When notified, District 20 Commander, William L. Sheridan N, requested that his Cooperative Charting Chairman, the energetic and extremely capable District Lt. Raymond Snyder, AP, accompany him to the rostrum for the awards presentation. Other major winners last year were the Charlotte Squadron of District 27 and Edgar L. Coleman AP of the Jacksonville Squadron, District 23. District 6, Buffalo, was among the other units honored for their outstanding contribution to the cooperative charting effort.

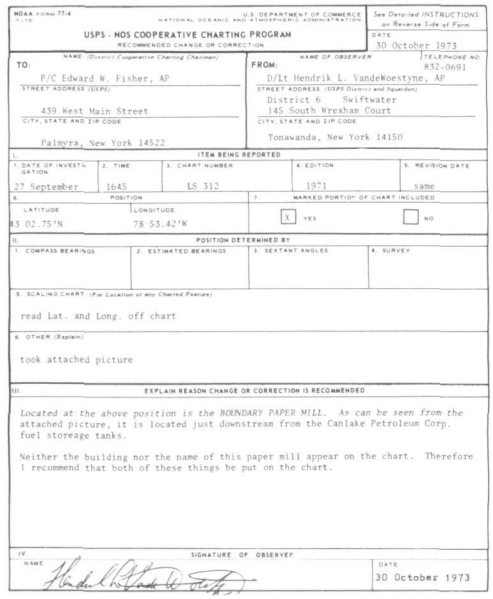


The Great Lakes show the mariner dramatic contrasts. They run the gamut from miles of desolate, uninhabited shorelines and large open water areas to incredibly congested, narrow channels and harbors. Lake Survey has one field team, the Revisory Section, that devotes its entire effort to checking the thousands of miles of coastline bordering these vast inland seas. They cover one-third of the U.S. shore each year. Thus, in three years harbors and restricted areas in the entire region are surveyed. It would be physically impossible for the team with its present capability to cover every mile of shoreline so they concentrate on areas where changes occur most frequently. Such areas are usually the most critical to navigation. This is one place where USPS plays a special and valuable role. Because of sheer numbers, Power Squadron members can visit and regularly check territory not feasible for Revisory to cover.

Before the Revisory Section starts out, Districts and Squadrons where they will be surveying are alerted. When the team arrives, they are frequently met by, or contact, members of the local Power Squadron. Those living and working there have intimate knowledge of their local waters, which is invaluable to the survey team.

Another way USPS helps Lake Survey's charting program is to check out permits for new construction in navigable waters in their area. From the time a permit is issued, a contractor has two years to start work. It is important to the mariner and the chartmaker to know when such construction starts and when it is completed. Information on new bridges, overhead cables and similar types of projects is essential to good charting. The sending of such material is something new being started by Lake Survey this year. While providing valuable data, it is expected to stimulate interest in cooperative charting. Appropriate credit points are given for reports on such new construction, and in many cases Lake Survey will arrange to have a Notice to Mariners published to alert all navigation of starts, completions, and progress reports on marine work.

To keep the program useful and encourage participation, a simple form has been devised. Use of the form is not mandatory, but is recommended because it serves as a reminder of what information should be included. A boater out for a Sunday afternoon cruise, for example, might have his chart open. As the chart is used, he routinely compares it with the shoreline. If a distinctive landmark or other feature not shown on the chart is seen or if something shown on the chart isn't there, a report is warranted. He might also cross-check the item with the Great Lakes or coast pilot. He then makes a note of the error including date, time, chart number and edition date—and on returning, notifies the Squadron Cooperative Charting Chairman. The Chairman is an expert and can help complete the form. He also makes sure that it gets to the right people and that proper credit is received.



NOAA FORM 77-4 (1-75) — U.S. DEPARTMENT OF COMMERCE, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION — See Detailed INSTRUCTIONS on Reverse Side of Form

USPS - NOS COOPERATIVE CHARTING PROGRAM
RECOMMENDED CHANGE OR CORRECTION

DATE: 30 October 1973

TO: (NAME (District Cooperative Charting Chairman))
P/C Edward W. Fisher, AP
STREET ADDRESS (USPS): 439 West Main Street
CITY, STATE AND ZIP CODE: Palmyra, New York 14522

FROM: (NAME OF OBSERVER) D/Lt Hendrik L. VandeWoestyne, AP — TELEPHONE NO. 832-0691
STREET ADDRESS (USPS District and Squadron): District 6 Swiftwater, 145 South Wrexham Court
CITY, STATE AND ZIP CODE: Tonawanda, New York 14150

I. ITEM BEING REPORTED

1. DATE OF INVESTIGATION	2. TIME	3. CHART NUMBER	4. EDITION	5. REVISION DATE
27 September	1645	LS 312	1971	same

6. POSITION — LATITUDE: 43 02.75'N — LONGITUDE: 78 53.42'W
7. MARKED PORTION OF CHART INCLUDED: [X] YES [ ] NO

II. POSITION DETERMINED BY

1. COMPASS BEARINGS	2. ESTIMATED BEARINGS	3. SEXTANT ANGLES	4. SURVEY

5. SCALING CHART (For Location of any Charted Feature): read Lat. and Long. off chart

6. OTHER (Explain): took attached picture

III. EXPLAIN REASON CHANGE OR CORRECTION IS RECOMMENDED

Located at the above position is the BOUNDARY PAPER MILL. As can be seen from the attached picture, it is located just downstream from the Canlake Petroleum Corp. fuel storeage tanks.

Neither the building nor the name of this paper mill appear on the chart. Therefore I recommend that both of these things be put on the chart.

IV. SIGNATURE OF OBSERVER — NAME: [signature] — DATE: 30 October 1973

Well-prepared USPS-NOS Cooperative Charting Program Report with photo of paper mill, fuel storage tanks (above) to help chartmakers in their task. Precise position of item was given in position report (No. 6); other documentation helped enhance value of the report.

Some members check their charts by automobile while driving along a coast road. Others watch their newspapers for photos and stories of new waterfront construction or the razing of a significant landmark. To better describe their findings many cooperative charters include a marked section of the chart. Replacement charts are forwarded to

(Above) R.Adm. Alfred C. Holmes, NOAA, presents 1974 national award to USPS District 20 commander William N. Sheridan (center) and D/Lt. Ray Snyder (right), District 20 Cooperative Charting Chairman, at USPS meeting in Jan., 1975. (Left) USPS members on LSC vessel Laidly during Center's open house.

the observer immediately upon receipt of his report. Credits are awarded for reports, but more points are obtained for more complete data, such as precise positions, exact clearances, and such supporting data as photographs and contractor's 'as-built' drawings.

Cooperative charters find that accurate positions are not difficult to obtain. Using a sextant with an accuracy of 0.1-0.2 minutes of arc at the site of the unknown, they measure horizontal angles between three known objects and then, using a precision three-arm protractor, determine its position. The procedure is taught in USPS' Advance Pilot Course. Many charters use on-the-water rendezvous to get in a little cooperative charting work, particularly when they are cruising in unfamiliar waters.

When a Squadron decides to thoroughly field check a particular chart or area, responsibilities for selected phases are usually assigned so that nothing is missed. But many skippers always keep a few blank forms on board so that even on short cruises, he and his crew can note chart changes.

In the early days it was generally agreed that each Squadron should cover primarily its own area, and reports confirming that charted features were as shown were not needed. As the program progressed, this thinking changed. For example, one Power Squadron member cruised Baltic waters aboard a commercial passenger vessel last year. Somewhere he got charts of the area, field checked them and sent reports to Lake Survey! They were duly recorded, points awarded, letters written and then were forwarded to the National Ocean Survey headquarters for passing on to appropriate Norwegian authorities.

Though NOS wants to know when charts are wrong, it is also of great value to know when they are right. Reports regarding correct conditions are not accepted regularly. Duplicate reports, by different persons at different times, were once considered a nuisance by those receiving them. Today, they are valued, because they furnish confirmation of a discrepancy.

What changes do cooperative charters look for? Here are a few: aids to navigation, radio and TV towers, cables, channels, bridges, dumping grounds, fish stakes, geographic names, jetties or breakwaters, new or removed landmarks, marinas, marine construction, obstructions, piers, piles, ramps and shoals. Malfunctioning or off-station aids to navigation are particularly important—charters report them as soon as possible to the U.S. Coast Guard, and a report of the problem and the action taken is forwarded to Lake Survey, Center or NOS for credit.

Although the Great Lakes are essentially non-tidal, lake levels have to be an important consideration for the cooperative charting observer. Reports concerning bridge and cable clearances and channel and canal depths should include the day and time, so that measurements can be adjusted for possible wind effect. All charted clearances and depths are based on Low Water Datum (LWD) or Chart Datum. Thus, in the summer months when levels are at their highest, usually above LWD, there may be more water in a canal than the chart shows, but bridge clearances will be less than reported in the Great Lakes Pilot and on the charts. A variety of lake level reports are issued at no charge and are considered a must for cooperative charting activities.

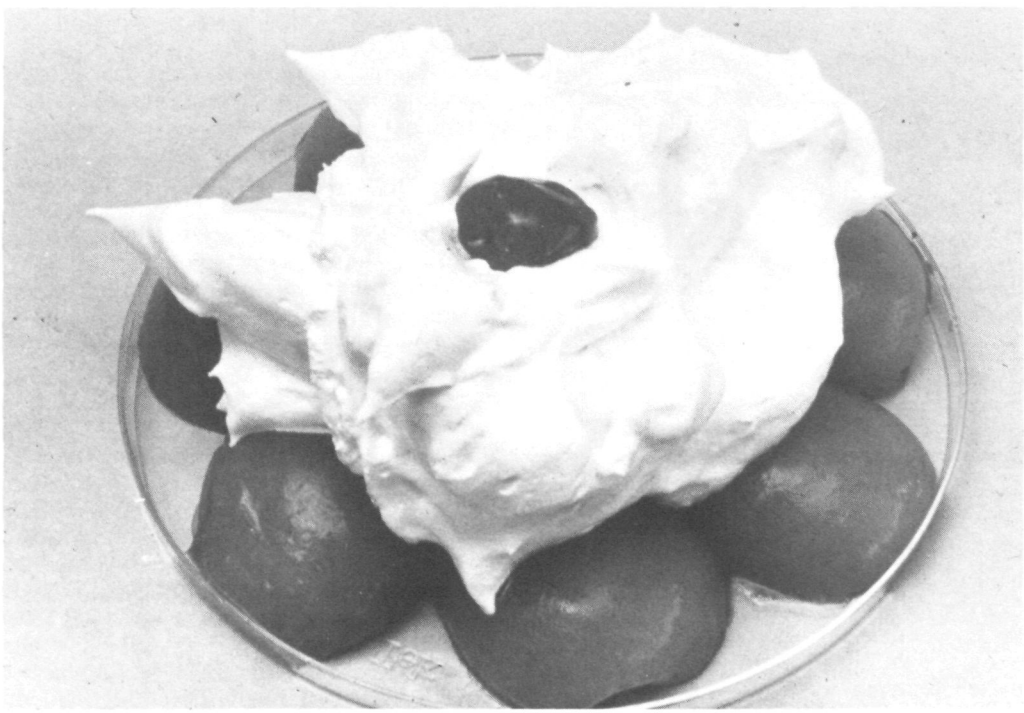
Liaison, coordination and communication are the keys to the ever-improving USPS-NOS Cooperative Charting program. Many Squadrons and Districts allot time at their meetings and conferences for the planning and discussion of cooperative charting activities. Meetings are held regularly on the national level to examine ways and means of improving and promoting the effort. Every spring the Lake Survey Center holds an open house on cooperative charting for Great Lakes Squadrons and Districts. Other seminars are held at NOS' Atlantic and Pacific Marine Centers. This year's Great Lakes meeting was held at Lake Survey's new marine base near the city of Monroe, Michigan's only harbor on Lake Erie. The base houses LSC's Engineering Division which services all vessels, vehicles, survey trailers, electronic gear and other equipment. The excellent turnout this year learned horizontal angle measuring by sextant, received a briefing on distance measuring by laser and on other precise surveying equipment, and were treated to a ride on Lake Survey's ultra-modern, high-speed, 54-foot Survey Vessel Laidly.

Years ago, when Lake Survey had completed its initial survey of the Great Lakes and had produced charts, someone decided that since there was now coverage of the entire area, there was no reason to continue making charts. In a few years the charts were so badly out of date they were a detriment to navigation. So Lake Survey was then re-established to provide accurate, up-to-date charts regularly. Chartmakers, and cooperative charters today know that just because a certain area was thoroughly checked last year doesn't mean the work is over and the job completed. As long as man exists, the job will never be completed. The U.S. Power Squadron-National Ocean Survey Cooperative Charting Program accounts for very measurable, significant and valuable source of data for keeping our Nation's nautical charts current and accurate. The number of reports and their completeness has improved every year since the program's inception.

NMFS scientists are developing

New Uses For Old Resources

BY JOHN A. DASSOW*



Consider the portion of lush ripe fruit smothered with a rich peaked dessert topping—an after-dinner dream! Now consider the small,bony, strong-flavored menhaden—out of favor for a century as a food-fish. There's a connection between this disparate pair which may prove of benefit to the dessert-loving consumer and the nation's fisheries.

More than 100 years ago, a housewife on the Atlantic coast who wanted to serve fish for dinner might fry up a mess of menhaden for her family. Then as now, menhaden was a most abundant species, easy to catch in great numbers and consequently readily available. But menhaden is bony, small, and strong-flavored, and when milder fare became easy to obtain, menhaden lost popularity as a food fish. Since the 1870's it has been used primarily in fish meal and oil.

In light of world population trends, however, fish such as menhaden are again being eyed for their possible food value—not as fresh fish, but as protein-rich convenience food supplements. NOAA's fishery utilization researchers, who are responsible for encouraging the greater use of fish as food, believe that such fish can be made more useful by the same technology and commercial applications that convert soybean to protein food additives, simulated meat products, and food extenders. They are considering new uses for old resources, such as menhaden, herring, and anchovy.

Generally, the flesh of these pelagic fish is dark, strong, oily (up to 20 percent oil), and relatively high in protein (15 to 17 percent of the whole fish). Nutritionally, their potential value is high—but they are not considered tasty. NMFS scientists are therefore trying to apply modern food-processing technology so that the fish can be used in large-scale production of acceptable food products. Together with this, they are studying consumption patterns and trends in fishery and other food products.

Research on acceptability and preferences for fishery products has generally shown that the housewife wants products that are convenient to prepare, economical, consistent in quality, and usable either as a main course for dinner or as a light lunch item. With the housewife's preferences as specifications, food processors have produced fish sticks, breaded shrimp, canned tuna, and other modern marine counterparts to TV dinners, heat-and-serve vegetables, and frozen meat pies.

In the fresh fish department, menhaden and herring are sure losers—small, bony, messy, oily, strong-flavored, unappealing in color and appearance. They obviously need a major overhaul before they can be acceptable as food. NMFS food technologists are working to provide that overhaul.

A little understanding of the market they are working with helps provide understanding of their procedures. Their market is primarily for processed meat—wieners ("weenies"), vienna sausage, Polish sausage, summer sausage, bologna, and canned meat loaf. Such products are used as the main course at dinner, as topping on pizzas, as ingredients in salads and casseroles, or just as between-meal snacks. They are usually spicy, with a homogeneous flavor and texture that reveal little about their initial ingredients. Unless the housewife reads the fine print on the side of the package, she doesn't really know what is in the meat. It tastes good, and she trusts the federal food and nutrition regulations to ensure that it is wholesome and healthful.

Besides the red-meat portions, cereals, and food additives, the only other ingredient presently allowed in these products is up to 15 percent poultry meat or portions. It is that 15 percent poultry allowance that the fisheries experts are pointing toward.

Scientists at the NMFS Seattle laboratory have shown in cooperative tests with several meat processors that the addition of minced flesh prepared from fresh, headed-and-gutted menhaden up to 10 or 15 percent by weight in a cured or processed meat product is a most practical possibility. Flavor and acceptability are good up to 10 percent, and there is no detectable fish flavor. A little added flavor can be detected in some meat products at the 15 percent level addition of minced menhaden, but none at all if a

** John A. Dassow is Deputy Center Director, Pacific Utilization Research Center, NMFS Seattle*

milder-flavored fish material is used.

The tests also showed that the minced fish improved the emulsion, as the meat processors term it, because fresh, minced fish has excellent binding properties for moisture and fat in the meat product. More important, and quite aside from the potential saving on the higher-valued meat materials, the fish can be used to improve the protein content and lower the fat content, making a more desirable product nutritionally.

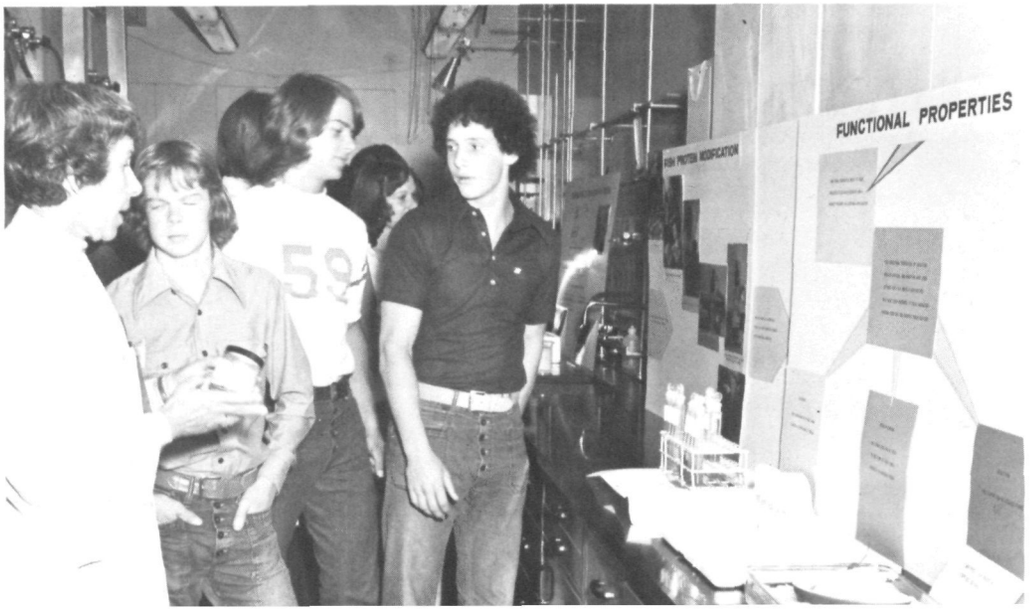
The Seattle laboratory is continuing studies of this process with other species of fish. Aside from the need to learn the characteristics of each species that may be used in meat products, they are also cooperating closely with processors to solve any quality problems and to develop recommendations for efficient and careful preparation of the raw fish materials.

At present U.S. Department of Agriculture meat-processing regulations do not permit the substitution of fish for poultry in the processed meats. But when the problems have all been solved, changes in these regulations may be in order. One obvious question is "If minced fish is so good at the 10 to 15 percent level in processed meat products, why not make up products with 100 percent fish?" As it turns out, production of fish sausage is not only a good possibility for the United States but is already a significant industry in other countries, particularly Japan, where over 100,000 tons of fish sausage and related products are produced annually. In view of that, NMFS researchers visited Japan in 1974 and learned much from them concerning the technology and production of fish sausage and similar products.

Four basic problems must be solved, however, before there can be any large-scale production of fish sausages and related cured specialty products. *First*, there is the important factor of raw-material supply. Food processors will not invest in fish sausage production on a substantial scale until they are assured that suitable raw material can be obtained in the quality and with the delivery conditions needed for year-around production. So a number of other species must be readily available provide this broad material potential. *Second*, the characteristics of each species must be understood, and its production in a stable form as an intermediate raw material must be practicable. Otherwise, the successful operation of the fish-sausage plant will be jeopardized whenever catches or landings of favored species are minimal. A variety of species must be usable to enable the processor to obtain supplies at various times and areas. *Third*, the products offered to the consumer must be equally or more palatable and nutritious than their 100-percent-meat

Menhaden by the ton is about to be pumped from this seine to a processing plant ashore at Southport, N.C. This plentiful ocean resource is currently under study by the National Marine Fisheries Service for its potential as a protein-rich convenience food supplement and a number of other possible uses. In the U.S., commercial fishermen take more menhaden than any other fish.

Experts at the Seattle labs of the NMFS carry out a variety of projects designed to find the most effective commercial use for fishery products. (Top left) Headed and gutted fish is fed into a machine which extracts the flesh from skin and bone waste. (Top right) A step in making fish spread using a device to prepare an emulsion of fish muscle and other food ingredients. (Above left) Evaluating the texture characteristics of Pacific fish species for use in kamaboko, a Japanese fish cake. (Above right) Minced fish and other ingredients are passed through a food emulsifier to reduce it to microparticle size prior to packaging and freezing it into blocks. (Right) Functional properties of fish proteins and their use in making a whipped topping for desserts are demonstrated at the 1974 NOAA Open House in Seattle.



Modern Technology Provides Better Use of Fish

This chart shows the progress being made by NMFS researchers in Seattle, in adapting modern food processing technology to obtain nutritious and palatable foods from fish that are not directly acceptable for table use.

Problem Fish are:	Possible Solutions	Progress to Date
Small.	Mechanize handling and refrigeration aboard vessel.	Equipment available.
	Mechanize unloading, washing, handling.	Equipment available.
	Mechanize heading and gutting.	Equipment available, but modifications likely.
Bony; skin and scales undesirable.	Separate edible minced flesh from skin and bones mechanically.	Commercially available. Two types of machine in use.
Oily; tend to become strong, rancid, and dark.	*Alt. 1*—Blend dark, oily flesh with light, non-oily species.	Pilot tests successful; stability is improved.
	Alt. 2—Remove dark, oily portions by washing flesh.	Laboratory tests promising; need pilot studies on washing techniques.
	Alt. 3—Blend flesh with additives to stabilize oil.	Laboratory tests successful; more studies needed with commercial antioxidants.
Strong-flavored.	*Alt. 1 & 2*—Same as Alt. 1 & 2 above.	Same as for Alt. 1 & 2 above.
	Alt. 3—Produce products in which flavor is modified as in smoked, cured, specialty products.	Best if blended with wild fish, meat, or cereal components, using small percent of stronger-flavored species.
	Alt. 4—Use as protein substitute in processed meats at 10 to 15 percent level in cured sausages and smoked products.	Freshness of fish very important, since no flesh treatment prior to addition.
Soft, firm, moist, or otherwise have poor texture.	*Alt. 1*—Blend with fish having different texture, e.g., soft flesh with firm flesh.	Pilot tests successful, but each species needs test under commercial conditions.
	Alt. 2—Use texture modifiers or moisture-binding additives.	Same as preceding.
Unappealing and unacceptable because of past use and reputation.	Change form and use flesh as ingredient in flavored, processed product in which species or portion is not immediately apparent. Emphasize flavor and convenience in final product. Consider institutional and fast-food outlets for many convenience foods.	Such solution has been highly successful in the meat and poultry industry. Potential of new convenience foods at institutional level particularly promising.

counterparts. The factors in quality-control assurance must be well established both in production and in the distribution chain. Past experience has well shown that the consumer soon rejects an item that is tasty and appetizing one time and barely edible another time. *Fourth*, the market demand and the economic feasibility of producing and marketing these products on a national scale must be established on a reasonable basis by both the government and the industry. The processor must make a substantial investment not only for the production lines but also for the market promotion and consumer education needed for a new product.

Once fish sausage and processed fish products have a firm place in the market, the consumer can expect a wide variety of specialty and cured fish products in various shapes and flavors. Tests have shown that minced fish flesh has excellent properties for producing a variety of shaped or molded products and snack foods, with a wide range of textures and spice or smoke flavorings. These are the properties that make fish flesh good for emulsifying and binding fat and moisture in a simulated meat product, and that provide cohesion and texture control in spreads or dip products as well as in sausage or portion-controlled loaf or lunchmeat specialties.

Flavored fish spreads are prepared from the minced flesh of various species of fish by emulsifying and blending the flesh with a variety of ingredients and flavors followed by packaging and heat pasteurization. This process produces a surprisingly stable and versatile snack food. Basic flavors used so far have been scallop, chive, and smoke; but the product concept allows numerous variations by the processor. The product is convenient to store and prepare. Frozen fish spreads were stored for 2 years in our freezer at 0°F, thawed, and then proved to have unimpaired whipping and emulsifying properties. Stable, smooth, creamy dips and salad-type dressings were quickly produced in the blender. The Seattle researchers think this type of refrigerated or frozen pasteurized spread could be one of the most versatile snack foods. Potentially, they can be produced from menhaden, herrings, and, indeed, almost any species.

Thanks to the modern food technology that produces simulated meat products, and other textured vegetable protein foods from the once lowly soybean, most consumers are familiar with food products that incorporate protein isolates and modified proteins—even though they have never heard of the terminology. In recent years NMFS laboratory research has shown that menhaden, herring, rockfish, and hake can be used to produce protein isolates and modified proteins that are as far removed from the original fish as textured soy protein is from the original bean.

The interesting development in these new fish protein isolates is that the "functionality" of the protein has been protected and, indeed, enhanced by the process. These functional properties in fish protein isolates are important because manufacturers of modern processed foods need ingredients not just for nutritive value but to improve or stabilize the desired physical properties of their product. For example, processed meats and fish sausage should be moist and cohesive, spreads and dips should be smooth and have a stable emulsion, dessert toppings and whipped desserts should be light and stable, and baked goods should have good crumb characteristics and moisture control. A functional fish protein isolate or modified protein can provide these properties.

These new product concepts still have a long road to travel from the laboratory and pilot plant to the supermarket. The strongest elements supporting our vision of new products from old resources are the two ends of the road—the availability of the resources at one end and consumer demand at the other. Large quantities of menhaden, herring, and other species of pelagic fish can be channeled into these new food products as soon as industry and the appropriate government agencies are convinced that the alternative resource uses are desirable for achieving national food goals. Economics and a favorable dollar return for new investment are, of course, essential and can only be assured by the market end. Assuming market specialists are correct about the continuing change in our consumption trends and the increasing use of convenience and processed foods, these new fishery products will have a secure place in the market basket. Research at the National Marine Fisheries Service Utilization Research Center laboratories will continue on ways that America's national fishery resources can be used to provide the consumer with the best food choices.

"A little imagination helps..."

NOAA's Resourceful Instrument Makers

In NOAA instrument shop, Boulder, veteran machinists build—often design—tools for research. Top, shop supervisor Orville McKim (center), trainee Diane Rayburn and Michael Cawley. Right, Peter Karas and McKim examine gust probe assembly for Office of Weather Modification.

Photos by Harry Covey

BY LOUISE A. PURRETT

From a collapsible display case to a massive wind-sensing system, they can build it in NOAA's instrument shops. There, skilled hands work behind the scenes to produce the precision parts—and sometimes the entire research tool—that NOAA scientists need to study winds, waves, atmospheric aerosols, pollution, ocean sediments, cloud formation, severe storms, and all the multitude of things that NOAA scientists study.

In an instrument shop in Boulder, a long room split down the middle by a row of machine tools and lined with workbenches, a small team of veteran machinists fashion the research tools for the Environmental Research Laboratories there. They work among an array of raw materials—standard parts in drawers and shelves, sheets of metal leaning against a wall. A cart contains some discarded instruments that one of the team is dismantling to salvage the parts; very little goes to waste. Their tasks range from delicate and meticulous sensors to the sturdy casings to protect them. They even repair cameras.

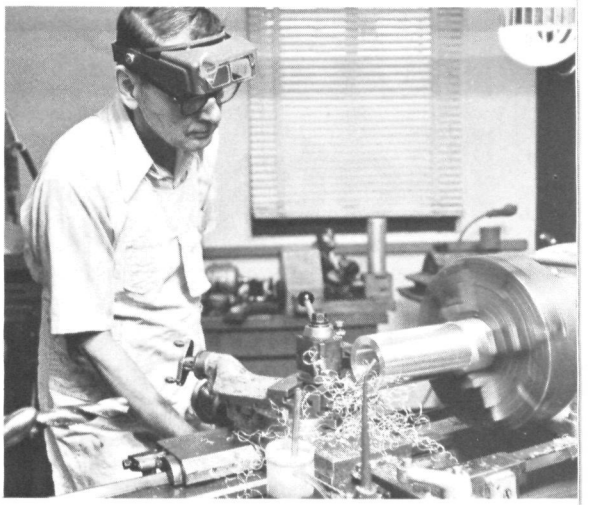
Sometimes the instrument-makers work from detailed engineering drawings spread out on a workbench. The drawings may set out complete specifications for the job, and all that's needed is the skill to match. More often, however, the starting point is only a rough sketch, or a verbal description of the function the device is to perform. According to shop supervisor Orville L. ("Mac") McKim, about 95 percent of the shop's work falls into the latter category. "A customer will come in here and sketch out what he has in mind. We'll go over it with him, make suggestions, point out limitations. After we go through several sheets of paper we have a rough design worked out. Sometimes we change it as we work, too. Maybe we'll find that something works out better if we shift things around a little, add a gear, use a different material. It might take a lot of working back and forth talking things over with the customer at each stage. There's no set procedure here. We make our own procedure as the job progresses, trying to be practical and economical at the same time.

Sometimes a scientist or technican will come into the shop with just an idea of what he wants, and the instrument maker designs it from scratch. "We do a lot of engineering and design," notes Mac. "the job requires a lot of imagination."

One of the group, Dr. Barthold Bouricius, applied his engineering skills recently to a device for the optical propagation group of the Wave Propagation Laboratory. The finished instrument, as carefully machined as a fine clock, will be taken to Hawaii, where it is to be installed on a 14 inch telescope and pointed at selected stars for measurements of optical distortions in the atmosphere.

Sometimes a little imagination helps. The best design for a collapsible display case turned out to be a series of rubber balls drilled with holes and connected with plastic tubing—much like Tinker Toys. In fact, Peter Karas, who designed it, found that toy horses and airplanes could also be built with the "display case." McKim once made what he calls a "beam stretcher" for lasers—a mirror device he designed to increase the wave-length of laser light.

The instrument makers come from backgrounds as diverse as the tasks they find



Dr. Barthold Bouricius (above) shows McKim device to be attached to telescope to measure optical distortion. (Top right) Bouricius works at lathe on device for Office of Weather Modification. (Bottom right) Richard Cupp and Peter Karas discuss mirror mount Karas built for a laser wind sensor that will direct beams of infrared laser light into weather systems.

themselves tackling. McKim started out as an auto mechanic before entering a four-year machinist apprenticeship program at the U.S. Naval Air Station in San Diego. His experience since then includes six years at Dow Chemical's Rocky Flats plant in Colorado, and aircraft and nuclear energy work.

Karas, who also completed his apprenticeship at San Diego Naval Air Station, had been a carpenter. Michael Cawley was a railroad brakeman before switching to machine work. Karas and Cawley ran into each other twice in their careers before ending up together in the instrument shop. Both worked on nuclear reactors in the Arco desert of Idaho, though different employers, and the two worked at the same chemical plant in Pocatello.

All three are journeymen machinists with 25 or more years' experience.

Bouricius, formerly a researcher with NOAA's Wave Propagation Laboratory, spent a number of years at General Electric space, aircraft, and space vehicle laboratories, conducting research on the physics of planetary atmospheres, the space environment, and nuclear propulsion.

"We all have experience in atomic research," says McKim.

Their broad experience now comes in very handy. One day Karas may be seated at his workbench assembling a delicate gust probe to be mounted on a long rod protruding from the nose of an airplane to determine the aircraft's motion with respect to both ground and air. The next day he may be machining a sturdy metal plate to support a massive movable mirror for directing laser beams into such weather phenomena as dust devils and waterspouts.

One of the biggest jobs in recent years has been helping to build a lidar, a laser radar for probing weather systems with beams of laser light. "We were all pretty busy on that one," recalls McKim. The completed system occupies two large trucks. Other jobs can be solved with a little ingenuity. McKim once converted a power gasoline chain saw into a drill for obtaining volcanic core samples.

The instrument-makers, who thoroughly enjoy their work, relish this constant variety, and the opportunity it offers for creativity. Diane Rayburn, who is nearing the end of a year as an instrument-maker trainee, views McKim's shop as the ideal place to learn the machinist's trade. Unlike many shops, where the work may be limited to repeated production of a few parts, the NOAA instrument shop has allowed her to learn a wide range of skills.

Diane chose the trade for practical reasons. "I needed a job, this is interesting work, it pays well, and there's a demand for it. The guys here have been great. They're always willing to take time to explain things." Diane spent a year at a vocational school in Boulder before joining the NOAA shop, and has recently been accepted for a formal four-year apprenticeship program with the National Bureau of Standards.

Machine work isn't just an eight-to-five job for most of the team. Their skill often enters into their leisure activities. Karas likes to work on cars. McKim has modified a VW "bug" for cross-country jaunts and added a tow-bar to haul it along on camping trips. McKim also teaches evening courses in machining at a local vocational school. "I like to help people get started in this trade. It's a good career. These days lots of people with regular college degrees are out of jobs. There's always a demand for good machinists. But it's the kind of thing you have to like to be good at it."

In this instrument shop, the keys are ingenuity and versatility, and the only routine is novelty. "We never know at 8 in the morning what we're going to be doing at 8:05," says McKim. Each day brings something new, and they love it.

Four Nets, More Shrimp

*BY DAVID L. HARRINGTON

When oldtime fishermen change to new gear and start outcatching commercial men who had been beating them for years, that's proof other members of this competitive breed will buy.

The University of Georgia Sea Grant program employed this psychology to convince shrimp fishermen that twin trawling—towing four nets, two off each side of one boat—catches more shrimp than the double rig they were accustomed to using.

The adaptation of twin trawls for shrimp fishing in the southeast Atlantic states, its acceptance by commercial fishermen, and the resulting increase in shrimp production is widely regarded as one of Sea Grant's most significant contributions to commercial fishing.

At the Brunswick Fisheries Extension Station of the University of Georgia Marine Extension Service, our unofficial motto is "fishermen helping fishermen." Our six agents all have commercial fishing backgrounds, and the station has its own commercial shrimp trawler, the 57-foot Capt. Gene, which is used in testing new gear. Thus, the agents have found it easy to develop rapport with fishermen, not only in Georgia, but also in the Carolinas, Florida, and Texas. This rapport and understanding are largely responsible for the staff's success in introducing new techniques.

Our philosophy of gear development and demonstration is that the commercial man probably has the best ideas. We combine our ideas with what the commercial man wants—but cannot afford—to do. Once we have refined new gear, we show it to the fishermen, help rig their boats, ride with them to eliminate any "bugs," and then turn them loose. If the new gear pays off, we know from experience that other fishermen will adopt it.

The shrimp fishery in the United States really is not very old. In fact, many of the people who were in it in the beginning are still around. But its evolution in less than a lifetime is amazing. Initially, all shrimp trawling was done by single rig boats, each

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towing one large net. In the 1950's, shrimp fishermen in the Gulf of Mexico began double-rig trawling. By adding large outriggers to the mast, the boats could tow two smaller nets, one on each side. The double-rig method increased production, the two smaller nets catching significantly more shrimp than a single large one.

The present-day double-rig shrimp boat is probably the most efficient fishing vessel in the world. Regardless of its size, it can be operated by two or three men. With this small crew, two large nets can be set out, towed, hauled back, emptied, and set out again, the catch sorted, and the shrimp iced down.

The efficiency of the southern shrimp boat is based mainly on gear handling methods and on equipment. It is attained by following certain unwritten, and really impossible, precepts: the equipment is low in cost, but never breaks down; if it does, it is simple to rapair; it is easy to operate; and it catches a lot of shrimp.

Shrimp boats also have an unusual crew structure. The captain is a captain, navigator, engineer, master fisherman, rigman, winch operator, deckhand, and—sometimes—cook. The deckhand is usually half captain, half engineer, rigman, winch operator, fisherman, ice-hold man, and—normally—cook.

With a good crew and a catch that is not too trashy, the men can eat well and, if they're lucky, get enough sleep. It's not a soft life by any means, but it's satisfactory if your're making money.

Soon after double rigging was introduced, a few Gulf shrimp fishermen began experimenting with twin-trawling. their reasoning was obvious:

If two smaller nets can catch more than one large net, why not try four? But these pioneers were discouraged by troubles with rigging and retrieving the twin-trawling gear. Fishermen seldom have the time or money to experiment. They may try something new, but if problems crop up, they usually go back to proven, standard equipment.

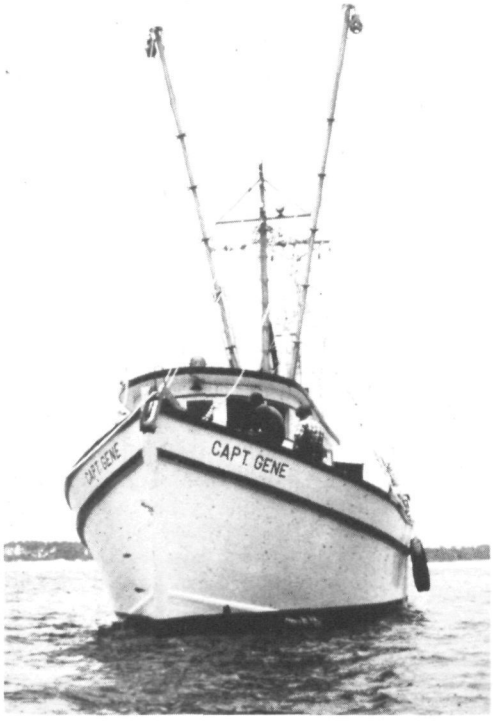
In Georgia, the twin-trawl story began with a visit from Captain Jim McMurrey of Freeport, Texas. He and a few other Gulf shrimp boat captains were experimenting with twin trawls. Captain James Higgins, a Georgia extension agent and a long-time fisherman, accepted an invitation to ride on the Gulf captain's boat and observe his twin-trawl gear in operation. His report convinced us that twin trawling could be successful in the south Atlantic shrimp fishery.

So the University of Georgia Sea Grant program undertook the project of refining the twin-trawl system for the shallow-water shrimp fishery along the East Coast.

The Captain Gene was rigged with twin trawls. Many hours of towing followed. There were foulups and snarls. Changes were made, which sometimes led to worse foulups and snarls. Eventually, it worked.

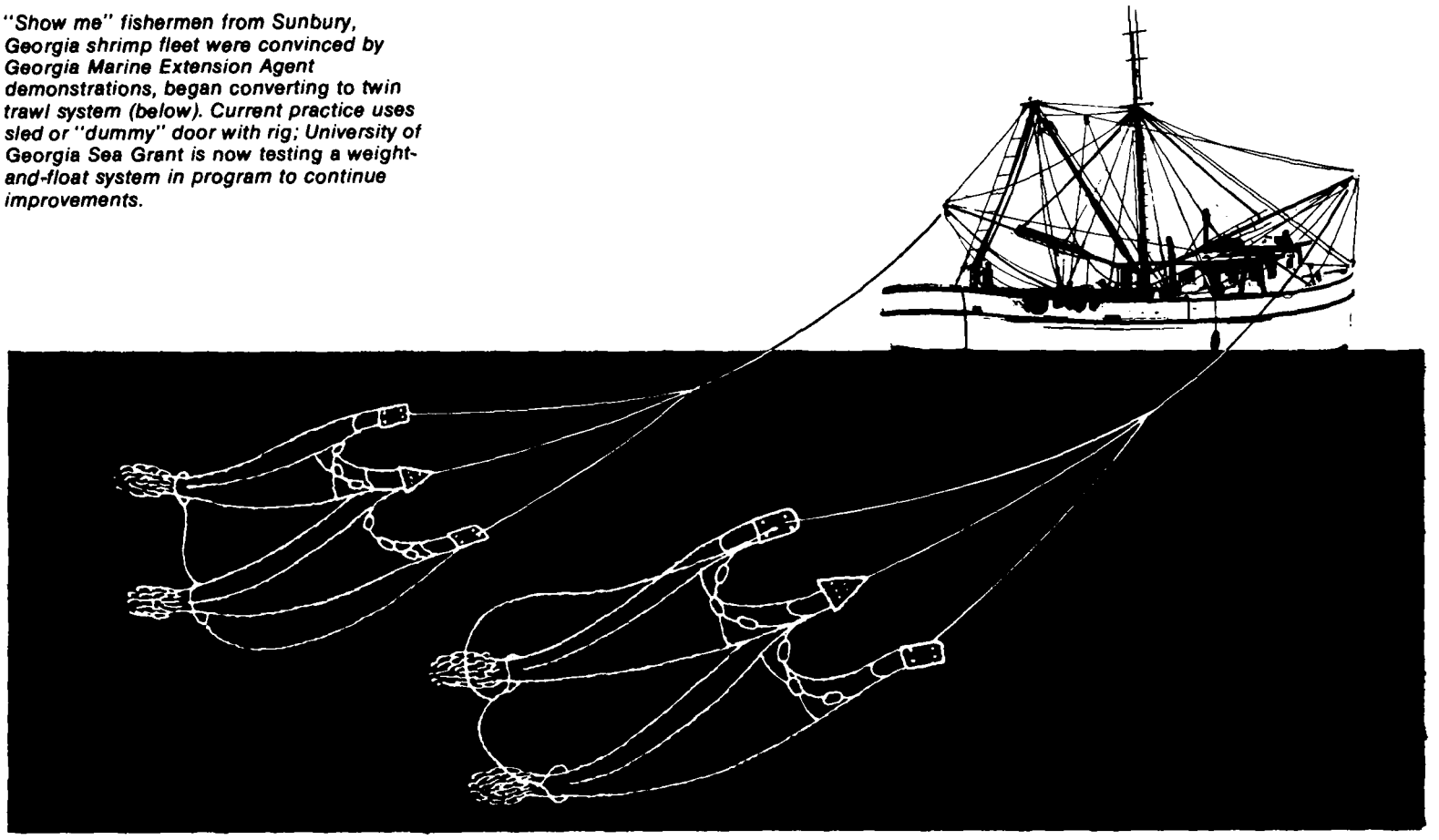
Because the shrimp fishing grounds in Georgia and South Carolina are in tight places, such as sloughs, along banks, on the beach, or near wrecks, the maneuverability of boats rigged with twin trawls was a major concern. Our tests showed that they actually are more maneuverable than double-rigged vessels.

The tests also demonstrated that the twin-trawl system maintained a higher catch rate than the standard gear. The increased efficiency is attributable to increased towing speed. The smaller nets and smaller trawl doors offer less resistance; therefore towing



Fishermen talk to fishermen in Marine Extension Service of University of Georgia Sea Grant program, often using 57-ft. commercial shrimp trawler (above) for gear testing. Extension agent Tom Shierling (center above), ex-crab fisherman, shows fast method to build crab traps; Capt. James Higgins (right above) shows fishermen net mending methods; Jack Rivers (below) shows Texas fishermen different trawling techniques. At left, rigging a commercial fishing boat with twin trawls.

"Show me" fishermen from Sunbury, Georgia shrimp fleet were convinced by Georgia Marine Extension Agent demonstrations, began converting to twin trawl system (below). Current practice uses sled or "dummy" door with rig; University of Georgia Sea Grant is now testing a weight-and-float system in program to continue improvements.



speeds are higher for any given throttle setting, and the boats get more miles per gallon of fuel.

After the tests, the University's Sea Grant program published a bulletin, "Shrimp Fishing with Twin Trawls." Notices of the bulletin, printed in a few foreign and national trade journals, brought hundreds of requests for the bulletin and additional information from foreign countries and other states. Twin trawling began catching on in such places as Australia, South America, New Zealand, South Africa, and Vietnam, in Georgia and the Carolinas—and even in Texas and Louisiana where it all began.

Early in 1974, Fulton Love, a Georgia netmaker, realized the potential of the twin-trawl gear, and convinced several captains in his area that at least one boat ought to try it.

Captain Ellis Phillips was the first of the Sunbury, Georgia, fishermen to try the twin-trawl gear. "We hadn't ever seen a twin trawl until Dave Harrington came down here," Captain Phillips says. "We went out together four or five times, and then I had just two nets built and went to it—pulling the twins against a single (two nets on one side of his boat, and one on the other). The twin trawl side was beating the other so bad, I just went ahead and had Fulton Love build the rest of them and went to pulling them on both sides.

"One time, right at the last of the season," Captain Phillips recalls, "there must have been 12 to 15 boats fishing right in the same territory, within a half-mile range. I caught more than 1300 pounds that day. The others had seven or eight hundred pounds. I even tore up a net, and pulled the other three the rest of the day. The other fishermen didn't believe me, but I had the shrimp."

Before switching to the twin trawl, Captain Ellis had always had about the fifth highest annual shrimp catch at the Sunbury dock. This year, using twin trawls, his catch is the highest of all. He's Number One at the Sunbury dock.

After seeing what Captain Ellis was achieving, six other Sunbury boats switched over to twin trawls during the season. Their status in the local pecking order of shrimp production rose accordingly.

At the Brunswick station, we were fairly confident they'd go for it, once they got used to it. We told them that from our experience the gear would pay off on the roe white and brown shrimp. We told them to take it off during the late summer and early fall months, because production might drop. So what did they do? They doubled the catch of those who weren't pulling twin trawls during the roe white and brownie seasons. They left the gear on when we told them to take it off, and loaded the topline with floats. The production ratio fell off a little, but they still managed to beat the other boats by 20 to 30 percent.

There are no secrets on the waterfront; the fishermen's communication network is hard to beat. Fulton Love, the netmaker, knows this as well as anyone. "The University is able to experiment with something like twin trawls. People like us just don't have the money. These twin trawls have definitely helped our fishermen. They're catching more shrimp. And there will be a lot more boats pulling them. I'd say in five years at least a third of the boats on the coast will be pulling them. Right now, several boats in Savannah are planning to switch to them, and several more at Fulton, along the lower Georgia coast."

Converting a shrimp boat from the more traditional double rig to twin trawls is really quite simple. In the double rig, one funnel-shaped net is towed on each side of the boat by a pair of stout wire bridles attached to winches on deck. Long booms or outriggers extend from the sides of the shrimpboat like a pair of gaint fishing poles. The bridles run through a pair of pulleys on the outboard end of the outriggers. This keeps each set of bridles apart and prevents the nets from coming together as they are towed astern of the vessel.

To keep the mouth of the net from collapsing, a system of "doors" is used. As their name implies, the doors are rectangular in shape. Made of wood or steel and attached to the end of each bridle just in front of the mouth of the net, they form a pair of hydrodynamic baffles or wings. As the net is towed through the water, the two doors spread open the mouth of the net, which then catches any shrimp of fish they may wander across its path.

In converting to twin trawls, which involves four nets rather than two, the only major change is the addition of a third wire to each pair of nets. This wire is used to pull a dummy door or sled between each pair of nets. The sled in turn pulls the center wings of what are now two adjoining nets. The result is a pair of nets towed on

either side of the boat. As with the double-rigged trawl, two of the bridles on each side of the boat run to the pair of doors that spread open the mouth of the net.

Last fall, the University's extension agents took the Captain Gene and its new gear to Panama City, Florida, where divers photographed and documented the performance of the twin trawls. The divers also were able to take precise measurements of net spread, height, door and sled performance, and make many other important observations. The performance of several types of net was documented during this operation.

This film footage since has been shown to more than 200 fishermen on the East Coast, and has helped tremendously as an educational tool. Most important of all, it shows the spread performance of the twin trawls—and the more spread, the more ground they cover.

On the Captain Gene, six-foot doors presently are used to spread twin 36-foot nets. That's 72 feet of webbing. Some commercial boats even are using six-foot doors to spread more than 80 feet of nets. In conventional fishing, that much webbing would require nine to ten fishing doors.

Late last season, the University helped Captain Thurmond Kern, who has been a fisherman all his life, adapt to twin trawls. "Some of those boats have been beating me steady for 15 years," Captain Kern says. "Of course, they've had twice the horsepower I have and still do. Then I put those four-barrel rigs on, and beat them tow after tow. No, sir. You won't find me pulling anything else now."

That's what it takes to prove new gear to a commercial fisherman. It all boils down to what's in his wallet at the end of the year and how he fared compared to other fishermen.

For the past three years, Georgia shrimp fishermen have had a serious problem with cabbagehead jellyfish—two-to-four-pound nonstinging jellyfish which overload the nets in just a few minutes' time. These huge weights can break the tackle and rigging, and in any event the fishermen lose time and money separating the jellyfish from the catch.

The Fisheries Extension Station has been developing several types of jellyfish separators. With the twin-trawl rig, four separators can be tested and compared simultaneously.

Our jellyfish separator is a modification of existing designs developed by the French and the Dutch. It is like a funnel within a funnel. A six-inch-mesh net sewed inside the two-inch mesh net allows the shrimp to pass through but stops the jellyfish, which are then passed out of the net through a hole in the back. When the system was first introduced to local fishermen, they sat back and said that there was no way that they were going to fish with a net that had a hole in the end of it. They thought they would lose too many shrimp.

This is a logical assumption to make, but our tests have proved otherwise. Comparing catches on the same trawl, we found only 15-20 percent fewer shrimp in the jellyfish separator nets than in the unmodified nets. This is a small shrimp loss considering the time it takes to separate the jellyfish from the shrimp by hand.

If the jellyfish are back this season, we will continue testing modifications of the separator trawl. If they do not reappear, the Marine Extension Service staff will concentrate on other problems reported by the fishermen.

For example, the station provides instruction in navigation techniques aboard the Captain Gene, and the uses of other equipment—such as depth sounders and fish locators—are being explained to the fishermen. All of this assistance is given so that the fishermen eventually can operate independently.

Another problem is net repair and net building, a dying art. In Georgia, a lot of the old, retired fishermen do a little net mending; but most fishermen from Georgia go to commercial netters whenever they get a rip or need a new net. Because there is only one netting company in Georgia, this usually involves sending nets to Florida for repairs. So the Brunswick station is offering courses in net repairing and net building to help out the local fisherman and save him a little money.

The Marine Extension Service also is assisting fishermen in several areas interested in forming cooperatives, and is working closely with seafood processors.

We have found that academic degrees are not even remotely necessary for good commercial fishery extension work. If we need special expertise, as we do in such areas as waste disposal, food science, legal assistance, marketing and economics, it is available on campus.

Basically, we just try to stay responsive to the needs of the fishing industry.

Seafood Jamboree

Time to entertain? Today's smart party-givers take their entertaining in stride. They know how to be creative and serve marvelous food without spending hours in preparation. Many of these busy but clever folks have decided that it is time to use imagination, revise menu plans, and try something different. If you are casting about for new ideas—try fish! Fishery products are good to eat, good for you, and there are countless ways to prepare and enjoy the bounties from the sea or fresh water. The National Fisheries Education Center suggests you try these imaginative new recipes and join in the "Seafood Jamboree!"

KOULIBIAK
Salmon Turnover

1 can (1 pound) salmon
2 cups cooked brown rice, kasha, or cracked wheat
1/2 cup dairy sour cream
1/4 cup butter or margarine, melted
1 tablespoon lemon juice
1 teaspoon dill weed
1/4 teaspoon salt
1 package (8 ounce) refrigerated crescent rolls
2 hard-cooked eggs, sliced
1 egg, beaten
Additional melted butter or sour cream

Drain, bone, and break salmon into chunks, or flake. Combine rice or kasha or cracked wheat, sour cream, melted butter or margarine, lemon juice, dill weed, and salt; mix well. Stir in salmon. Unroll refrigerated dough, but do not separate into triangles. Roll out dough on lightly floured board into rectangle, 15 by 10 inches, pressing dough together as needed so that it does not separate. Cut two thin strips of dough 1/4-inch wide from the long side; set aside. Place dough on baking sheet. Spoon 1/2 of salmon mixture in 3-inch wide strip down center of dough to within 1 inch of each end. Arrange overlapping egg slices down center of filling. Top with remaining salmon mixture. Bring sides of dough up over salmon mixture and pinch dough together to seal. Pinch ends of dough together and fold up against roll. Place another baking sheet, upside down, over roll and turn over. Remove baking sheet. Brush roll with beaten egg. Decorate with reserved strips of dough. Brush with beaten egg. Bake in moderate oven, 375° F., 20 to 25 minutes or until dough is browned and done, brushing crust several times with beaten egg, if desired. Slice and serve warm or hot with melted butter or sour cream. Makes 6 to 8 servings.

Salmon Lasagna

- 1 can (1 pound) salmon
- 1 package (6 ounce) sliced mozzarella cheese
- 1/2 pint (1 cup) creamed cottage cheese
- 1 egg, beaten
- 1 jar (15 1/2 ounce) meatless spaghetti sauce
- 6 lasagna noodles (about 1/3 pound), cooked
- 1/3 cup grated or shredded Parmesan cheese

Drain and flake salmon. Dice 1/2 of the mozzarella cheese; cut remaining cheese into 1 1/2 inch squares. Combine diced mozzarella cheese, cottage cheese, and egg; mix. Spread a thin layer of spaghetti sauce over bottom of shallow 2-quart casserole. Top with layers of the following: 3 lasagna noodles, 1/2 each of the cottage cheese mixture, salmon, the remaining spaghetti sauce, mozzarella and Parmesan cheeses. Repeat using remaining ingredients. Bake in moderate oven, 350° F., 25 to 30 minutes or until thoroughly heated. Let stand 10 to 15 minutes before serving. Makes 6 servings.

Crunchy Baked Fish Fillets

- 2 pounds ocean perch or other small fish fillets, fresh or frozen
- 1/3 cup butter or margarine, melted
- 1 small clove garlic, minced (optional)
- 1/2 teaspoon fine herbs blend
- 4 cups whole potato chips, crushed to make 1 1/2 cups crumbs
- 2 or 3 tablespoons grated or shredded Parmesan cheese

Thaw frozen fish. Combine melted butter or margarine, garlic, if used, and herbs; heat. Arrange fillets, skin side up, in shallow baking pan, 15 by 10 by 1-inch. Brush fillets with butter mixture; sprinkle 1/2 of the crumbs over fillets. Turn fillets and repeat process using remaining butter mixture and crumbs. Sprinkle with Parmesan cheese. Bake in hot oven, 400° F., about 15 minutes or until fish flakes easily when tested with a fork. Makes 6 servings.

Crabmeat Chantilly

- 1 package (6 or 7 ounce) frozen king, snow, or other crabmeat, *or*
- 1 can (6 or 7 ounce) king, snow, or other crabmeat
- 2 tablespoons sliced green onion
- 2 tablespoons margarine or cooking oil
- 1 tablespoon flour
- 1/2 teaspoon salt
- Dash cayenne
- 1 cup half and half or milk
- 1/4 cup salad dressing (not mayonnaise)
- 1 package (10 ounce) frozen asparagus spears, cooked and drained
- 1 tablespoon grated or shredded Parmesan cheese

Thaw crabmeat; drain and cut in chunks. Cook green onion in margarine or cooking oil until onion is tender, but not brown. Stir in flour, salt, and cayenne. Add half and half or milk; cook, stirring constantly, until thickened. Remove from heat. Stir in salad dressing. Fold in crabmeat. Arrange asparagus spears in heatproof platter or shallow 1 1/2 quart baking dish. Spoon sauce over asparagus. Sprinkle with Parmesan cheese. Broil about 4 inches from heat, 3 to 5 minutes or until lightly browned and hot. Makes 4 servings.

Curried Tuna With Fruited Rice

1 cup finely chopped peeled apple
1/4 cup chopped onion
1/4 cup margarine or cooking oil
3 tablespoons flour
1 1/2 teaspoons curry powder
1 teaspoon salt
2 cups milk or half and half (half milk, half cream)
2 cans (7 ounce each) tuna, drained and broken in large pieces
2 tablespoons finely chopped preserved ginger or chutney
1 tablespoon lemon juice

Cook apple and onion in margarine or cooking oil until tender. Blend in flour, curry powder, and salt. Add milk or half and half; cook, stirring constantly, until thickened. Add tuna, ginger or chutney, and lemon juice; mix carefully. Heat. Serve over hot Fruited Rice. Makes 6 servings.

Fruited Rice

1 can (13 1/4 ounce) pineapple tidbits
2 cups liquid (pineapple juice and water)
2 cups precooked rice
1/4 cup light raisins

Drain pineapple tidbits; save syrup. Combine pineapple syrup and add water as needed to make 2 cups liquid. Cook rice in liquid as directed on package label. Fold in pineapple tidbits and raisins. Serve with Curried Tuna. Makes 6 servings.

Catfish With Herb-Mushroom Sauce

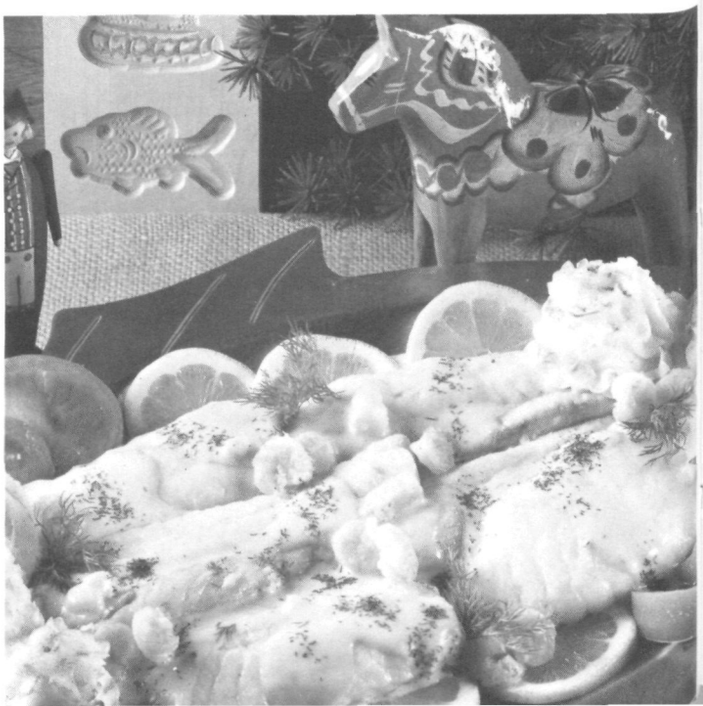
6 skinned, pan-dressed catfish, fresh or frozen
1 teaspoon salt
1 can (4 ounce) mushroom stems and pieces, drained
1/4 cup sliced green onion
1/4 cup melted margarine or cooking oil
2 tablespoons chopped pimiento
2 tablespoons lemon juice
1/4 teaspoon leaf thyme

Thaw frozen fish. Clean, wash, and dry fish. Sprinkle salt evenly over inside and outside of fish. Place in well-greased baking pan, 13 by 9 by 2 inches. Cook mushrooms and onion in melted margarine or cooking oil until onion is tender. Add pimiento, lemon juice, and thyme; mix well and spoon over fish. Bake in moderate oven, 350° F., for 25 to 30 minutes or until fish flakes easily when tested with a fork. Baste fish with pan juices several times during baking. Makes 6 servings.

FISKGRATIN (Swedish Fish Au Gratin)

2 pounds cod fillets, fresh or frozen
1 1/2 teaspoons salt
1 teaspoon dried dill weed
3 cups stiff hot seasoned mashed potatoes*
1/4 cup butter or margarine, melted
1/2 cup shredded Swiss cheese
Paprika
1/4 cup finely chopped onion
2 tablespoons flour
1 cup milk
2 egg yolks, beaten
1 can (4 1/2 ounce) tiny shrimp
1 tablespoon lemon juice

Thaw frozen fish and shrimp. Arrange fish in shallow 3-quart baking dish or on a large heatproof platter. Sprinkle with 1 teaspoon salt and 1/2 teaspoon dill weed. Cover with foil and bake in hot oven, 425° F., 10 minutes. Remove from oven; remove foil and spoon off any liquid collected. Spoon 6 large dollops of mashed potatoes at either end of fish platter. Drizzle 2 tablespoons butter or margarine over fish and potatoes; return to oven. Bake uncovered 10 to 12 minutes longer or until fish flakes easily when tested with a fork. Sprinkle cheese over potatoes and sprinkle with paprika. Return to oven just until cheese softens. Cook onion in remaining 2 tablespoons butter or margarine until onion is tender, but not brown. Stir in flour and remaining 1/2 teaspoon salt. Add milk; cook, stirring constantly, until sauce is thickened. Pour over egg yolks, beating constantly. Return to saucepan and cook, stirring constantly, about 2 minutes. Add shrimp, lemon juice, and remaining 1/2 teaspoon dill weed; mix and heat. Spoon a small amount of sauce over fish and serve remaining sauce with fish. Makes 6 servings.



Bacalao

- 2 pounds cod or other thick fish fillets, fresh or frozen
- 2 1/2 teaspoons salt
- 1/8 teaspoon pepper
- 3 cups thinly sliced potatoes
- 3 cups thinly sliced onion
- 1 clove garlic, minced
- 2 tablespoons olive or cooking oil
- 2 tablespoons butter or margarine
- 1 medium-size green pepper, cut in rings
- 1 medium-size tomato, thinly sliced and cut in half
- 1 bay leaf, broken in half
- 2 tablespoons melted btter or margarine (optional)

Thaw frozen fish; cut into large chunks. Combine salt and papper. Add potatoes to large pan of rapidly boiling water; bring to rapid boil. Drain at once. Cook onion and garlic in oil and butter or margarine until onion is just limp. Layer onion mixture, sliced potatoes, green pepper rings, fish, and tomato into shallow 2-quart baking dish, sprinkling each layer with salt mixture. Add bay leaf. Cover with aluminum foil, crimping it securely to edges of dish. Bake in moderate oven, 350° F., 1 hour or until fish flakes easily when tested with a fork. If desired, brush fish and potatoes with melted butter or margarine. Broil about 3 inches from heat 3 to 4 minutes to brown lightly. Makes 6 to 8 servings.

Celebration Salmon Pie

- 1 can (1 pound) salmon
- 1 cup salmon liquid and milk
- 1 cup soft bread crumbs
- 3 eggs, beaten slightly
- 1 cup diced celery
- 1/4 cup chopped onion
- 2 tablespoons margarine or cooking oil
- 2 tablespoons chopped parsley
- 1 tablespoon lemon juice
- 3/4 teaspoon salt
- 1 unbaked pastry shell (9-inch)

Drain salmon; reserve liquid. Add milk to salmon liquid to make 1 cup. Bone, skin, and flake salmon. Combine liquids, bread crumbs, and eggs; let stand while preparing remaining ingredients. Cook celery and onion in margarine or cooking oil until celery is tender. Add cooked vegetables, flaked salmon, parsley, lemon juice, and salt to egg mixture; mix. Pour into pastry shell. Bake in a hot oven, 400° F., 25 to 30 minutes or until crust is done and salmon mixture is set. Let stand 8 to 10 minutes before cutting. Makes one 9-inch pie, enough for 6 servings.

Salmon-Spaghetti Casserole

- 1 can (1 pound) salmon
- 6 or 8 slices process American cheese
- 1 can (10 3/4 ounce) condensed cream of celery soup
- 1 package (10 ounce) frozen peas
- 1/2 cup chopped onion
- 1 package (7 ounce) spaghetti, cooked and drained
- 1 can (8 ounce) water chestnuts, drained and sliced
- 1/2 pint (1 cup) dairy sour cream
- 1 tablespoon lemon juice
- 2 teaspoons seasoned salt
- Pimiento or green pepper for garnishing (optional)

Drain salmon; save liquid. Bone and flake salmon. Cut cheese into 3-inch rounds, then cut in half. Save cheese pieces. Combine soup, salmon liquid, peas, and onion; heat until bubbling. Stir up spaghetti, water chestnuts, sour cream, lemon juice, and seasoned salt; mix well. Fold in salmon and cheese pieces. Spoon into shallow 2-quart baking dish. cover with aluminum foil, crimping it to edges of dish. Bake in moderate oven, 375° F., about 30 minutes or until thoroughly heated. Uncover. Arrange half circles of cheese around edge of baking dish. Return to oven just until cheese softens slightly. Garnish with pimiento or green pepper, if desired. Makes 6 to 8 servings.

Morton Confirmed As Commerce Secretary

Rogers C. B. (Clark Ballard) Morton, formerly Secretary of the Interior, is now the Secretary of Commerce. Nominated for the position by President Ford, he was confirmed in the new post on April 25.

Secretary Morton had served as Secretary of the Interior since January 29, 1971. In October 1974, the President named him Chairman of the new Energy Resources Council, which has responsibility for developing a national energy policy and program. He will retain this chairmanship.

Prior of his nomination to the Cabinet on January 25, 1971, he represented Maryland's Eastern Shore and Chesapeake Bay area, the 1st Congressional District. The owner of a farm and commercial cattle feeding operation near Easton, Md., he was first elected to the 88th Congress in 1962, and was reelected four successive times. During his first three terms he served on the Interior and Insular Affairs Committee and the Merchant Marine and Fisheries Committee. He was a member of the House Ways and Means Committee before becoming Secretary of the Interior.

He drafted basic legislation which in 1965 established the Assateague Island National Seashore in Maryland-Virginia, and aided in developing legislation for preserving estuarine areas.

The Secretary has been deeply interested in land-use planning for many years and was a member of the Public Land Law Review Commission from 1965–67. He sponsored the Administration's National Land Use Planning Bill which was introduced in the 91st Congress and continued to press for its enactment as Secretary of the Interior.

From April 1969 until he became Secretary of the Interior, he was Chairman of the Republican National Committee.

Secretary Morton was born September 19, 1914, in Louisville, Ky. He attended Woodberry Forest School in Virginia, and was graduated from Yale University in 1937. In 1943 he entered the Army as a private in the field artillery, served in the European Theater in World War II, and attained the rank of captain.

Following military service he joined the family business of Ballard and Ballard Company at Louisville, serving in various administrative posts, including president, until the firm merged with the Pillsbury Company in 1951.

California Experiments

ERL Tests Device For Air Pollution

A remote-sensing experiment being conducted by the Environmental Research Laboratories at El Monte airport in California is providing pollution meteorologists a continuous view of how the atmosphere becomes stratified over Los Angeles, and how the strata change from minute to minute, and day to day.

The remote-sensing device is an acoustic sounder, one of several developed by ERL's Wave Propagation Laboratory in Boulder, Colo.

The instrument is being evaluated as a potential tool by the National Weather Service, and used as a source of research data by meteorologists at the University of California at Los Angeles.

Acoustic sounders like the one at El Monte beep high-pitched bursts of sound upward into the atmosphere, and receive faint echoes from changes in air density. Because air density varies with temperature, the record can be read as a profile of thermal turbulence in the atmosphere up to about a kilometer above the sounder.

The technique's main advantages are that acoustic sounders probe the atmosphere in real time, providing a continuous view not available from conventional balloon soundings; and the method is relatively inexpensive. For researchers, the acoustic profile points up atmospheric trends that are not visible in conventionally sensed data, some of which could become useful predictors for air pollution meteorologists.

The system consists of a "speaker," or transducer, that beeps sound pulses in a narrow beam vertically into the atmosphere. Signals from the transducer are guided by a horizontal cone onto the curve of a parabolic surface, which reflects and focuses them vertically into the air through an octagonal, acoustically insulated horn some 12 feet in diameter at its open end. The roughly cornucopia-shaped horn also "listens" for returning echoes.

The entire system is buried almost flush with the ground, and covered by a protective wire mesh. The installation at El Monte was made last summer by John Wescott and Larry Vohs, both of the Wave Propagation Laboratory.

Space Age Technology Helps NWS Predict Spring Floods

Spring temperatures bring snowmelt flooding to the Upper Midwest and Great Plains with such regularity that National Weather Service forecasters can predict that the onset of high waters will be within a few weeks of mid-April each year.

"The trick is forecasting not when the floods will begin, but their severity," says Dr. Robert A. Clark, NWS Associate Director for Hydrology.

Observations of the areal extent, amount, and character of snow on the ground are vital to flood forecasters. Down through the years, the NWS has built up a network of thousands of "cooperative observers"—public spirited volunteers who provide reports of snow and water conditions each week (more often during the spring warming period). In the past, some forecasters have flown over data-sparse areas in small aircraft to make first-hand observations of the amount and condition of the snow cover.

Researchers Count Fish By Computer

A method that can provide precise and rapid estimates of certain fish stock populations using a computerized, hydroacoustic system has been developed by a Sea Grant team at the University of Washington.

Capping a six-year effort backed by NOAA through its National Sea Grant Program, the Washington research team has devised an acoustic system consisting of:

—Echo sounders that transmit sound pulses and receive echoes from the fish;

—A computer system that converts the fish echo data into estimates of fish populations, and is used either on ships to produce "real time" information on fish abundance, or in the laboratory where it processes data collected on tape recorders at sea.

The National Marine Fisheries Service is now using the sophisticated acoustic gear for surveys of hake stocks off the Pacific Coast.

NOAA Ships Launch New Investigative Season

A fleet of 25 NOAA ships has launched a new season of ocean investigations ranging from a study of environmental effects of oil exploration and development in Alaskan waters to searching for shrimp off the Brazilian coast.

Other fleet activities will include searching for sunken wrecks, studying the spawning of herring, assessing the environmental effects of deep sea mining of manganese nodules, charting coastal waters and analyzing the Atlantic seabed.

The ships' operations will take them through America's coastal waters and estuaries from Maine to Alaska, across the Atlantic and through the Pacific, and along the northeast coast of Latin America.

The NOAA Fleet is operated by the National Ocean Survey, and is manned by 1139 officers, scientists, technicans and crew. The ships range in size from a 73-foot, 125-ton fisheries research vessel to a 303-foot, 3959-ton deep sea oceanographic floating laboratory.

Shellfish Being Raised In Delaware

Fresh oysters and clams grown in Des Moines or, for that matter, any other noncoastal city in the United States, could become a reality if Sea Grant scientists at the University of Delaware are on the right track.

A team of Delaware aquaculturists, working under a NOAA Sea Grant, has completed work on the first stage of a unique project which has as its goal producing fast-growing, palatable, disease-resistant oysters and clams that can be reared at a competitive price in a totally self-contained environment. When successfully developed, the system would be available for commercial adapation anywhere in the United States.

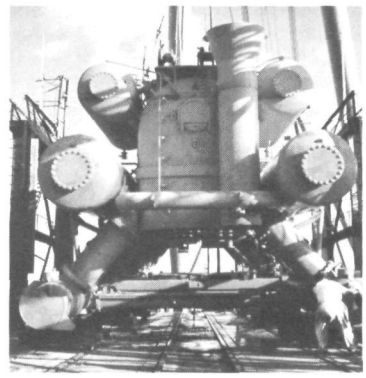
Eight groups of 250 shellfish each are well into their second year of growth, thriving on diets of laboratory-reared algae in a closed (recycled) seawater system. So far, the clams are growing three to five times faster than they do in Delaware Bay, and the oysters about one-and-one-half times faster. Some of the clams in the initial crops already have grown to marketable cherrystone size.

The team of biologists, chemists, engineers, nutritionists, economists, and an attorney is under the leadership of Dr. Melbourne R. Carriker, Professor of Marine Studies at the University of Delaware.

In addition to providing the potential for a new industry, the aquaculture system could be used to produce seed for boosting natural stocks of oysters and clams, and possibly increasing commercial catches.

The project's advantages apparent so far include potential year-round availability of fresh shellfish.

German Habitat In Undersea Study



On September 15, a two-month international scientific investigation of two problems besetting New England fisheries will begin off Rockport, Mass. Using the cold-water undersea laboratory "Helgoland" from the Federal Republic of Germany for on-site observation, German, Polish, and Russian scientists, technicians, and fisheries experts will participate with NOAA and university diver-scientists in efforts to:

—learn how environmental factors affect herring spawning;

—improve hydroacoustic (sonic) techniques for estimating the populations of major commercial pelagic fish species; and

—extend knowledge of underwater living and research from warm tropical seas to cold northern waters.

Dr. Donald Beaumariage, Director of NOAA's Manned Undersea Science and Technology office, is Program Coordinator. Dr. Robert Edwards, Director of the National Marine Fisheries Service Northeast Fisheries Center in Woods Hole, Mass., is NMFS Project Director.

The 75-ton Helgoland will be transported to the United States by a Polish factory ship, and emplaced in about 110 feet of water at the site of a known herring spawning area 8.5 miles offshore, east of Rockport in late August.

Teams of four—three scientists and one habitat technician—will live in the two-room underwater laboratory for periods of 9 to 22 days to carry out the research.

Hydroacoustic techniques for measuring fish populations consist of echo sounders that transmit sound pulses and receive echoes from fish, and computers that convert the fish echo data into estimates of the abundance of the fish "targets".

Species of fish also may be identified by analyzing the sound "signature." When the estimates are accurate, hydroacoustics is a far more rapid method of measurement than conventional methods such as tagging or analysis of commercial catches. Joint hydroacoustical studies in 1974 by the Northeast Fisheries Center and the Russian and Polish fisheries communities showed present measurements of fish to be in error by a factor of two to four.

The Helgoland will therefore be used as a base to conduct experiments with live specimens of such species as herring, cod, pollock, and spiny dogfish shark, to calibrate the hydroacoustic techniques. Aquanaut-scientists will observe live specimens of fish—both singly and in schools—while hydroacoustic equipment in surface ships obtains the acoustic signatures of the fish. Direct communications between divers and the ship will make possible exact identification of the fish species and estimates of the numbers being "observed" hydroacoustically, providing "ground truth" for the sonic observations.

NEW BUOY DEVELOPED

Five years of work in the development of deep ocean moored buoys that automatically supply environmental data for improved weather forecasting will culminate in mid-1975 with the deployment of a prototype operational environmental buoy in the Gulf of Alaska.

The 60-ton, 33-foot (10 meter) discus prototype buoy, being built by General Dynamics, will be delivered to the NOAA Data Buoy Office, in Bay St. Louis, Miss. It will become the forerunner of a series of operational buoys that will be deployed off the United States' coasts to furnish to the meteorological community environmental data from storm-spawning ocean areas.

NDBO Director James W. Winchester said, "the automatic environmental data buoy is a complementary system to many types of platforms including satellites, aircraft, ships and fixed platforms, each with its own advantages and limitations. Through the use of advanced technology the data buoy is now well suited for the acquisition of marine environmental data."

Forecasting For Idaho Improved

The National Weather Service's Zone Forecast Service has been extended to Northern Idaho, providing routine weather forecasts and warnings for smaller geographical areas than previously, and enabling residents of Northern Idaho to more readily relate forecast weather conditions of their own particular area.

Under the Zone Forecast system, the large geographical area from Idaho County north, formerly covered by a single weather forecast issued by the Weather Service Forecast Office in Boise, is divided into three smaller, more meteorologically homogenous areas. The Panhandle Zone forecast will cover the area including Shoshone and Benwah Counties north, the Palouse—Lewiston—Grangeville Zone forecast will describe weather for all of Latah, Nez Perce and Lewis Counties, the western portion of Clearwater County and the Grangeville area; and the remainder of Idaho and Clearwater Counties will be included in the Central Mountain Zone.

EPA, ESIC WILL SHARE SERVICES

The Environmental Protection Agency's Library Systems Branch and the Environmental Data Service's Environmental Science Information Center recently signed an agreement to share services. Under this agreement, EDS and EPA will share library programs, literature searching services, joint bibliography and other publishing programs, and sponsorship of training programs in areas of mutual concern (i.e. library automation, management, microform technology, contracting libraries, literature searching, and marketing of library services).

A similar negotiation was signed between the Department of Interior and NOAA in 1973.

Ocean Data Directory Published

Ocean Data Resources, a directory of marine data management activities in the United States, prepared by the Environmental Data Service's National Oceanographic Data Center, has been published by the United States Senate. A limited number of copies are available to interested NOAA personnel from EDS, Washington, D.C. 20235, or Tel: (202) 634-7306.

The report lists the locations, principal contacts, and facilities concerned with ocean data. While the report initially focused on Federal agency activities, State and regional activities, academic institutions, and industry have also been included to relate Federal ocean data activities to the overall national ocean data effort.

The report addresses itself primarily to data management activities; it does not include organizations involved in the actual acquisition of ocean data through research and survey. Appendices include addresses of referral services and a bibliography of directories of marine science activities.

noaa/people

John P. Webber has been appointed Special Assistant to the Environmental Science Information Center's Director.

Thomas H. Grayson has succeeded **Frank Lewis** as Chief of the Computer Systems Branch of the National Weather Service's Techniques Development Laboratory at Camp Springs, Md.

Patrick Iannelli has been named Official in Charge at the Weather Service Office in Parkersburg, W. Va. He succeeded **Fred Helgeson,** who was named OIC at Caribou, Maine.

James K. Huntoon received the second annual Elmer Neumann Award for achievements in the field of Employee-Management Relations.

Capt. Clinton D. Upham has been appointed Commander of the NOAA Ship Discoverer.

Jorge Fenucci has been awarded an Andre Mayer Research Fellowship.

Dr. Kirby J. Hanson has been appointed Chief of the Data Analysis and Interpretation Group for NOAA's Geophysical Monitoring for Climatic Change program in ERL's Air Resources Laboratories in Boulder, Colo.

Thomas Winterfeld, Advisor for International Programs in the Environmental Data Service's National Oceanographic Data Center; **Dr. Paul Lefcourt,** EPA; and **Dr. Tern Niler,** Professor at Oregon State University, will represent the United States at the VIIIth Session of the Intergovenmental Oceanographic Commission Working Committee on International Oceanographic Data Exchange to be held in Rome, Italy.

Robert J. Shephard has been appointed Program Manager for the Marine Advisory Service within the Office of Sea Grant. He will replace **Howard H. Eckles,** who retired.

Capt. Kenneth A. MacDonald has been appointed Commander of the NOAA Ship Surveyor.

Michael R. Riches attended a Solarimetry Workshop held in Rio de Janeiro, Brazil at the invitation of the Brazilian Government.

Cdr. K. William Jeffers is now Chief of Operations of the National Ocean Survey's office of Fleet Operations in Rockville, Md.

Robert E. Hamilton has been named Meteorologist in Charge at the St. Louis, Mo., WSFO.

John P. Lee has been named Meteorologist in Charge at the WSFO in Louisville, Ky. He succeeds **John R. Burke,** who retired.

Dr. W. Eugene Rench has been named Meteorologist in Charge of the new Environmental Studies Service Center at Stoneville, Miss.

Robert C. Clark, Jr., presented a paper at the recent 1975 Conference on Prevention and Control of Oil Pollution in San Francisco, Calif.

Madeline Randell is the Environmental Research Laboratories' first participant in the Cooperative Education Program.

Kent H. Hughes has joined the Environmental Data Service as Special Assistant for Marine Sciences. He succeeds **Richard M. Morse** who has accepted a two-year assigment with the United Nations in Nairobi, Africa.

Richard A. Foster, Chief of the Program Division in the Office of Programs and Budget, has been selected to participate in the second year of the Federal Executive Development Program.

Frank D. Taylor has been named Official in Charge of the Las Vegas, Nev., Weather Service Office. He succeeds **Reid B. Gardner,** who retired.

Dr. John W. Townsend, Jr., Stuart G. Bigler, W. Clyde Conner, William J. Denney, Edwin B. Fawcett, Dr. Neil L. Frank, Dr. Ronald L. LaVoie, and **Dr. James D. McQuigg** have been elected as Fellows of the American Meteorological Society.

Curtis J. Smith is the new Chief of Substation Management at the National Weather Service Eastern Region Headquarters in Garden City, N.Y. He succeeds **Dwight Rigney,** who has retired.

Capt. Robert E. Williams has been appointed Deputy Director of the National Ocean Survey's Pacific Marine Center in Seattle, Wash. He succeeds **Capt. Gerald L. Short,** who retired.

Dr. David S. Crosby, a parttime mathematician with the Satellite Experiment Laboratory of the National Environmental Satellite Service, has been promoted to full professor and has also been selected as Chairman of the Department of Mathematics, Statistics and Computer Science of the American University.

Dr. Edwin Kessler and **Dr. James D. McQuigg** have been elected Fellows of the American Association for the Advancement of Science.

Lt. (j.g.) Donald D. Winter and **Carl B. Feldscher** presented papers at the 14th Annual Canadian Hydrographic Conference in Halifax, Nova Scotia.

Frederick M. Cramer has been named Meteorologist in Charge of the Apalachicola, Fla., office of the National Weather Service. He succeeds **Robert L. Smith,** who retired.

John G. Norris was selected as the Outstanding Federal Employee of the Year for 1975 at the 19th Annual Employee of the Year Awards Program sponsored by the Honolulu-Pacific Federal Executive Board.

Roland A. Finch wrote a paper selected by the NMFS Publications Policy Board as the best publication appearing in a 1973 edition of the Fishery Bulletin.

Jessie Herrold was selected as "Secretary of the Year" by Juneau's Potlatch Chapter of the National Secretaries Association.

Harvey R. Bullis, Jr., was appointed Assistant International Coordinator for fisheries at the recent Cooperative Investigations of the Caribbean and Adjacent Regions VII meeting in Mexico City.

A NOAA Unit Citation recently was presented to the Horizontal Branch of the National Geodetic Survey's Information Center for its contributions to the success of the updating of the U.S. Horizontal (distance) Control Network.

From left above are Mary E. Yenca; Valerie N. Council; Ervin H. Lange; R.Adm. Allen L. Powell, Director of the National Ocean Survey; Roy A. Anderson; Harry Weber, Chief, Horizontal Branch; James Drosdak; Nancy S. Munro; and Sharon J. Niemi. Not in the photo are Henry B. Ames and Kenneth E. Hawkins.

Dr. Michael A. Heeb has been appointed Assistant Program Manager for NOAA's Marine Advisory Service within the Office of Sea Grant.

Louis J. Boezi was selected Chief of the Instrument Engineering Branch of the National Weather Service Engineering Division.

Lt. Cdr. Merritt N. Walter has been named Commanding Office of the NOAA Ship Townsend. **Lt. Cdr. Abram Y. Bryson, Jr.,** is the ship's Executive Officer.

Marcella Guerra, Karon Gleason, Nancy Walters and **Lee Johnson** are ERL's first candidates for a work-study program to provide additional employment opportunities to staff members as part of ERL's equal employment opportunity and affirmative action efforts.

Frank Makosky has been selected to head the National Weather Service Forecast Office at Little Rock, Ark.

Lt. Cdrs. Lowell J. Genzlinger, Charles N. Whitaker, Bernard N. Mandelkern, and **Melvyn C. Grunthal** attended the recent Canadian Forces Ground School on the Canadian-built DeHavilland Buffalo Aircraft.

Lt. Cdr. John O. Rolland is the new Chief of the Atlantic Hydrographic Party.

Donald H. Pack has been appointed Chairman of the American Meteorological Society Committee on Meteorological Aspects of Air Pollution.

Cdr. Sigmund R. Petersen has been appointed Commanding Office of the NOAA Ship Miller Freeman.

Dr. Douglas R. Greene has been appointed to a three-year term on the American Meteorological Society Committee on Radar Meteorology.

William T. Hodge has been named the new U.S. Data Manager for the International Field Year for the Great Lakes.

John M. Amstadt and **Nicholas F. Sampogna** were elected to the Board of Directors of the Commerce Federal Credit Union.

John Robinson has been appointed Meteorologist in Charge at the National Weather Service Office in Cincinnati, Ohio.

Howard Booker designed a circuit, etched it, put the parts together and produced a digital fathometer calibrator to check survey fathometer and depth recorder data validity.

noaa/update

Possible Deep Sea Mining Site in Pacific is Studied

An intensive study of the first Pacific Ocean site to be identified for commercial deep sea mining has been completed by NOAA scientists.

The NOAA study was part of a major Department of Commerce effort to assess the pre-mining environment of selected areas and evolve some predictions about the environmental effects of deep ocean mining. The 15,000-square-mile (40,000-square-kilometer) research site, at latitude 15 degrees north, longitude 126 degrees west,—identified by U.S. marine mining interests as a desirable mining site—is part of a manganese nodule zone that covers a broad band of the Pacific Ocean floor.

A team of scientists aboard the NOAA research vessel Oceanographer departed from Seattle in mid-April for a site about halfway between Hawaii and Central America. The first phase in the Deep Ocean Mining Environmental Study (DOMES) was a series of baseline studies to determine the pre-mining condition of possible mining sites. This expedition is the second DOMES baseline study.

The DOMES project was supervised by the Marine Ecosystems Analysis Program Office, part of the Environmental Research Laboratories.

Led by Barrett Erickson of ERL's Pacific Marine Environmental Laboratory, a dozen scientists from NOAA, Columbia University's Lamont-Doherty Geological Observatory, the City University of New York, and the Interior Department's Geological Survey subjected the area to 26 days of geological, chemical, physical, and biological scrutiny.

Maine Awarded Grant

NOAA has awarded a second grant, totaling $328,870, to help Maine continue development of a program for managing its coastal zone. Under terms of the Coastal Zone Management Act of 1972, Maine will provide an additional $164,435 in state matching funds.

The first grant from NOAA totaled $230,000 and was made in March 1974.

The management program Maine is developing will attempt to reconcile increasing and conflicting uses of the shoreline for oil refineries, airports, beaches and beach homes, highways, harbors, power plants, wildlife refuges, and commercial service establishments.

Governor James B. Longley has designated the State Planning Office to administer the grant, according to a proposal submitted to the Office of Coastal Zone Management. The State Planning Office will allocate a portion of the grant to several other state agencies for assistance in carrying out the second-year work program.

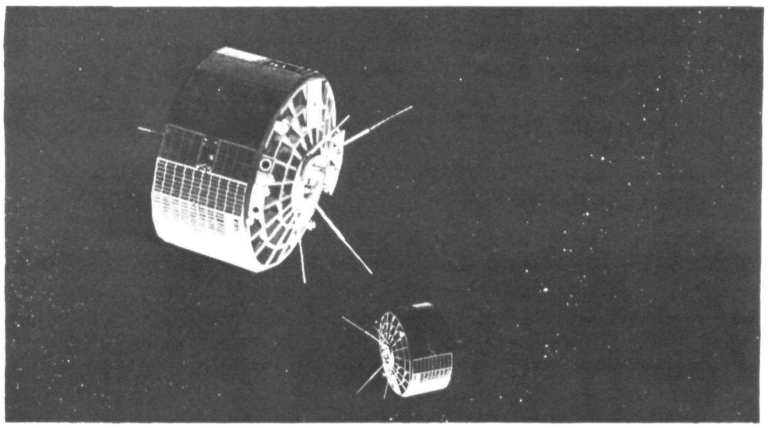
Townsend Elected To Academy

Dr. John W. Townsend, Jr., NOAA's Associate Administrator, has been elected a member of the National Academy of Engineering. He was honored for his leadership in developing sounding rockets and earth environment satellites and advanced technology environmental studies.

Election to the Academy is the highest professional distinction that can be conferred on an American engineer and honors those who have made important contributions to engineering theory and practice or who have demonstrated unusual accomplishments in the pioneering of new and developing fields of technology.

Others in the Commerce Department selected for membership in the Academy this year are Dr. Betsy Ancker-Johnson, Assistant Secretary for Science and Technology, and Dr. F. Karl Willenbrock, Director of the National Bureau of Standards Institute for Applied Technology.

TIROS 1 Weather Satellite in Operation for 15th Year



NOAA recently commemorated fifteen years of weather satellite data and its application to the forecasting and warning of destructive storms.

"From a small beginning 15 years ago," said David S. Johnson, Director of the National Environmental Satellite Service, "the Nation has developed a sophicated and effective operational weather satellite system based upon the accomplishments of the world's first polar-orbiting weather satellite, TIROS 1, launched by NASA from Cape Canaveral on April 1, 1960."

Results from TIROS 1 led to the decision by the U.S. government to create the national operational weather satellite system which permits the detection and continuous surveillance of every disturbance.

Although NOAA still flies satellites based upon TIROS-type capability, Mr. Johnson said, "we have substantially modified and increased the polar orbiting technology to provide on a continuous basis meteorological data to locate storms, especially tropical storms and such phenomena as thunderstorms, frontal systems, fog, ice and snow."

Major storms detected by the satellite system include:

Tropical Storm JENNIFER, which was far out in the Pacific on October 11, 1969, but curved during the night, accelerated rapidly toward Mexico, and struck the city of Mazatlan the next afternoon. Her changes in course and speed were detected in the morning satellite picture in time to warn Mazatlan of the impending disaster.

Other major Eastern Pacific hurricanes in which satellite pictures played the crucial role in enabling weather forecasters to issue timely, accurate warnings were PAULINE (Sonora, Oct. 1968); NAOMI (Mazatlan, Sept. 1968); HELGA (Baja California, Sept. 1966); and BERNICE (Los Angeles, July 1969).

Forecasters in Boston on November 5, 1969, used the morning satellite picture to brief a search and rescue party heading for a tanker breaking up in the Atlantic. Weather and clouds caused by a developing storm system were clearly displayed in the picture. The party was able to avoid areas of squalls and high seas enroute, thus saving valuable time in accomplishing the rescue. Hurricane FIFI (Sept. 14–21, 1974), the severest hurricane of record to affect Honduras, had day-and-night continuous coverage by satellite.

TUNA PRODUCERS ENTER PROGRAM

The Van Camp Seafood Company and Westgate-California Foods, Inc., are the first large producers of canned tuna to enter the Commerce Department's voluntary inspection program, which is administered by the National Marine Fisheries Service.

Under the terms of the contract, an NMFS inspector will be in each processing plant, statistically sampling the tuna as it is processed, to be sure that it is wholesome, clean, and meets the Department's high quality standards.

As a reult of entering the program, Van Camp and Westgate will be permitted to place the Department's "Packed Under Federal Inspection" (PUFI) mark on their canned tuna.

Van Camp, a subsidiary of Ralston Purina, produces "Chicken of the Sea" tuna, and Westgate produces "Breast O'Chicken" tuna and "Carnation" tuna.

ALASKA OIL IMPACT STUDY IS EXPANDED

A Federal effort to assess the environmental risks of developing the offshore petroleum potential of the northeastern Gulf of Alaska is expanding to cover five other key areas of the northern state's share—about 60 percent—of the nation's total continental shelf area.

The multimillion-dollar program, conducted by NOAA under the auspices of the Interior Department's Bureau of Land Management, will examine the life forms and physical environment of these additional areas, selected for their petroleum potential:

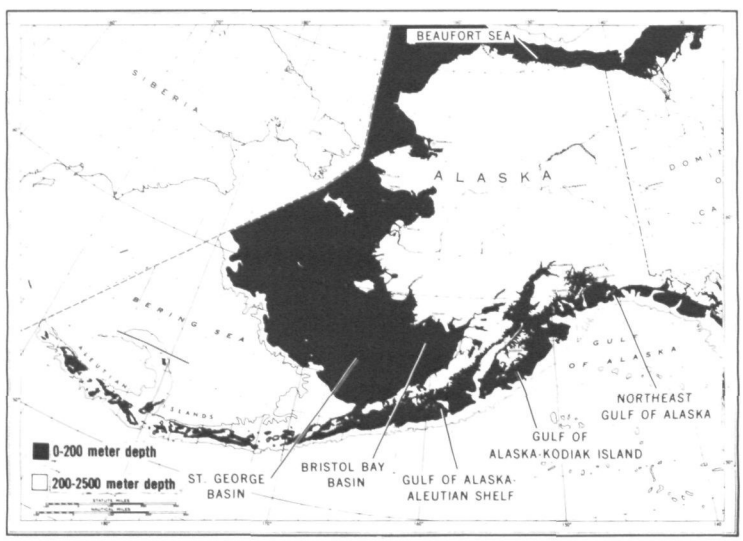
—Two areas along the northwest rim of the Gulf of Alaska, one centered off Kodiak Island, the other running southwestward along the Aleutian Shelf to the Shumagin Islands; the present environmental study will continue in the northeast Gulf of Alaska.

—Two in the broad, shallow shelf area of the Bering Sea: one in St. George Basin, a prominent declivity north of the Aleutian chain; and one in Bristol Bay Basin, between the Alaskan "mainland" and the Alsaka peninsula, which becomes the Aleutian chain.

—One in the Beaufort Sea, running eastward from Barrow to Alaska's boundary with Canada.

The proposed four-to-five year program, which will be managed by the Environmental Research Laobratories in Boulder, Colo., will seek to provide a basis for predicting the primary environmental impact of petroleum development.

Over the first two years of the program, investigators will intensively study Alaskan marine ecosystems.



The marine food web from birds and mammals to planktonic life forms and marine microbes will be counted, and their pathologies determined. Scientists will attempt to define the peculiar adaptations of these life forms to their northern environment, and their susceptibilities to contaminants. Efforts will also be made to determine the role played by regional life forms in transporting, storing, and breaking down some hydrocarbon and trace-metal contaminants.

Winds, Turbulence Measured Over Colorado's Rockies

Using fence posts, cables, clothesline, and a computer, scientists from the Environmental Research Laboratories have transformed two acres of a steep-sided narrow Colorado valley into a rare type of radar.

They are using the new system—the only one of its kind in the United States—to obtain the first ground-based, all-weather measurements of the tricky winds and turbulence over the Rocky Mountains east of the continental divide.

The VHF (very high frequency) radar was constructed, by John L. Green and his colleagues in ERL's Aeronomy Laboratory, near the old mining town of Sunset, Colo., about 10 miles (16 kilometers) west of Boulder and 7,500 feet (2,300 meters) above sea level.

The Doppler capability of the versatile radar permits it to track both horizontal and vertical winds, and "see" turbulence in clear air. Doppler radars sense the change in frequency—the "Doppler shift"—caused by a target's movement toward or away from the radar.

Its unique all-weather capability derives from the radar's unusually long wavelength—24 feet (7.4 meters)—which permits echoes to be obtained from the air itself. Conventional weather radars have wavelengths of about four inches (10 centimeters).

Thus far, the scientists, using limited power and antenna size, have measured winds to altitudes of about 60 miles (100 kilometers) with the radar.

U.S. Proposes Seal Management Change

The United State Delegation to the recent Conference on North Pacific Fur Seals in Washington, D.C., proposed that a different management concept be introduced in a permanent Convention on the Conservation of North Pacific Fur Seals.

The concept of "optimum sustainable population," which is included as a management objective in the Marine Mammal Protection Act of 1972, would require consideration of the esthetic and recreational value of the fur seals and the necessity of maintaining the health and stability of the marine ecosystem as well as maintaining the number of seals needed to permit maximum productivity.

A draft environmental impact statement outlining the "optimum sustainable population" concept and how it would affect fur seal management received favorable comment from private citizens and representatives of States, environmental protection groups, and conservationists who have reviewed it.

Suny/Cornell Named Sea Grant College

Secretary of Commerce Rogers C.B. Morton has announced selection of the State University of New York (SUNY) and Cornell University as a Sea Grant College.

"The joint SUNY/Cornell Sea Grant Program, now in its fourth year, has been from the beginning an unusual and outstanding coequal partnership between one public and one private university," Secretary Morton said. "Together," he pointed out, "they have mounted very strong programs of applied research, education and training, and advisory services in marine affairs—programs that qualify them for the honor of Sea Grant College status."

In recognition of the excellence of a university's marine programs, the Secretary of Commerce may honor it with Sea Grant College status.

"The SUNY/Cornell Sea Grant College is unique in that its projects are carried out at 15 diverse institutions," Mr. Wallace noted. "It is a leader in the development of multiple-campus programs and demonstrated that such an arrangement is not only possible but beneficial, bringing a wide array of talents to bear in solving important problems and allowing many campuses, both public and private, to work effectively with local constituencies."

SUNY/Cornell Sea Grant research programs have three principal objectives: to develop awareness of the coastal zone and the need for planning its use; to assist the State in using and managing coastal resources; and to aid industry in making more effective use of marine resources.

CHART SERIES IS EXTENDED

With the cooperation of the Defense Mapping Agency Aerospace Center, NOAA is extending the U.S. civil version of the World Aeronautical Chart series to cover Latin American and Caribbean areas.

The WAC is an international chart format established by the International Civil Aviation Organization which the United States has revised to conform to domestic requirements. A U.S. military version of the WACs has been issued until now for the Latin American and Caribbean areas.

Satellite Sensors Tested

A team of scientists from NOAA and the National Aeronautics and Space Administration, aboard one of NOAA's heavily instrumented research aircraft in the air over the Atlantic, tested new laser and microwave devices designed to measure ocean waves from space.

The clear weather and high, seaward-blowing winds behind winter storms spinning into the Atlantic north of Cape Hatteras create an ideal natural laboratory for their tests.

Staging out of NASA's Langley Research Center, the C–130 aircraft and the scientific team trailed the parade of winter storms out to sea, flying patterns at levels from 300 to 20,000 feet testing how clearly new remote-sensing devices "see" wave motion at the sea surface.

The project provided data needed to develop and refine proposed air-borne and satellite sensors, including those scheduled to fly aboard SEASAT, the first satellite dedicated to observing the ocean from space planned for launch late in the decade.

Project leader Duncan Ross, an oceanographer with the Environmental Research Laboratories' Atlantic Oceanographic and Meteorological Laboratories in Miami, Fla., explains, "even under conditions of constant wind, the return energies we receive from the ocean surface can be altered by other factors. For example, what we interpret as ocean-wave slope and height is highly dependent on how long a time local wind conditions have persisted, and over what distance the wind is blowing. These returns are even affected by how stable the atmosphere is at a given time and location.

"Thus, if we want to predict how the surface will 'look' to our sensors, we need to know what variations to expect from various combinations of wind speed and duration, and the distance over the water or fetch.

Robert Berles of AOML adjusts down-pointing laser in NOAA's C-130, with cargo door open and "RADSCAT" antenna deployed, scanning ocean surface by remote sensing.

"The conditions behind a winter cold front off the Atlantic coast give us a near-perfect environment for this kind of experiment. We have constant winds in the 25 to 35 knot range, blowing offshore. This gives us the ability to monitor varying returns as fetch increases in the seaward direction."

"gulfstream" Published

"gulfstream" is the new National Weather Service title for "The Gulf Stream Monthly Summary," formerly published by the Naval Oceanographic Office. The publication includes Gulf Stream position at the beginning and end of each month, historical mean position of the stream, monthly mean Sea Surface Temperature (SST), SST anomalies, and selected bathythermograph traces. Each month a special article is included on research or interesting data on the Gulf Stream.

NMFS Study Sees Squid As Economy Aid

A recent economic study conducted by the National Marine Fisheries Service indicates that a viable squid fishery off the New England coast could add over $600,000 a year to the economy of the region.

The study was conducted for the New England Fisheries Development Program, a government-industry cooperative effort aimed at developing a market for species of marine life found in the area which are underused by Americans.

Approximately 70 million pounds of squid were taken from the waters off the coast of the northeast United States by foreign and American vessels in 1973. Of the United States quota of approximately 12 million pounds in the area, only about three and one-half million pounds were harvested that year.

The majority of squid landed by U.S. fishermen in the area is caught incidentally while trawling for cod, flounders, haddock, and other fish, and is used for food and bait.

During four trips to test the feasibility of a directed squid fishery, a charter boat making 218 tows caught over 169,000 pounds of squid and over 14,000 pounds of finfish for a total value of almost $30,000.

The study provides evidence that the quota, if taken, could supplement the earnings of about 30 vessels in a seasonal squid fishery.

Hamburger-Textured Fish May Be Available Soon

Fish as easy and convenient to use as hamburger may soon be available to the homemaker, according to the National Marine Fisheries Service.

Experiments at the NMFS Utilization Research Center at Gloucester, Mass., show that minced fish with the same texture as hamburger can be produced. It has the same nutritional value as beef, is lower in fat content and cheaper to produce, since it can be made from a variety of fish species not now being used to the fullest extent.

Project Director Joe Mendelsohn said that minced fish in one pound frozen blocks is a highly acceptable market form and has commercial potential for both retail and institutional trades.

In the early 1970's a new technology was begun with the introduction to the fishing industry of a meat-bone separator machine which removes the bones, skin, and scales from headed, eviscerated fish, produces fish flesh resembling hamburger, and is more economical than other methods because it makes the maximum amount of edible flesh available from each fish.

As a result of this technology and a shortage of whole fillets for conventional frozen blocks, fish processors began using minced fish to produce $13^1/_2$-to $18^1/_2$-pound blocks from which to make fish sticks and portions.

Key Largo Nominated Sanctuary

The largest living coral reef in continental United States coastal waters—a major tourist attraction and a valuable scientific resource—may become the first marine sanctuary of its kind in the Nation.

The Office of Coastal Zone Management has received a nomination to designate as a sanctuary an approximately 100-square-mile area off Key Largo, Fla.

The area, up to five miles wide and about 21 miles in length, is adjacent to the John Pennekamp Coral Reef State Park and overlaps the Key Largo Coral Reef Preserve. Its nomination as a marine sanctuary, submitted by the Florida Department of Natural Resources, is a move to preserve the reef's ecosystem, parts of which are currently without protection.

Earlier this year the site of the wreckage of the Civil War gunboat USS Monitor, off Cape Hatteras, N.C., was designated as the country's first marine sanctuary, for its historic value. The coral reefs would be designated for their value as a natural resource.

Within the area, which is seaward of John Pennekamp Coral Reef State Park, is a wide variety of plant and animal life, featuring coral but ranging from plankton to giant jewfish and predatory shark. Of great importance is the fact that the reef is still "alive," the coral continuing to grow and develop. Coral reefs recently have come under considerable stress from a variety of man's activities.

Under proposed terms of the nomination, removal or destruction of natural resources and marine life other than fish would be prohibited, as would dredging, filling, or polluting.

Fishing, skin diving and boating would be permitted under limited conditions, and the proposed sanctuary could be temporarily closed to public use to allow recovery from overuse and to permit scientific research.

Dr. Robert R. Kifer, Marine Sanctuary Coordinator for OCZM, said the nomination proposes that the sanctuary be administered by the Florida Department of Natural Resources, Division of Recreation and Parks. This agency would be joined by the state's Division of Marine Resources and the U.S. Coast Guard in enforcement.

RAINFALL DATA IS AUTOMATED

The National Weather Service's Office of Hydrology has announced that one portion of a new program for automatically obtaining data on rainfall and river levels has been used operationally for the first time. The program employs automatic recording instruments and minicomputers to interrogate them.

The program is to be expanded in coming months into a nationwide network. Information on river levels and precipitation amounts will be obtained with much greater speed and reliability than by present means, which involve a large number of human observers. The result will be faster issuances of river forecasts and flood warnings.

The observing network is called tha Automatic Hydrologic Observing System (AHOS); the minicomputer interrogation network is called Automatic Data Acquisition System (ADAS).

The recent operational test was conducted when heavy rains over the basins of the Potomac and Shenandoah Rivers in West Virginia, Virginia and Maryland caused sharp rises in both rivers on March 21 and 22, and provided an opportunity to test AHOS and ADAS for the first time together.

Automatic interrogation of a station in the flood area was initiated on March 21, using a minicomputer at NWS Headquarters in Silver Spring, Md., and continued at regular intervals through March 25, when the rivers subsided. Results were described as excellent by Dr. Robert A. Clark, NWS Associate Director for Hydrology.

By the end of this summer, the NWS anticipates that automatic interrogation of more than 200 AHOS sites throughout the United States will be possible by ADAS minicomputers at Albany, N.Y.; Dayton, Ohio; Athens, Ga.; Stephenville, Tex.; Omaha, Neb.; Tucson, Ariz.; and Medford, Oreg. The AHOS network to be interrogated by ADAS will eventually grow to about 2,500 sites. An additional 2,500 AHOS installations in more remote areas will be interrogated by NOAA's system of Geostationary Operational Environmental Satellites (GOES), now coming into use.

These 5,000 observing stations will include those operated by the NWS, the U.S. Geogogical Survey, the Army Corps of Engineers, and other Federal, state, and local cooperating agencies.

NOAA Purchases Orion Aircraft

"NOAA Forty-two," the first of two new WP-3D Orion aircraft purchased by NOAA, was delivered to Dr. Wilmot N. Hess, Director of the Environmental Research Laboratories in Boulder, Colo., at the Lockheed-California Company's Burbank plant. The $7 million "flying laboratory" is being operated by ERL's Research Facilities Center in Miami, Fla.

It is the first new airplane ever purchased by what is now NOAA, built to the special requirements of its atmospheric and oceanic airborne research programs.

When instrumented in mid-1976, the airplane will begin flying environmental research missions, such as severe storm studies, cumulus cloud and hurricane modification experiments, and investigations of air-sea interaction, air quality, and the relationship of weather patterns to climatic change. NOAA project scientists expect the two Orions to be the most advanced research aircraft in the world.

AG FORECAST PROGRAM GROWS

The National Weather Service has expanded its agricultural weather forecast program for the states of Tennessee, Mississippi, and Louisiana to cover all portions of the states. Previously the program centered on only the large agricultural producing areas of the states.

The forecast will be modeled after those in Arkansas, where statewide agricultural forecasts have been issued for some time, and will include such spceific agricultural elemnets as drying conditions, dew points, vegetative wetness, and duration of sunshine.

This added service will help users, expecially those outside the intensive agricultural areas make better operational decisions. According to John A. Riley, Jr., Chief of the NWS Southern Region Meteorological Services Division, it has been estimated that agricultural weather forecasts save farm interests millions of dollars each year. The increase in forecast service areas will benefit many more agricultural interests as well as the consumer.

HANDICAPPED VET PROGRAM CREATED

NOAA has launched a program to train handicapped veterans in data processing.

Using NOAA funds and with the cooperation of the Veterans Administration and IBM, a six-month pilot program has been started at the VA Hospital in Hampton, Va. If the VA pilot program works, it could be extended throughout the VA system with its thousands of handicapped veterans. The pilot program will cost about $10,000.

Capt. Leonard S. Baker, Director of the National Geodetic Suvey, which is financing the program explained that the NGS is interested because it has 25 million pieces of data which must be processed into a central data bank.

The NGS is constantly gathering data from its geodetic operations, which involve maintenance of the nation's distance and elevation networks, and is now conducting a program to update the distance (horizontal) network in which practically all nations in North America are participating.

Unified Measurement System Established For Continent

Nine nations—Canada, Costa Rica, Denmark (Greenland), El Salvador, Guatemala, Mexico, Nicaragua, Panama, and the United States—have combined in a program which will modernize the geodetic networks that provide the basis for all accurate distance (horizontal) surveying on the North American continent.

In the United States, the National Geodetic Survey is spearheading the program, which is expected to result in a modern unified system of precise measurements of the entire continent that will provide an improved base for topographic mapping, navigational charting and largescale engineering projects.

Cdr. John D. Bossler, project manager for the U.S. operation, said modernization of the horizontal network in the 48 conterminous states and Alaska is expected to be completed by 1983. The task, last performed almost a half century ago, may cost $16 million. It has been estimated, however, that improved accuracy and expansion of the network will reduce survey costs in new construction alone in the United States by 25 to 50 percent at an annual estimated benefit of $20-$40 million.

SUNSHINE: LESS IN FALL, MORE IN SPRING

There's a little less sunshine in your life, according to a 23-year study by Environmental Research Laboratories meteorologists Dr. James K. Angell and Julius Korshover. They report that in the contiguous 48 states between 1950 and 1972, there was an eight percent decrease in the percentage of possible sunshine received at the earth's surface during autumn, and a three percent increase during spring.

Between 1952 and 1964 there was no significant variation in the yearly average value of percentage of possible sunshine, but between 1964 and 1970 there was a 1.3 percent decrease in sunshine, corresponding to a decrease in daily sunshine duration of about 10 minutes in all regions of the contiguous United States.

Reduction Of Fish Waste Sea Grant Project Aim

For every pound of shrimp that a Gulf Coast shrimp fisherman catches in his trawl, he throws back about three to four pounds of usable but unwanted fish that have been caught unintentionally, Sea Grant scientists at Texas A&M University have found.

According to Vito J. Blomo and John P. Nichols, leaders of an investigation supported by NOAA's Sea Grant Program, the so-called incidental catch comprises a variety of species ranging from porgies, which could have ended up on someone's dinner table, to menhaden, which could have been processed into fish meal and fed to chickens.

The researchers calculated that shrimp fishermen discard between 52 and 368 million pounds of fish per year in the Western Gulf alone—an area that yields about 45 percent of the approximately 220 million pounds of shrimp landed annually in the Gulf of Mexico.

Seeking ways to prevent continued waste of such large amounts of valuable protein, the scientists evaluated the possible markets for the discarded trawl fish and estimated the potential volumes that could be marketed. They concluded that the majority of the discarded trawl fish could be used only for processing into fish meal, fish oil and solubles, and pet food. However, they point out that, depending on the particular species, some of the incidental catch could be suitable as more valuable seafood—fresh and frozen fillets, fish sticks and portions, and whole fresh fish. They found that two major obstacles to be overcome if the discards are to be put to profitable use are that neither a working market structure nor economically feasible system of using the shrimpers' incidental catch exist.

NOAA, HUD AGREE ON AID FOR COAST PLANS

An agreement to help coastal states coordinate their planning and management activities assisted by NOAA and the Department of Housing and Urban Development's Office of Community Planning and Development has been signed in Washington, D.C.

The joint agreement for coordination was signed by Robert W. Knecht, NOAA's Assistant Administrator for Coastal Zone Management, and David O. Meeker, Jr., HUD's Assistant Secretary for Community Planning and Development. The agreement is expected to help make state planning and management more effective and loss costly for coastal areas.

Both agencies are involved in assisting states develop comprehensive planning programs. OCZM is concerned specifically with helping states create programs for managing the lands and waters in their coastal zones. HUD, with its recently added mandatory land use element, provides financial assistance to comprehensive planning at the state, regional and local levels of government.

A key element of the agreement, which is expected to simplify state efforts, is HUD's willingness to accept approved coastal zone management programs as meeting the minimum land use planning requirements necessary for states to remain eligible in HUD's 701 program.

In effect, coastal zone management programs approved by the Secretary of Commerce would constitute accepted portions of HUD land use elements for the geographic areas concerned.

The two agencies also agreed that both HUD and OCZM will participate in reviewing state coastal zone management and 701 program applications; that the staffs of both agencies will work towards establishing procedures to facilitate development of both programs; and to explore the possibility of joint funding of pilot projects within coastal states.

Chum Success May Create New Fishing Industry

Reviving the chum salmon fishery may create a new, clean industry for Oregon, says James Lannan, Sea Grant researcher and professor of fisheries and wildlife at Oregon State University.

Once the basis for an active industry, the chum salmon fishery was crippled by extensive exploitation and spoiled spawning grounds, according to Mr. Lannan.

But a new hatchery design—developed with Sea Grant support—may change all that. Chum runs in Whiskey Creek near Tillamook, Oreg., increased from about 400 to 1969 to 3,000 in 1974. The sevenfold increase, due primarily to the new hatchery system, has led to predictions of a multimillion dollar chum salmon industry.

More than three million chum salmon have been hatched in gravel incubators and released into Whiskey Creek. This research is supported jointly by the OSU Sea Grant College Program and the Oregon Agricultural Experiment Station.

If fish production continues at the same rate that it has at the Netarts pilot hatchery, private chum hatcheries in Oregon can expect returns of two to three million pounds of fish annually by 1980.

"Missing Link" May Improve Chances Of Finding Oil

A team of geologists exploring the deep coral reefs off Belize (British Honduras) in Central America has discovered a "missing link" in the ancestry of a group of rock-building marine plants.

In their research, supported by the National Science Foundation's geology program and NOAA's Manned Undersea Science and Technology Program, Robert N. Ginsburg, professor of marine geology and geophysics at the University of Miami's Rosenstiel School of Marine and Atmospheric Science, and Noel P. James, formerly of the University of Miami and currently associate professor of geology at Memorial University, Newfoundland, used a research submersible (minisub) to collect specimens from the precipitous ocean-facing reef wall to depths of 800 feet.

The modern marine plants or algae, calcareous crusts that look like giant potato chips, are remarkably like fossil forms found in limestone 200–300 million years old in Western Texas, Kansas, New Mexico and in North Africa and the Soviet Union.

The fossil algae are major components of the limestones, and previously were thought to be extinct. Buried in lime sand and mud that hardened by sea water into marble-like limestone, the fossils form porous rock reservoirs that are frequently oil-bearing.

Dr. John L. Wray, research associate in Marathon Oil Company's Denver Research Center and adjunct professor of geology at the Colorado School of Mines, a leading authority on fossil algae who established the similarlity in form and internal structure between the living and fossil algae, feels the find "opens new ideas of the ancestry of these important rock-building plants, and gives us precise information on their environments."

FISH FREEZING PLANT PARTICIPATES IN DOC INSPECTION PROGRAM

The Bellingham Cold Storage Co., Bellingham, Wash., has signed an agreement to participate in the Deartment of Commerce's Sanitation Inspection Fish Establishment (SIFE) program.

The Company, which is participating through the National Marine Fisheries Service, is one of the largest freezing and processing facilities in the United States and is the largest cold storage plant using the sanitary inspection service offered by the Department.

As a qualified SIFE plant, the company will be listed in the "Approved List, Sanitarily Inspected Fish Establishments," a quarterly publication distributed to seafood purchasers listing plants that have been sanitarily inspected, approved, and certified by the USDC.

More importantly, since Bellingham is a SIFE plant, all companies having products custom processed and packed by Bellingham are eligible for contract product inspection. Companies whose product has been certified as meeting the requirements of inspected products will be allowed to display the Federal inspection marks on their products. This assure the consumer that the product complies with requirements of wholesomeness, cleanliness, sanitation, true weight, and good quality.

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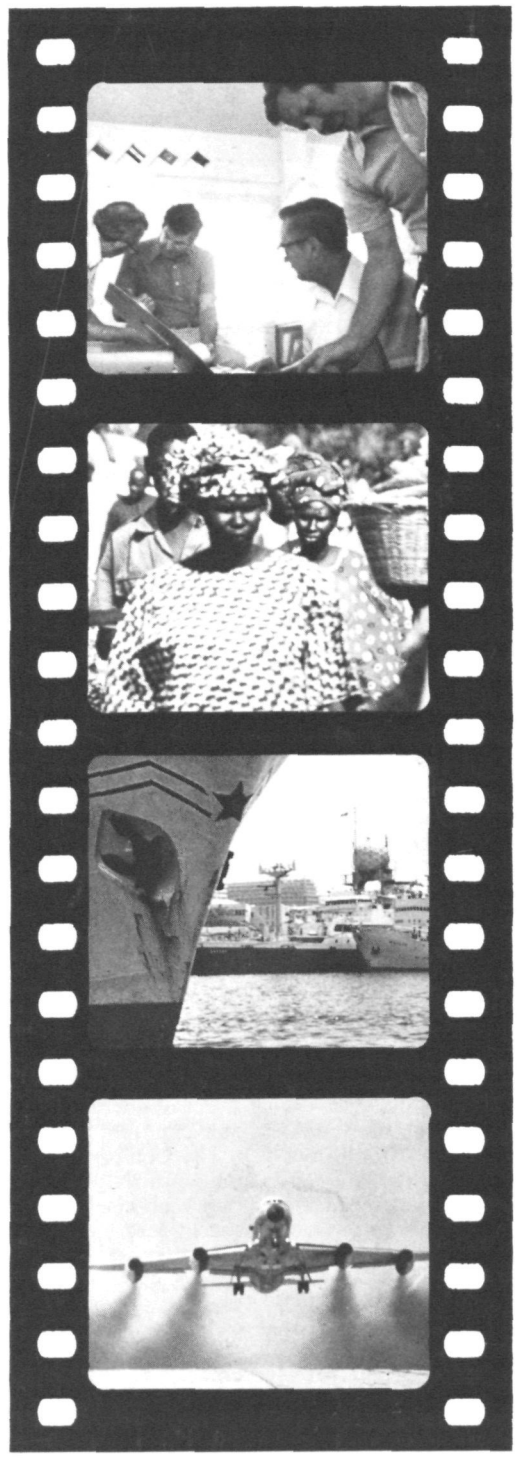

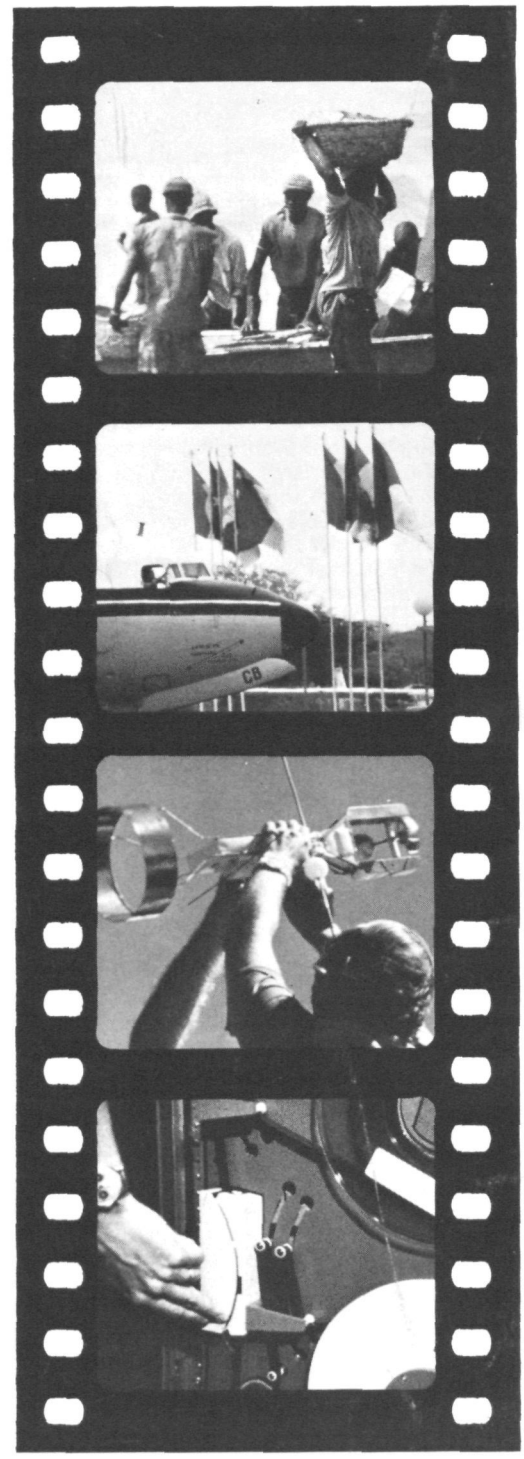

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