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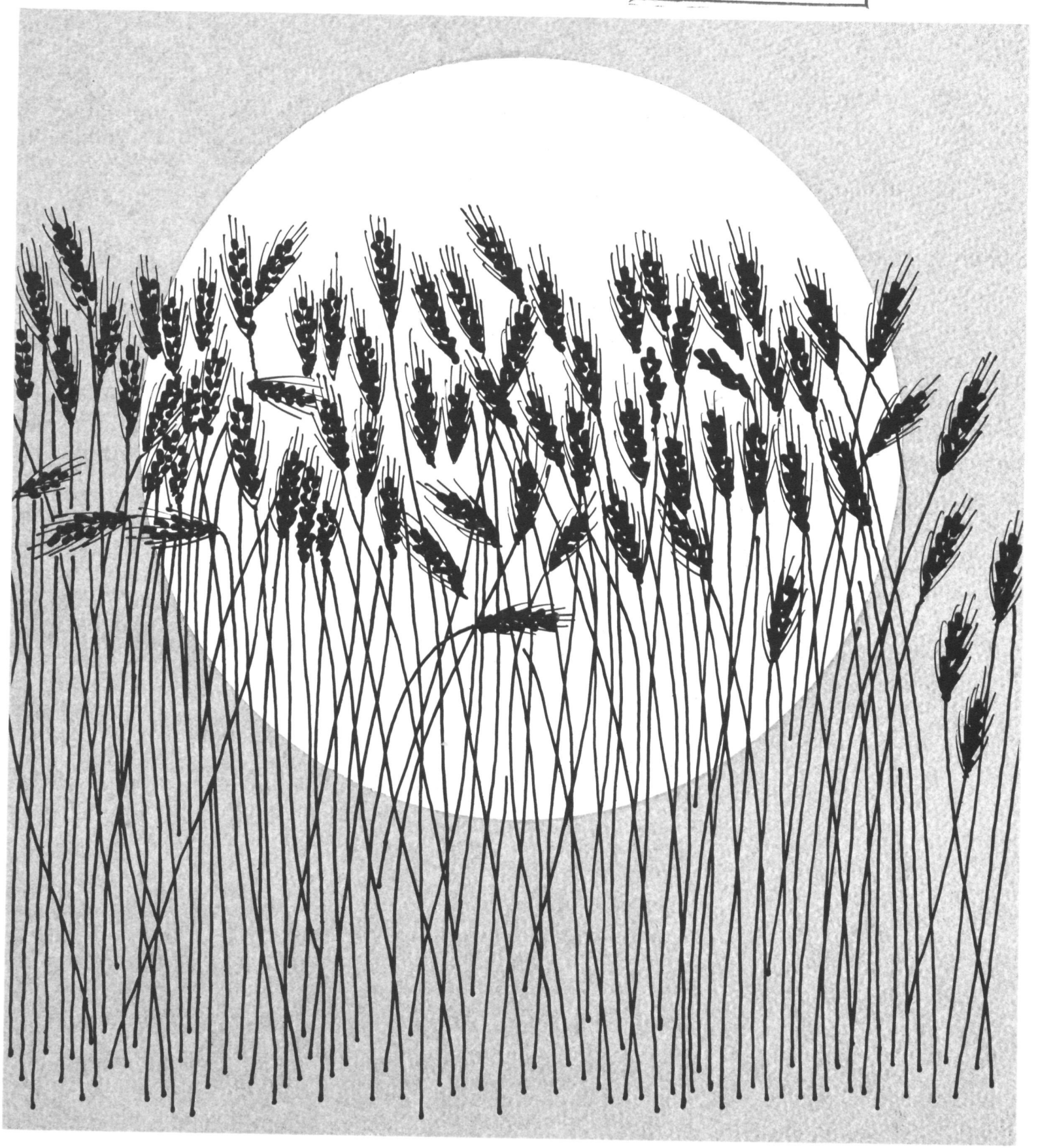

National Oceanic and Atmospheric Administration

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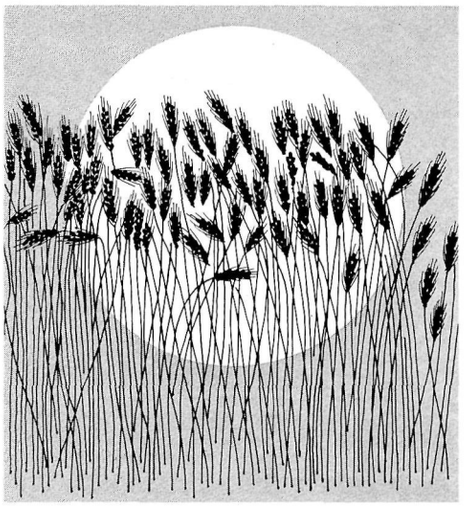

COVER: A graphic view of Autumn

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U.S. DEPARTMENT OF COMMERCE
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National Oceanic and Atmospheric Administration

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Howard W. Pollock, Deputy Administrator
Dr. John W. Townsend, Jr.,
Associate Administrator

Management by Objectives

Henry B. Turner
Assistant Secretary for Administration

The new Management by Objectives program—MBO—is one of managing for results organized around three basic elements:

- A clear, concrete statement of objectives that are tangible, achievable and verifiable.
- A plan to achieve these objectives, including the individual steps required and when each step will be taken.
- A method for regularly checking to see if these plans are being followed and, if not, what corrective action should be taken.

The key to MBO's operation is verification. Both objectives and the steps leading to their achievement must be clearly verifiable. The answer to the question "did we make it?" should be either "yes" or "no," never "maybe." This is absolutely essential to the operation of the program.

An objective is an intended result clearly stated in concrete, verifiable terms. Wherever feasible, it should include quantitative measures of achievement. The date of achievement and persons responsible are also needed.

An objective should be expressed in terms of direct impact on the public or the economy. Where this is not possible, presumed impact and the basis for that presumption should be clearly expressed when the objective is established.

But deciding what the objectives are is only half the battle. One must also develop plans to achieve those objectives and a method for checking progress. This can be done in a number of ways. At the Department level we do it through a simple system of projects and milestones.

A project is simply a plan to achieve all, or some well-defined part, of one of our objectives. It produces a verifiable end product which clearly relates to the achievement of that objective. It normally lasts about a year and involves only one objective. (An objective may last longer than a year and involve more than one project.)

A project consists of one or more individual steps, or milestones, that must be taken in order to deliver its end product. These also must be verifiable and have definite completion dates. Every other month, the status of each milestone must be reported to the Secretary.

We call this system the Departmental Project System and use it to track objectives of significant interest to the President, the Secretary and their top staffs.

Similar systems are used in NOAA to track objectives of interest to the Administrator and his staff.

But MBO involves more than just projects and paperwork. It is also a program of people-to-people communication.

Our objectives and projects are not imposed by fiat from above. Rather they are developed at the working level, through personal consultation with the officials who will be responsible for their achievement. Statements of these objectives are in effect openly arrived-at "contracts" between these officials and the Department's top management.

The reporting of progress against these projects is more than just on paper. It too involves personal discussions of accomplishments and problems. Such discussions can be crucial. They give those responsible for these projects a unique opportunity to advise top management of problems before they arise, and to get their help in solving them when they arise.

This process involves all major levels of the Department. For objectives of interest to the President, it also involves the Office of Management and Budget. Face-to-face meetings between the Secretary and the Director of the Office of Management and Budget are a regular feature of the program.

This then is MBO, a straightforward, common sense approach to everyday management. It is designed to give the line manager a voice in the direction and goals of his organization, and to allow him to report on his progress towards those goals in the simplest manner consistent with the need of top management for information. In this sense, it is *his* program—not the President's or the Secretary's or anyone else's.

And this makes it a rare specimen indeed.

Photo: Carl Purcell, AID

CLIMATE: A KEY TO THE WORLD'S FOOD SUPPLY

BY PATRICK HUGHES

"The poorest nations, already beset by man-made disasters, have been threatened by a natural one: the possibility of climatic changes in the monsoon belt and perhaps throughout the world. The implications for global food and population policies are ominous. . . ."

HENRY KISSINGER, Address before the UN General Assembly, April 15, 1974

MAN HAS REACHED A CRITICAL CROSSROADS in his relationship with the environment. It is the juncture of four major trends: growing world population, rising affluence, increasing food demands, and — despite increasing world grain production— dwindling grain reserves.

Grains are the world's basic food. World grain reserves have been declining since 1961, and suffered a much sharper drop in 1973. According to Dr. James McQuigg of NOAA's Environmental Data Service, reserves now have fallen to a level about equal to the difference between production in highly favorable weather and that in unfavorable weather situations. In the words of Addeke H. Boerma, Director General of the United Nations Food and Agricultural Organization, "The chances of enough decent food for millions of human beings may depend simply on the whims of one year's weather."

Dr. McQuigg points out that most of the world's current food-production system was developed after the mid–1940's. With some exceptions, until the mid- and late–1960's this was also a period of global weather patterns highly favorable to food production. In many mid-latitude countries, the combination of modern technology and generally favorable weather brought production increases that have no historical precedent.

Most forecasts of worldwide food production have been based on the assumption that global weather will stay about the same as it has been in the recent past. But it has already begun to change.

In the Sahelian zone of Africa south of the Sahara, the countries of Chad, The Gambia, Mali, Mauritania, Niger, Senegal, and Upper Volta are enduring a drought that in some areas has been going on for more than six years now, following some 40 previous years of abundant monsoon rainfall. And the drought is spreading—eastward into Ehtiopia and southward into Dahomey, Egypt, Guinea, Kenya, Nigeria, Somalia, Tanzania, and Zaire. Many climatologists have associated this drought and other recent weather anomalies with a global cooling trend and changes in atmospheric circulation which, if prolonged, pose serious threats to major food-producing regions of the world.

Annual average temperatures over the Northern Hemisphere increased rather dramatically from about 1890 through 1940, but have been falling ever since. The total change has averaged about one-half degree Centigrade, with the greatest cooling in higher latitudes. A drop of only one or two degrees Centigrade in the annual average temperature at higher latitudes can shorten the growing season so that some crops have to be abandoned. There is reason to believe, for example, that rice was once grown far north of its present boundary in parts of Asia.

According to British meteorologist Hubert Lamb, the average growing season in England is already two weeks shorter than it was before 1950. Since the late 1950's, Iceland's hay crop yield has dropped about 25 percent, while pack ice in waters around Iceland and Greenland ports is becoming the hazard to navigation it was during the 17th and 18th centuries.

At lower latitudes, as in the Sahel, the amount of precipitation available during certain phases of the growing season is critical to food production. The kind of climatic variation now in progress includes changes in the tracks of precipitation-producing storms through major grain-producing regions.

In India, for example, before the global warming trend of 1890–1940, severe drought struck about once every four years. With the warming, however, and more abundant monsoon rains, drought came only once every 18 years or so, greatly increasing India's grain production. Some climatologists think that if the current cooling trend continues, drought will occur more frequently in India—indeed, through much of Asia, the world's hungriest continent.

Archaeologists have related the decline of a number of ancient civilizations to climatic changes that brought recurrent drought to previously fertile crop land. Paradoxically, many of today's com-

World Wide Photo

Troubled faces (opposite page) mirror anguish brought by the Sahel drought. Above, results of 1974 dry spell in a midwest cornfield, where ordinarily the stalks would be seven feet high.

plex agricultural systems are more sensitive to such climatic variability than were simpler, if less-productive, systems of earlier civilizations. Some modern varieties of grains, for example, are highly productive only if there is abundant water. When water is scarce, they produce less than older varieties.

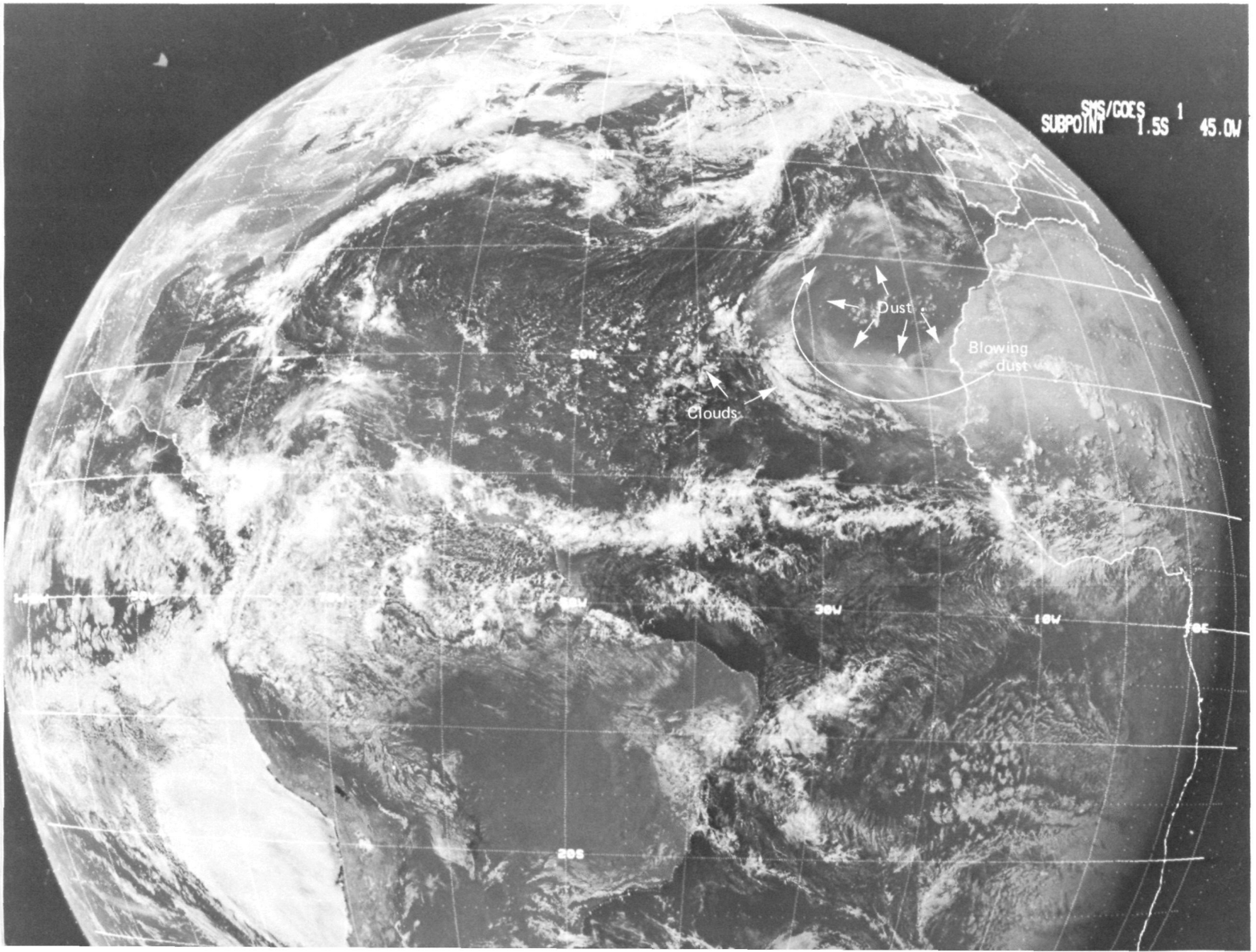
From 1890 through 1940, man enjoyed the warmest climate the world had known for five or six centuries. And even the relatively colder centuries that preceded the warm spell were much warmer than the average over the past million years of the Earth's history. This fact, plus the relatively brief duration of earlier warm periods, makes a return to a cooler climate a realistic expectation in the long run.

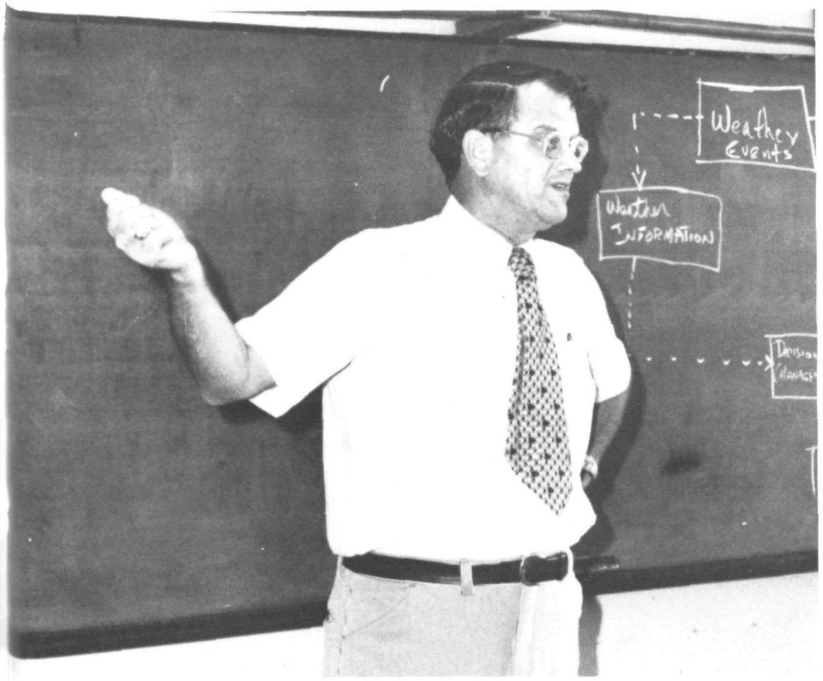
Dr. Reid Bryson, Director of the University of Wisconsin's Institute for Environmental Studies, thinks that the relatively warm period from about 1890 to 1940 was only a brief intermission in the "Little Ice Age," a period of worldwide expansion of snow cover, mountain glaciers, and Arctic pack ice which began in the 15th century and became pronounced by the early 17th century. There were three major glacial advances in the Alps, Norway, Iceland, Alaska, and probably elsewhere around 1650, 1750, and 1850, separated by slight withdrawals. Average annual temperatures in England and perhaps worldwide were one to two degrees Centigrade colder than they have been before or since. In the United States, average Midwestern temperatures in the 1850's were as much as four degrees Centigrade colder than they are today.

Both the Little Ice Age and our own climatic era are relatively minor variations superimposed on long-term fluctuations between cold, glacial and warm, relatively brief, interglacial periods of the ice age in which we are now living. For most of the Earth's history our planet had no permanent ice cover. For more than two million years now, however, we have had permanent ice fields which alternately expand and contract. The last major glacial period ended about 10,000 years ago. Some climatologists think that the present cooling trend may be the start of a slide into another period of major glaciation, popularly called an "ice age."

Many other scientists disagree. J. Murray Mitchell, Jr., of the Environmental Data Service, a world authority on climatic change, comments, "We observe these trends, and we know they are real. But we can't find the central tendency, we just don't know how long they will last." Mitchell himself suspects that the present cooling trend will reverse itself rather soon.

This striking SMS-1 photo taken last July 30 provides a global view of extreme drought conditions over north and west areas of Africa. Borne by hot, dry winds blowing off the Sahara, dust-filled air extends more than 1000 miles from Dakar over the Atlantic, Balloon-shaped dust pattern. Traveling westward at 16 miles per hour, reached Florida on August 5.





Dr. James McQuigg discussing the role of weather and climate in economic and social decision making, Japan Meteorological Agency, August 1973.

Civilization as we know it developed during the current interglacial period. If the past is any guide, our relatively balmy climate will eventually give way to the glacial conditions that have characterized most of the last two million years. Just when such a major, long-term cooling might begin, however, and how rapidly it would proceed, are not known.

During the last major glaciation, ice sheets penetrated deep into Europe and North America. According to Lamb, annual mean temperatures near the glaciers may have been as much as 12 degrees Centigrade lower than they are today. Global precipitation amounts were also lower, and there was a marked increase in the size of subtropical arid zones and deserts.

Scores of "ice ages" have come and gone. Based on past performance, it probably would take at least a few thousand years for a full-fledged glacial expansion, although considerable fluctuations of ice and snow cover are possible over a period of a few hundred years. In either event, there would be plenty of time to prepare.

In summary, the current cooling trend may be but a temporary climatic variation, it may lead to another "Little Ice Age," or it may, indeed, signal the death of the present interglacial period. We do not know. We may never know.

Whatever the case, a study of the past reveals that the Earth's climate is highly variable—indeed, that variability is one of its fundamental characteristics. It is this variability and the difficulty of its prediction, rather than any relatively long-term cooling trend, that poses the immediate threat to precariously low food reserves.

A serious drought in the United States, for example, would be disastrous for global food supplies. Wheat is the world's leading agricultural crop, and the United States, the world's biggest exporter, supplies some 30 million tons of the 70 millions tons normally available on the world market.

On September 24, 1973, Secretary of State Kissinger proposed to the UN General Assembly "that a World Food Conference be organized under United Nations auspieces in 1974 to discuss ways to maintain adequate food supplies, and to harness the efforts of all nations to meet the hunger and malnutrition resulting from natural diasasters." This conference, cited by the UN as "the most important political meeting on the global food situation ever held," will be convened in Rome on November 5–16, 1974.

In preparing for the Conference, the State Department asked NOAA to evaluate the relationship of weather and climatic change to worldwide grain production. The study was conducted by a NOAA task team headed by Dr. McQuigg and its findings were forwarded to the State Department in Early May.

Because man's life-support and economic systems are becoming increasingly sensitive to large-scale climatic variation, the Environmental Data Service recently established a NOAA Center for Climatic and Environmental Assessment. CCEA provides tailored consultant services and products to Federal agencies dealing with the impact of climatic and other environmental factors upon social and economic programs and policies.

Specifically, the Center models and assesses climate and climatic variation, as well as other natural environmental phenomena and their variations, and evaluates their probable impact upon national and international problems such as the energy crisis and world food supplies. Food-supply objective include modeling and assessing large-scale climatic changes and evaluating their effect on grain production in major crop regions of the world.

With America's abundant surpluses of past years gone, the world's peoples now live from year to year as far as food supplies are concerned. For the foreseeable future, one of the keys to coping with or improving this precarious situation will be our ability to anticipate, plan for, and adapt to the climatic variability that has so long characterized the planet on which we live. □

NOAA Photo

A New Approach:

HELPING FARMERS OUTWIT THE WEATHER

BY EDWIN P. WEIGEL

Billions in savings are envisioned by using satellites and computers to advise on the best options possible for maximizing yields and minimizing losses.

In the Nuclear Science Center of Auburn University in the quiet, tree-shaded town of Auburn, Alabama is one of NOAA's most precocious offspring.

It's called the Environmental Studies Service Center. And it was one year old last July.

Headed by youthful Dr. Ray E. Jensen and D. R. "Shorty" Davis—Director and Assistant Director, respectively—the Center is small in staff but large in talent and ambition.

With only a handful of people, the Center has set for itself the goal of providing the most technologically advanced weather service to agriculture in the world. Its territory covers three states—Alabama, Georgia and Florida.

Jensen and Davis don't state their goal in quite such lofty terms when asked about it, but the conclusion seems inescapable when they begin to talk.

What they have in mind is to eliminate much of the guesswork in weather-related decisions in agriculture by "putting numbers" on choices farmers now make largely by guess and by gosh.

Among other things, their plans involve use of cloud and temperature measurements from satellites, fed to electronic computers, to arrive at the best decisions possible for such tasks as preparing the soil, planting, irrigating, spraying, dusting and harvesting.

Already they are using numerical models of crop growth—"plants grown in computers"—to provide weather-related advice to cotton farmers and peanut growers. By feeding a model in a computer the current observations of rainfall, temperature, humidity and amount of sunlight, they arrive, for example, at a decision regarding the probability of an outbreak of fungus known as peanut leaf spot. During prolonged hot, moist weather, the probability becomes increasingly great. Timely dusting with a fungicide takes care of it. And the peanuts grow plump and tasty.

The Center issues "Peanut Leaf Spot Advisories" twice daily during the growing season by teletype transmissions on the NOAA Weather Wire. These are relayed to farmers by radio, TV and newspapers. Fungus advisories are also issued for other such unlovely ailments as Apple Scab, Pecan Scab, Potato Blight, Peach Brown Rot, and Tobacco Blue Mold—for which similar crop-saving remedies are applied.

In addition, the Center issues advisories for a wide variety of other weather-related decisions farmers must make. One is to prepare them for the likelihood of fruit- and vegetable-killing frost, against which they must light heaters and apply other artificial means of keeping the temperature above freezing. A related type warns of the first hard freeze in autumn, so farmers will remember to drain irrigation pipes and water-cooled systems of farm machinery to avoid costly damage to equipment.

Livestock raisers and poultrymen are warned about days when heat and humidity will cause prostration and death among animals confined in barns, pens or vehicles, and among chickens crowded in brooders, laying houses or coops en route to market. A little extra ventilation and a little less crowding adds up to thousands of dollars in preventable casualties.

When cotton is harvested on warm, moist days it may mold, rot and discolor. Forewarned, growers can schedule the harvest for a time when the air is relatively dry. A similar advisory is valuable for protecting the cheesecloth used in tents and canopies under which some crops are grown in the South. It is expensive stuff and can be used for two crop seasons if handled with care. Between seasons it's baled and kept under cover. Cloth baled with relative humidity above 50 percent generally rots. The Center helps farmers pick a dryer time.

There are advisories against winds that may damage tender young vegetables at the transplant stage, about the chances for lightning strikes on tobacco barns and how to prevent them, about the best times to apply fertilizers, pesticides and irrigation water so the least amount will do the most good.

Advice on planting times is a vital aid, particularly for cotton. Too early and the seeds may not germinate, requiring a costly replant; too late and the yield may be reduced, because cotton needs a long growing season. Knowledge of just when soil temperature will be at a safe level for germination means a bigger payoff to the farmer.

Advice on when to ask crop dusters to apply pesticides takes into account not only a day when rain is unlikely to wash the stuff off prematurely, but also a day when strong winds won't carry it over to a neighbor's crops or property. A special case is the aerially delivered bait used to poison fire ants—a ferocious species that produces large and painful blisters. Timing is critical. The poison must be applied when the ants are foraging. This occurs only when the soil is warm and moist. Applied during a spell of dry, cloudless days—good flying weather—it does little to kill the ants, but becomes merely one more environmental pollutant. The Center helps decide when is best.

In our energy-conscious society, advisories that warn of heavy rains which will wash away recently applied fertilizers and pesticides offer a double savings. By averting the need for a second application, costly fuel is saved that would be needed to spread it, and a costly waste is averted of the fossil fuels and electricity needed to

Assistant Director D.R. Davis and Director Ray Jensen examine a teletype transmission of an agricultural weather advisory.


GEORGIA FARM REPORT
GEORGIA
FARM REPORT
VEGETABLES
KKTT

manufacture the chemicals in the first place.

The list goes on and on. Ray Jensen and his staff are almost messianic in their conviction of the global benefits to accrue from highly sophisticated weather advice to farmers. In a paper that he and Assistant Director Davis prepared for delivery this year, they pointed out that an estimate by J. C. Thompson of California State University in 1972 indicated there were at least 3.5 billion dollars in preventable weather-related losses to U.S. agriculture annually. This was 43 percent of total weather losses of 8.2 billion, and 6.4 percent of the total agricultural production that year of 54.7 billion dollars.

With such a glittering reward to U.S. agriculture—undoubtedly the most efficient in the world—it's not hard to see why they believe the benefits on a worldwide basis are stunning, and a task of paramount importance.

Lest it be thought that their specialized chore of providing weather advice to agriculture is entirely new, it should be pointed out that there has been an Agricultural Weather Service within the National Weather Service since 1959. What Jensen and his staff hope to do is to modernize the work of that branch so that the most advanced techniques of two broad fields—meteorology and agriculture—are brought to bear on the problem of maximizing yields and minimizing losses.

A brief review is useful for perspective.

The Agricultural Weather Service was authorized by Congress in 1959 to make specialized weather information available to farmers—principally cotton farmers—of the Mississippi Delta. It was an immediate success. Surveys after the first year indicated a 40-dollar return for every Federal dollar spent. As a result, Congress authorized similar programs in other areas.

The programs have two parts: forecasts for farmers issued by weather offices, and advisories on application of those forecasts by farm-trained meteorologists such as Jensen and Davis.

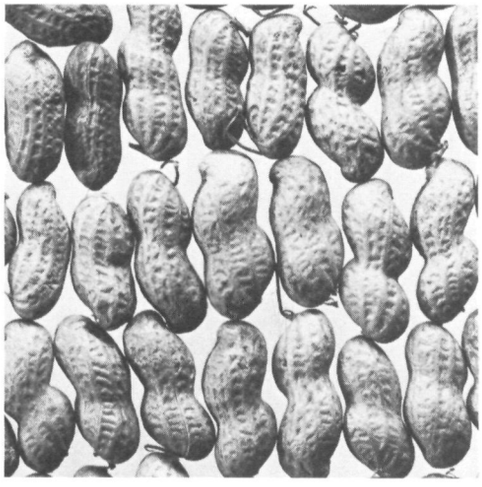
Objectives in all of them are to provide aid for weather-related decisions which will maximize yields, cut costs, avoid waste, and provide research leading to still-greater farm efficiency. Data for the more-specialized work is gathered at a network of weather-observing stations associated usually with Agricultural Experiment Stations. Weather advisories resulting from these efforts reach farmers through university or Federal farm specialists and through a teletype circuit which ties in radio and television stations and newspapers.

This system is still a going concern, and very popular. It has already produced outstanding results for certain crops.

A good example is the ozone advisory for shade-grown tobacco in northern Florida and southern Georgia. It was pioneered by Shorty Davis when he was Agricultural Meteorologist for NOAA at the University of Florida Agricultural Research Center at Quincy, in cooperation with C.E. Dean, Professor of Agronomy at the University of Florida.

When to dust or spray crops? The satellite and computer will help narrow the time frame.

Chickens are big business, as this assembly-line in a modern poultry house shows. Farmers moving birds to market need latest weather data.



What do farmers of cotton, beef and peanuts have in common? All have highly weather-dependent operations. Extreme heat can kill livestock, cause crop diseases. NOAA's numerical models at Auburn are helping solve problem.

Development of the ozone advisory was a classic blending of agricultural and meteorological research. It has almost all of the elements that the Center hopes to apply in efforts with other crops, plus a demonstrable payoff illustrated by dollar figures from the growers themselves. Because of this, and because of the intriguing detective work engaged in by the researchers, it is worth examining in detail. Here in somewhat abbreviated form, is how Shorty Davis describes it:

"To begin with, ozone is a relatively rare form of oxygen which has three atoms joined together instead of two. It has a sharp, pungent smell, and is often noticed as an aftermath of severe electrical storms. Not until recently has its effect on plants been realized. This was made clear in the 1960's in investigations of damage to tobacco in the Southeast.

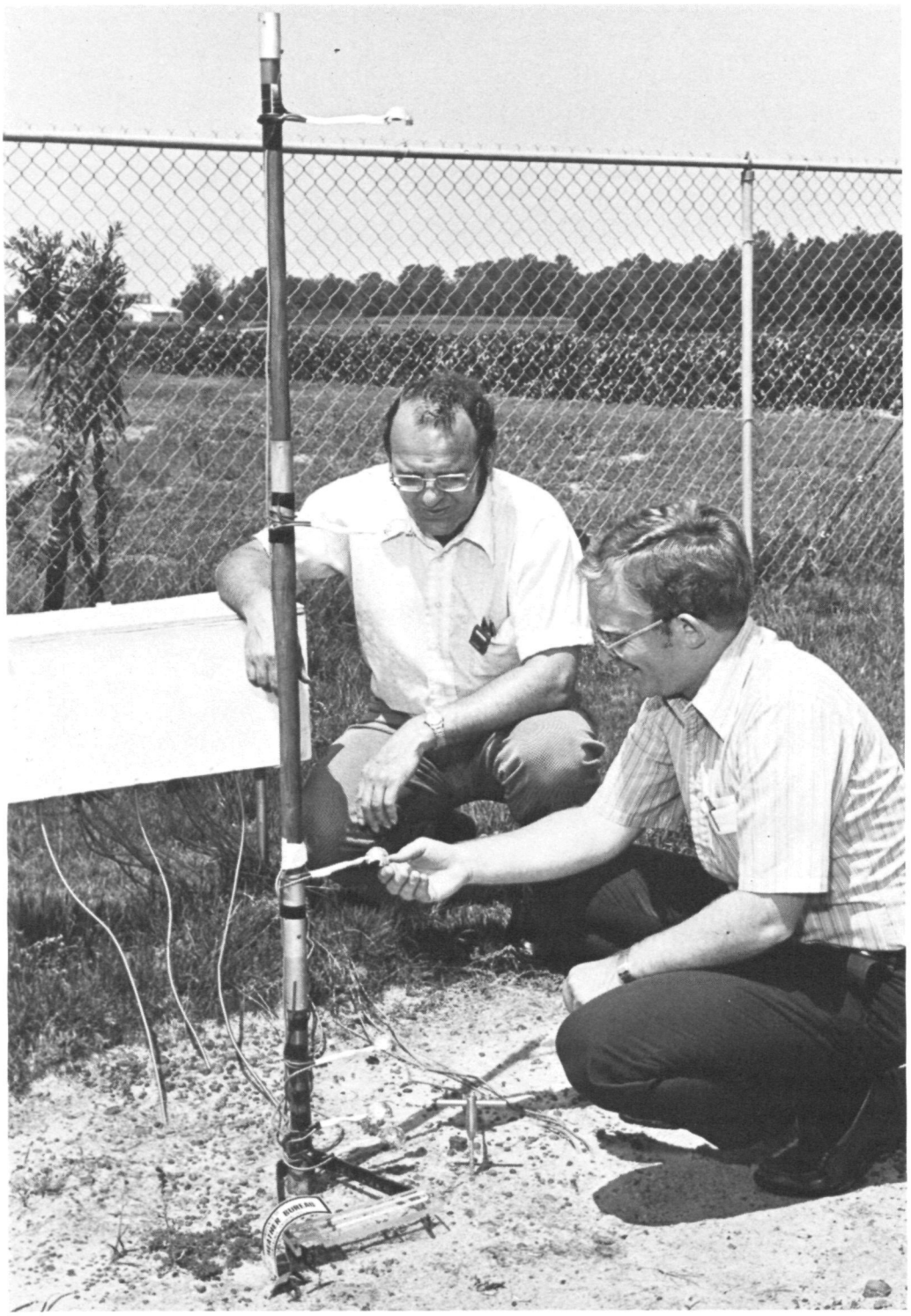
"The kind of tobacco where ozone damage is most critical is known as shade-grown tobacco. It's grown under a canopy of cheesecloth. This tobacco is used for the outside wrappings of cigars. Its market value is about 10 times that used in cigarettes, and runs on the order of 13 million dollars a year in this area.

"For many years, shade-grown tobacco farmers had been plagued by a problem known as weather fleck—tiny holes in the leaves which made them unfit for cigars. (Cigars with holes at the sides won't draw properly.) But the farmers didn't know what caused it.

"In 1962, Dr. Dean identified the culprit as ozone. When I came to the Experiment Station in 1963 the problem was acute, so I joined forces with Dr. Dean. We put in an ozone meter and set up a complete weather station at Quincy and began making careful weather measurements.

"Every time we observed an increase in ozone, Dr. Dean would check the tobacco. We found that fleck on the leaves correlated very well.

"So I then began to try to identify the weather conditions linked to increases in ozone. I found a number of them: One was



Meteorologist Don Drew (top) examines cotton plant development at Auburn's Agricultural Experiment Station. Above, Jerry Hughes (left) and Shorty Davis scan printout of instrument recording presence of water on shrub. Sensors on plant send electrical signal to station. At right, Ray Jensen (left) and Jerry Davis examine special instrument developed at the Center to measure precise temperatures from surface to height of several feet. Sensors are shaded by metallicized hemispheres made from halved pingpong balls.

in connection with passage of cold fronts that had either squall lines or well-developed thunderstorms associated with them.

"I also noticed that after a cold-front passage in late winter, spring, and early summer, the ozone would continue to increase until about the third day, when the mound of high-pressure air was centered over the area. It would peak out about that third day. This increase was traced to the fact that air masses lying up in the Arctic for a number of days became ozone-rich. This is stratospheric ozone which bleeds down to the surface. It persists until the air reaches this far south. That has proved to be a major source of the ozone that causes problems with crops.

"In connection with ozone increases linked to thunderstorms, I further found that the ozone was not necessarily localized around lightning strikes, as had previously been thought, but was more related to the height of the thunderstorm—being most marked with a really well-developed storm reaching up to the ozone-rich stratosphere, to an altitude of 50,000 feet (15 kilometers) or more.

"I'm quite confident what was happening was entrainment of ozone from the stratosphere into the thunderstorms and thence to the surface in the strong downdrafts characteristic of these powerful storms. I have records to support this.

"The greatest of all ozone increases I observed were in connection with well-developed squall lines, often running well ahead of a cold front, and I believe this is further evidence of the entrainment of ozone captured by towering thunderheads, with a massive concentration where the downdraft is deflected horizontally at the surface.

"There is one other instance where ozone is increased, without fail. That is with a stagnating air mass carrying heavy concentrations of pollutants—either natural ones, such as those emitted by pine trees and other conifers of the Southeast, or manmade, such as those from automobiles and stack exhausts, acted upon by sunlight. This condition goes with the blue haze

THE STAFF AT ESSC: BROAD AND DEEP

A key factor in the planning of the Environmental Studies Service Center was to select people who could meld the most-advanced thinking in agriculture, meteorology, satellite technology, and computer programming.

The current staff at Auburn is larger than envisioned for future such units, partly because this one is a prototype. Of the nine persons listed, two positions are reimbursible ones funded by the Department of Transportation; one is an intern, and one is a training slot for a similar center elsewhere. Nevertheless, the range of skills represents the clustered-talent plan described in the article. To illustrate:

Director Ray Jensen was born and raised on a South Dakota farm. He served in the Air Weather Service from 1948 to 1954. In 1960, he earned a bachelor's degree in math and physics and in 1971 a Ph.D. in soils. He joined the National Weather Service in 1956; has served as a general weather forecaster, agricultural weather forecaster, climatologist and, until his recent post, as chief of data acquisition at Southern Region headquarters.

Assistant Director Denzil Davis, known to everyone as "Shorty," served in the Air Force as a navigator and meteorologist in the 1940's. He has a bachelor's degree in math and did graduate work in geography. He also has been a college professor and retail merchandiser. He joined the Weather Service in 1957 and has been an aviation briefer, general forecaster, and river forecaster as well as agricultural meteorologist. His last previous assignment was Meteorologist-in-Charge of the Tallahassee, Florida, Weather Service Office.

Meteorologist Clarence M. Sakamoto served in the Air Force as a forecaster in the late 1950's. He has bachelor's degrees in both soil science and meteorology, and master's and doctoral degrees in agricultural meteorology and climatology, with a minor in statistics. He worked as a research assistant at Rutgers and Iowa State in the early 60's. He joined the Weather Service as an agricultural meteorologist in New Jersey in 1965. His last previous post was climatologist for Nevada, 1968-73.

Staff members at NOAA's Environmental Studies Service Center. From left: Shirley Mummert, Ray Jensen, D.R. Davis, Donald Drew, Clarence Sakamoto, Barbara Brannan, Elwynn Taylor, Jerry Davis. Not shown, Jerry Hughes.

Meteorologist Jerry Davis (no kin to Shorty Davis) served as an Air Force forecaster in the early 1960's. He has a bachelor's degree in mathematics, a master's in meteorology, and a doctoral in geography (climatology). He joined the Weather Service in 1968. Before coming to ESSC, he worked at the National Meteorological Center as a chart analyst and forecaster, then as climatologist for Ohio.

Meteorologist Elwyn Taylor graduated from Utah State in 1966 with a major in botany and a minor in meteorology. He completed doctoral studies and served as an atmospheric physicist in the U.S. Army before coming to Auburn. He has a strong background in satellite meteorology and plant physiology.

Meteorologist Donald Drew, at age 23, is the youngest professional staffer. A native of New Jersey, he earned a bachelor's and a master's degree in meteorology and climatology from Rutger's University. He joined ESSC after graduation last spring.

Computer Programmer Shirely Mummert is a 1970 honor graduate of the University of Maryland. She served as a management intern and computer programmer with the Bureau of Customs, Treasury Department, and as a computer programmer processing financial data at Auburn University before joining ESSC last April.

Electronic technician Jerrell Hughes served four years in the Air Force as a communications specialist, five years in the Navy as an electronic technician, 1½ years with Philco Corporation, and four years with the Federal Aviation Administration before joining the Weather Service in 1964. He is a graduate of Norman College, Georgia.

Secretary Barbara Brannan is an honor graduate of Middle Georgia College, with an associate degree in secretarial science. She worked for Auburn University before joining ESSC in June, 1973.

visible on a hot summer day. The hotter the day, the greater the ozone concentration.

"The next step was to combine what I found with what the agronomists found While I had been working out ozone-prediction methods they were working on damage-prevention methods. And they found several.

"Plant breeders noticed a difference in susceptibility between tobacco species, varieties, and even individual plants. So the breeders set to work to develop resistant types, which they did.

"The agronomists also noted that tobacco leaves at a certain stage of development were more susceptible to fleck than others. This happened to be the leaves just about right for harvesting. So we concluded that if we could forecast the occurrence of ozone, farmers could save those leaves by harvesting them before the ozone arrived, which is what we educated them to do. (Tobacco leaves are not harvested all at once, but successively throughout the growing season, from the bottom up.)

"The agronomists further noted that a plant that was wilting on a day with high ozone would not fleck. It turned out the tiny openings in the leaves were closed and thus blocked entry of the ozone. Solution: Tell the farmers to let the plants wilt on those days. Don't irrigate. It doesn't hurt the plants. In fact it actually improves quality. It gives a heavier, tougher leaf—a desirable feature for a cigar wrapper. Apply water when the ozone is gone.

"With these instructions, which tobacco farmers now follow religiously, the industry was able to show a very dramatic saving. In the first year of the ozone advisories, which was 1967, the South Georgia, North Florida Shade Tobacco Growers Association reported weather fleck losses of only a few tens of thousands of collars, compared to a million dollars the year before. This low level of loss has been maintained ever since."

There's good reason to believe other plants, too, are susceptible to ozone damage, including some with important nutritional characteristics, such as spinach, to-

matoes and potatoes. Working on ozone advisories for these, with agronomists' efforts to match, is on the list of the Center's ideas to explore.

About the only chore left to perfect the tobacco ozone advisory, says Jensen, is to computerize it. And that, too, will be done.

Use of computers will be one of the chief differences between the way the multi-person Center at Auburn operates and the way the one-man agricultural weather units operate.

Jensen says the Environmental Studies Service Center was designed to be a prototype for similar centers elsewhere and that the concept has already proved valid. His reasoning is detailed; his outlook, enthusiastic.

"Before, the one Weather Service man located at an Agricultural Experiment Station couldn't do much in the way of research. He was spread too thin. Unless he was a human dynamo like Shorty Davis all he could do was put out his advisories without trying to improve them much, or to develop new ones. And when he was ill, or on leave, there was no backup.

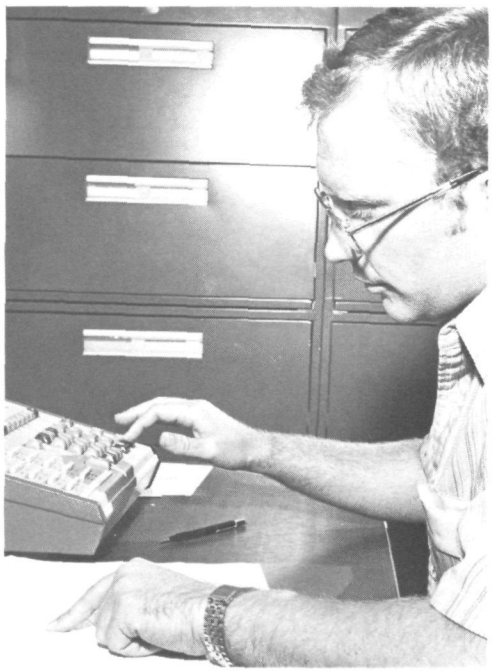
"Now with our four Ph.D.'s on hand, plus other people with rich and varied backgrounds, we not only can cover all the tasks performed before, but add new ones.

"And that's our job—to move on to new areas. Right now our programs are set up to exploit two areas—crop modeling in computers and satellite technology as it can be related to agriculture.

"The reason we're interested in crop modeling is that it's the best way to deal with the complex relationships between weather and crops. It's a very new field. Only in the past two or three years have there been developed any models that seemed to simulate the real thing at all.

"The model for growing cotton is the most advanced crop model in the world. And we're working with that. Other models are being developed for corn, soybeans and peanuts. We don't develop them; just use them.

"A computerized crop model describes in mathematical terms just how a plant operates, and you can run through a whole season in just a few minutes. It simulates the taking up of water and carbon dioxide to make food, the partitioning of carbohydrates between roots and fruit, as appropri-



Meteorologist Jerry Davis gives computer weather data; it gives back probability of outbreak of peanut leaf spot in the Southeastern United States.

Advisories are issued twice daily by teletype for distribution to Alabama, Georgia and Florida via NOAA Weather Wire, thence to waiting farmers by commercial radio, television and newspapers.

ate with time, just about everything that can happen to a plant, including being irrigated, fertilized, attacked by disease, and so on. All of these variables can be cranked into the model, to determine their effect on the real thing.

"With the cotton model the output is uncanny. You can see the plant growing . . . putting out leaves and branching . . . see the flowers appear . . . turn into bolls . . . and you can count the number of bolls . . . and then see how many will open.

"And of course among the most important inputs to these models are weather inputs: temperature, precipitation, amount of sunlight. We'll be experimenting with them to see if we can refine and expand our contribution.

"We're working on three modeling projects right now, which I'm targeting for operational testing by next spring. One is a soil-temperature model, with which we can predict soil temperature a month ahead with an error of less than one degree. We have that one well along, but are still trying to improve it. Soil temperature is the most critical factor of all in crop production. It's critical to selection of planting time.

"Second, we're experimenting with weather parameters in the cotton model, since it's the most sophisticated.

"And third, we're beginning work on a soil-water-balance model. You have to have this to run a good crop model, and it's one of the weakest parts right now. It's also useful to tell how much water is in the soil or changes that are taking place in the amount, for advice to farmers who can irrigate.

"When you take into account the long-run worry about the world food supply—How adequate is it? When will food shortages become calamitous?—it's clear that only by using tools such as these models can we do the best job possible of meeting the challenge.

"Then there's satellite technology. We've hardly even begun to use this for agriculture but it could be extremely important.

"Satellites can give us measurements of the amount of sunlight, the temperatures, and precipitation on an area basis—the kind of information that would require an enormous array of instruments if it were obtained on the surface. Satellite data may not be as precise as surface measurements, but we can take care of that problem. As it is now, if I set up a weather station for temperatures and other measurements at one locality, it's no help at all for a crop 50 miles away. The satellite could cover both, and much more.

"Another important use of satellites would be to map temperatures on cold nights over peninsular Florida. This would require pictures at a frequency of one every 30 minutes or less, such as the GOES-type satellite provides. With these, we believe we could measure temperatures with an error of no more than two degrees. The important thing here is we could identify cold pockets and warm pockets, which would allow us to give selective advice to citrus growers and others. We could say, 'Up in this area, you have no problem, so relax,' and in another area we could say, 'You do have a problem; get ready to light your heaters.'

"This could be extremely important in energy saving. As it is now, when growers expect a cold night, they all light up, rather than take a chance. And a lot of it is unnecessary. Selective advice would also help us guarantee that nobody got surprised, and lost his crop.

"We believe, too, that satellite pictures will help us sharpen the delineation of rainfall areas. This will improve the inputs to our soil-moisture models, making them more precise."

Jensen and Davis are extremely emphatic about the need for better measurements of solar radiation—the amount of sunlight striking the earth—in preparation of advisories to farmers. They say these measurements are woefully inadequate now and that satellite data will help immeasurably.

"Without good solar-radiation measurements," says Jensen, "you can't measure the rate of photosynthesis, which is the process by which plants make carbohydrates out of carbon dioxide and water with the aid of sunlight. Solar radiation is the energizing force which determines how much food is being made. It's vital to our crop models.

"It's important, too, in determining the drying rate of hay, baking of the soil, lots of other things."

They envision a system whereby they would get this data from a stream of photos from NOAA's GOES satellites, and are convinced their priority should be a high one because of the expected boost to the nation's food production.

Potential benefits to flow from centers such as the one at Auburn are echoed and underscored by R. Dennis Rouse, Dean of Agriculture and Agricultural Experiment Stations at Auburn.

The Dean is one spokesman for a planned coordinating committee of 9 or 10 persons, at least 3 from each state, to lend to the Center their agricultural expertise in choosing the best areas for concentrated effort. Speaking for Alabama, he said:

"Looking at the food needs of the nation, and the potential from this region, we believe the Environmental Studies Service Center can help Alabama match some of the big agricultural states in output. We expect our output to double in 10 years.

"For years we had a cotton economy, as high as 90 percent before 1940. Now about 70 percent of our agricultural income is from poultry and other livestock, and 30 percent is from crops. Only half of that 30 percent is from cotton, with the balance about equally divided between soybeans and peanuts.

"Our climate and soil are such that we have a tremendous potential for food production. As we move more and more into highly mechanized agriculture—which is our intent—the sophistication of our weather advice must rise accordingly.

"A good example is in the handling of poultry. Although many people don't realize it, we are third in poultry production in the nation now, behind Arkansas and Georgia. Alabama and Georgia are producing between 17 million and 18 million broilers a week, Arkansas a thousand or two above that.

"That's a lot of chickens, and the potential for losses in hauling the birds to market is highly weather dependent. Losses amounted to 100,000 birds on a single hot humid day in one Alabama county alone.

"If the poultryman knows it's going to be a hot day, he can reduce the number of birds from 12 in a crate to 10, and avoid losses. But that's expensive, involving a lot more trucks, when you're hauling millions of chickens.

"So accurate forecasts of heat and humidity help the poultryman make the one best decision to keep his costs and losses at a minimum."

The Center is issuing such advisories regularly now, and is studying ways to improve and sharpen them. State poultrymen's associations are offering enthusiastic encouragement.

Agribusinessmen such as these are keenly aware of the large and growing need for putting meaningful numbers on weather-related decisions. Around the nation and around the world, the trend is toward larger farms and more-centralized operations. And the corollary is that the fewer people in control will make better decisions, leading to more food and fiber at less cost.

Since weather is the principal variable, its importance can't be overestimated. That's why, when Ray Jensen is asked what he sees as the ultimate Agricultural Weather Service, he's like the man who just happens to have a deck of cards when somebody suggests a friendly game. His response:

"You know, what we're doing is not just for the Tri-State area here. If we get these things going . . . the physiological plant models and the satellite input and all . . . why, with a little tinkering, they would be exportable to other areas. We can begin thinking about national and global applications.

"I just happen to have worked up already a plan for a National Center for Applied Agricultural Meteorology . . . something like the National Meteorological Center at Suitland.

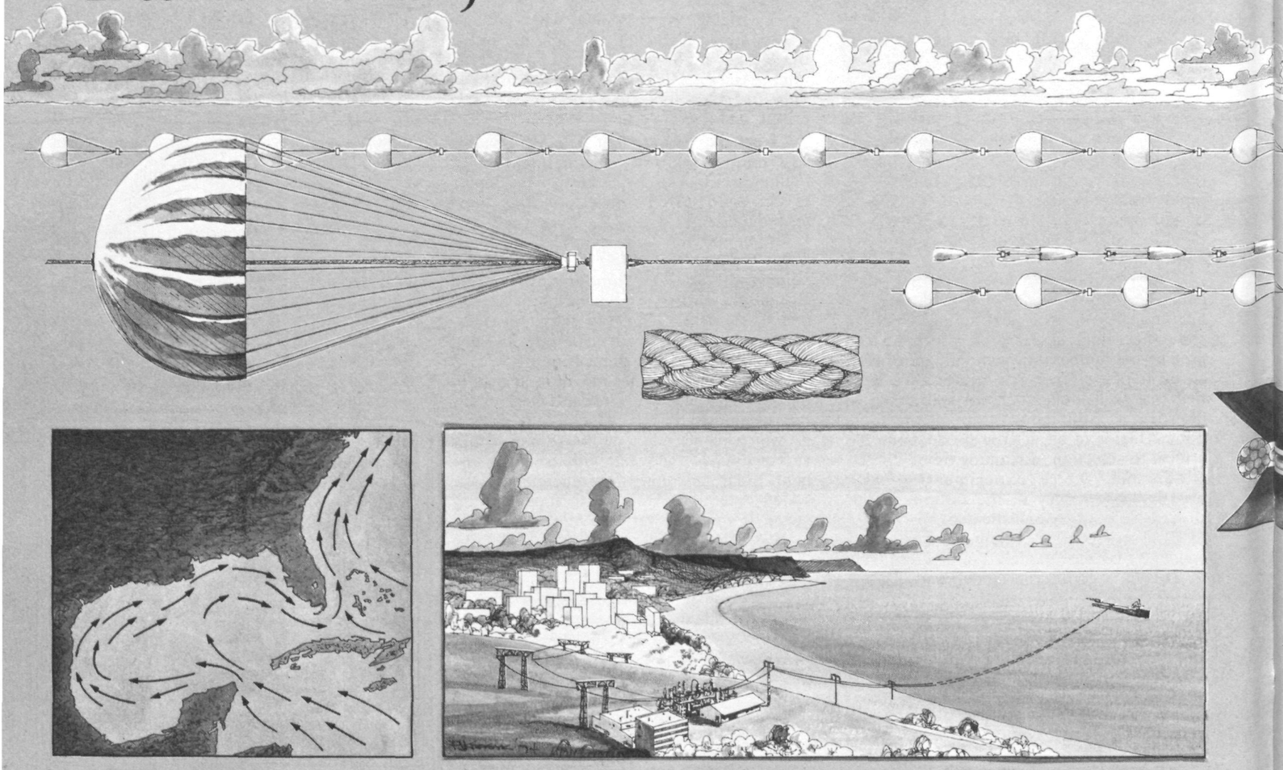
"As I see it, this National Center would have the big computers to run the crop models and update them daily if needed. Weather forecasts would be cranked in to make the crop predictions, and then these would be farmed out to two or three-man advisory centers each serving two to four states. These outlying centers would then refine the National Center's predictions to fit their particular areas and distribute them locally.

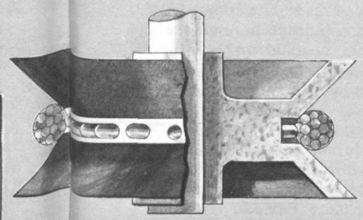
"I don't think it would be very difficult at all, once you had the models. And the benefits: Well, I think we could come darned close to meeting the sort of unofficial motto for this place, for every agricultural enterprise in the country, which is:

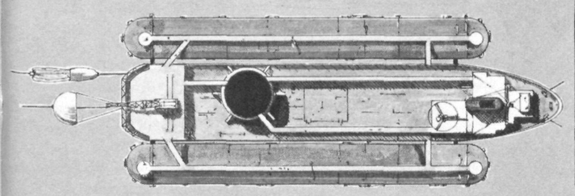
"Our job is to get the right information in the right form to the right farm at the right time." □

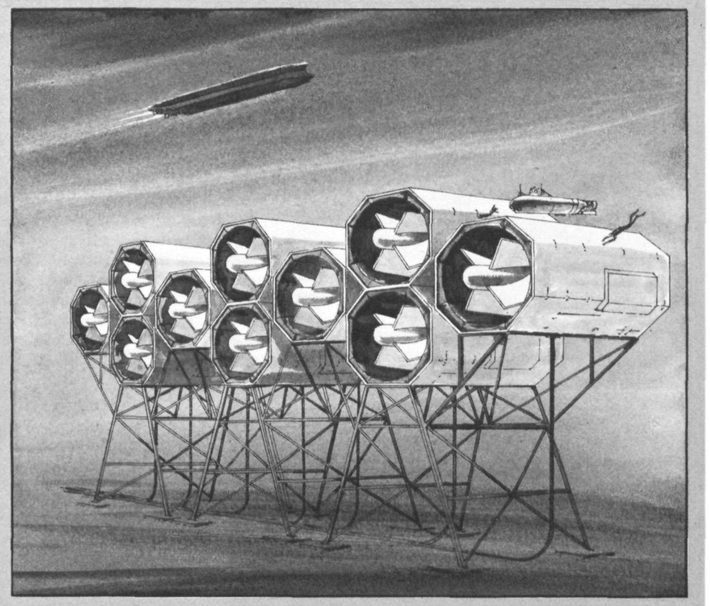
A Florida brainstorm session envisions

Parachutes, Windmills and Rivers in the Sea









BY LOUISE A. PURRETT

Underwater parachutes and windmills to reap the power of the ocean currents are not a visionary's dream, but a practical possibility, according to a team of experts assembled by Dr. Harris B. Stewart, Jr., director of the Atlantic Oceanographic and Meteorological Laboratories in Miami. In a workshop organized by Dr. Stewart, scientists and engineers from throughout the United States met to ponder ways to harness the section of the Gulf Stream known as the Florida Current. Their unanimous conclusion: it can be done.

"Over the years," says Dr. Stewart, "numerous persons have noticed the swift movement of the Florida Current . . . and have speculated on its potential as a source for useable energy." As long as there were adequate supplies of fossil fuels on land, there seemed little reason to try exploiting the current, he continues. But with the recent fuel shortages, and concern about the environment, "suddenly the idea of a fuel-free and non-polluting energy source seemed more attractive than it had as little as five years before."

Dr. Stewart, Dr. John Apel, another scientist with the NOAA Miami laboratories, and Dr. William S. von Arx of Woods Hole Oceanographic Institution first suggested the possibility of harnessing the current last year. The three had completed an oceanographic study of the current, measuring its velocity, tracing its movements, and assessing its potential as an energy source.

The Florida Current, said Dr. Apel, "carries more than 50 times the total flow of all the freshwater rivers of the world right past Miami's front door." If as little as four percent of this energy could be trapped, the researchers estimated that it would be possible to extract between 1,000 and 2,000 megawatts of power—about equivalent to a nuclear power plant.

Whether this enormous resource could actually be harnessed—economically—was a question for other kinds of experts. "We knew the sort of people we would need to do the evaluation that was required," recalls Dr. Stewart. "We wanted ocean engineers, heavy marine equipment specialists, turbine design engineers, corrosion and fouling experts, and energy economists."

This year, at Dr. Stewart's invitation, a group of such specialists finally met for three days on Singer Island, off Palm Beach, Florida to consider the engineering and economic feasibility of the oceanographers' scheme. John D. MacArthur, who was intrigued by the possibilities of the Florida Current as a fuel-free, non-polluting source of power, provided the funds for the workshop and donated the use of his hotel on the island.

In their report, recently published, the workshop participants conclude that there are, in Dr. Stewart's words, "no insurmountable engineering obstacles to trapping the kinetic energy of the Florida Current. It can be done."

The participants estimated that the energy resource available in the kinetic energy of the Florida Current is equivalent to that of about 25 one-thousand-megawatt power plants. But the amount of energy that could be extracted from the current in practical systems might not exceed the output of two such plants. That amount of energy might not be worth the investment of time, money, and human resources that will be needed to harness the current. But the workshop participants note that there are sizable kinetic energy resources in other ocean and river currents around the world, and that much of the research and development invested in the Florida Current could also be applied to extraction of other types of ocean energy, such as ocean winds. Even the temperature difference between the relatively warm ocean surface and the colder bottom waters could be exploited. There are devices, explains Dr. Apel, that produce an electric current when their terminals are exposed to different temperatures.

The participants in the MacArthur workshop considered a number of ways of harnessing the Florida Current: turbines similar to those now used in many power plants; vertical, egg-beater-like propellers; open propellers that resemble windmills; rotors with cupped blades; and a new technique proposed by one of the workshop participants, Garry Steelman, an Iowa inventor. Mr. Steelman's technique utilizes a string of parachutes arranged in an underwater ellipse, somewhat like a conveyor belt. The parachutes on top open up in the current, are dragged along by the flow, then collapse to be carried back to the starting point.

To decide which of these systems is most workable and solve the practical problems of setting up an energy extraction system, the group recommends a year-long study. The Current itself—its oceanography, meteorology, and ecological niche—must be better understood. The amount of energy available, and the environmental effects of extracting it, must also be evaluated. Engineers should determine the amounts of stress that waves or hurricanes may impose on an underwater structure.

Whatever system is selected to convert the energy of the moving water to usable power will have to be anchored somehow in the current. Methods of keeping the system in place, such as an anchor and tether combination, will have to be evaluated, as well as methods of installing and servicing the apparatus.

Finally, the energy collected must be transferred to shore and delivered to customers in a useful form and at a reasonable price. One possibility is to use the current's energy to compress air, which could then be piped to shore to drive the turbines in a power plant. Or, the energy collected from the current could be used on the site to extract hydrogen from seawater. Hydrogen is a highly efficient, clean fuel that could be bottled and shipped to power plants around the country where it could be burned to generate electricity.

If the results of the year-long study are encouraging, design of an experimental system, laboratory tests, and ocean test of a pilot model could begin. The final step would be a small, 5- to 20- megawatt prototype power plant.

The participants in the MacArthur workshop estimated that the cost of construction of a full-scale plant and the retail prices for energy from the flowing Florida Current would probably be competitive with costs projected for other energy sources in the 1980's.

Tapping the energy in ocean currents could not satisfy all the nation's power needs, Dr. Stewart concludes, "but it can supplement other sources to help meet the demand in those areas where relatively fast currents are found close to shore."

a down-to-earth approach to lofty problems

BY JOAN VANDIVER FRISCH

EVEN THOUGH THE ATMOSPHERE is Spaceship Earth's oxygen tank, there are additional less well-known protective and useful roles it also plays: it shields us from the harmful extreme ultraviolet radiation from the sun, and provides us with an electrically charged layer which reflects radio waves back to earth, making global-range communications at high frequencies in the 3 to 300 megahertz range possible.

This layer, the ionosphere, is the region of the atmosphere between about 40 miles (60 kilometers) and 250 miles (400 kilometers) above the earth's surface where atoms and molecules of the atmosphere are ionized (or given a positive electrical charge by the removal of negatively charged electrons' by radiation from the sun.

The structure and resulting effectiveness of this layer in reflecting radio waves depends, in part, on its chemistry. A better understanding of this chemistry will be provided by a new laboratory device, a flow-drift tube, developed by scientists at NOAA's Environmental Research Laboratories in Boulder, Colorado.

Because it combines the best features of two previously used instrumental techniques, the new flow-drift tube apparatus is able to examine, over a broad range of temperatures, many of the chemical reactions that occur in the ionosphere between ions and neutral (un-ionized) molecules. The device can study in the laboratory the chemistry that occurs at altitudes that are too high for balloon probing and that can only be reached by sounding rockets or satellites. In fact, the first of a new series of satellites, called the Atmospheric Explorers, was launched less than a year ago. A better understanding of the ionospheric chemical reactions will play an important role in analyzing, interpreting, and utilizing the data returned by these satellites.

"Chemical reactions between the ions and molecules actually play a large role in controlling the density of electrons in the upper part of the ionosphere, and it is these electrons that are partially responsible for reflecting radio waves back to the earth, making long-distance radio communication possible," explains Dr. Daniel L. Albritton, a physicist with the Aeronomy Laboratory, one of the Environmental Research Laboratories.

"With the new apparatus, we can investigate how the rates of these ion-molecule reactions depend on the temperature of the ionosphere. This temperature dependence is important because the ionosphere has not only its daily and seasonal temperature changes, but also experiences changes due to the variation in solar activity like sunspots and flares, which substantially increase the solar energy received by the earth's atmosphere.

"Measurements of the temperature dependence of these controlling ion-molecule reactions is needed over the ionospheric temperature range in order to understand the details of the seasonal and sporadic changes in ionospheric electron densities, on which radio communications sensitively depend."

The study of ion-molecule reactions in gases did not become an active area of research until about 1950. Since then, this research field has experienced a very accelerated growth, which, to a large extent, has been a consequence of the development of a variety of new experimental techniques that have greatly extended the capabilities to measure the rates of these reactions.

One of the most productive of these techniques has been the flowing afterglow apparatus developed about ten years ago by Drs. A. L. Schmeltekopf, F. C. Fehsenfeld, and E. E. Ferguson, at what is now NOAA's Aeronomy Laboratory. Using this flowing gas apparatus, these scientists have studied hundreds of ion-molecule reactions, and their efforts were the breakthrough in the initial understanding of the chemical reactions of the ionosphere. The key feature of the flowing afterglow technique has been its chemical versatility, that is, its ability to examine a wide variety of ions reacting with many different kinds of atoms and molecules. The flowing afterglow apparatus can make measurements over the temperature range −300 to 1150 degrees Fahrenheit (−80 to 900 degrees Kelvin).

However, the temperatures in the ionosphere can be higher than these, and, during periods of unusual solar activity, much higher. There are other types of experimental techniques that can study ion-molecule reactions at relatively high energies, which correspond approximately to high temperatures. For example, ion beam techniques have considerable chemical versatility, but can make measurements only at relatively high energies. Drift tubes, in which the energy of the ions is increased by weak electric fields, can cover the ionosphere's temperature range, but this technique has rather limited chemical versatility. Therefore, there has existed an ionospherically interesting energy gap between the extremes of low and high energies in which it has been difficult to make measurements on a wide variety of ions and molecules.

The new experimental device—a flow-drift tube—bridges this gap by combining the chemical versatility of a conventional flowing afterglow with the energy variability of a conventional drift tube, allowing measurement of the energy dependence of both positive and negative ion-molecule reactions that were not previously possible.

Although the gas bottles, pumps, gas flow control valves, and the supporting electronic equipment fill an entire laboratory room, the heart of the new flow-drift apparatus consists chiefly of a shiny stainless-steel, horizontal cylinder approximately 3 inches (8 centimeters) in diameter and 4 feet (125 centimeters) long. The gas flow controllers and the large pumps maintain a steady flow of helium, the ion-transporting gas, down the tube.

"The functions of the upstream and downstream parts of the tube are different," explains Dr. M. McFarland, a chemist with the Aeronomy Laboratory, who recently completed his graduate work by assembling and using the flow-drift tube. "In the upstream part of the device, the desired ions are created from a selected parent gas such as oxygen or nitrogen, in the same versatile manner as has been done in the conventional flowing afterglow for many years, by either impact from high speed electrons or by carefully chosen chemical reactions, both involving the ions' parent gas. The helium gas flow transports the ions into the downstream part of the flow-drift tube, where the ion-molecule reactions actually take place."

"This region is constructed like a conventional drift-tube: that is, a weak, uniform electric field exists down this part of the flow tube. The purpose of the electric field is to increase the speed of the ions by as much as 10 times, so that when they collide with atmospheric gas molecules that have been added to the downstream section for this purpose, the collision will be up to 100 times the energy that the ions possess at room temperatures. By varying the strength of the electric field, the NOAA scientists can study how the reaction of the colliding ion and neutral molecule changes with energy."

The new ions that are created by the reactions are identified and detected in a mass spectrometer located at the end of the flow-drift tube. The laboratory has a small computer that is used to process the data from the apparatus.

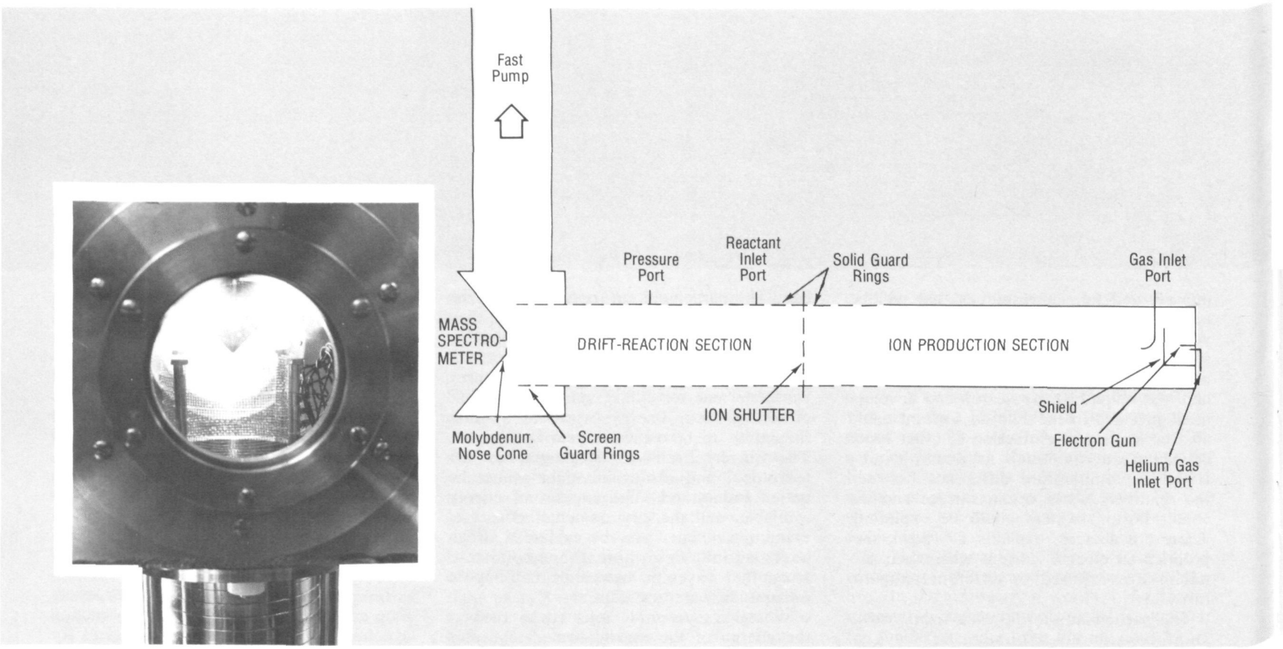
One ion that is of particular importance is the atomic (one atom) oxygen ion. The sun's extreme ultraviolet radiation strikes the oxygen atoms in the upper ionosphere, creating from them atomic oxygen ions and electrons in great numbers.

This ionization process cannot be easily reversed; that is, when an electron happens to collide with an atomic oxygen ion, the two do not effectively recombine to form an original oxygen atom. As a result, the electrons, on which much of radio communication depends, are lost only very slowly by recombination with atomic oxygen ions.

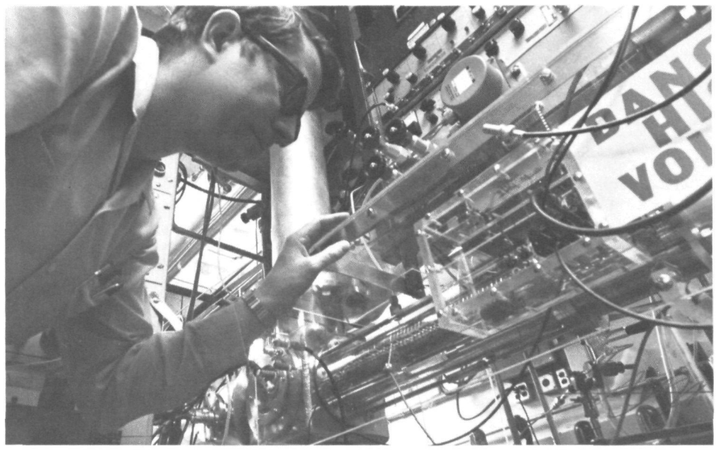
However, there is an alternate way in which electrons are lost. Ion-molecule reactions can convert the atomic (one atom) oxygen ions, into some type of diatomic (two atom) ions, which can recombine with electrons much more rapidly. In this manner chemical reactions can change the electron density of the ionosphere because they convert atomic ions, which only slowly consume electrons, into diatomic ions, which can swiftly devour electrons.

At normal ionospheric temperatures, the converting reactions are slow and do not convert many atomic to diatomic ions. Because of this behavior, the Environmental Research Laboratories scientist says there are relatively few diatomic ions to consume the electrons. This is one of the fortunate reasons why our planet supports an ionosphere with enough electrons to allow the radio communications we do have.

The NOAA scientists have found that the rate of these converting reactions depends sensitively on the ionospheric temperature. In particular, at high temperatures, these reactions are from 10 to 100 times faster, implying that the electrons are lost by recombination much faster at the higher temperatures, thereby influencing radio communications. □



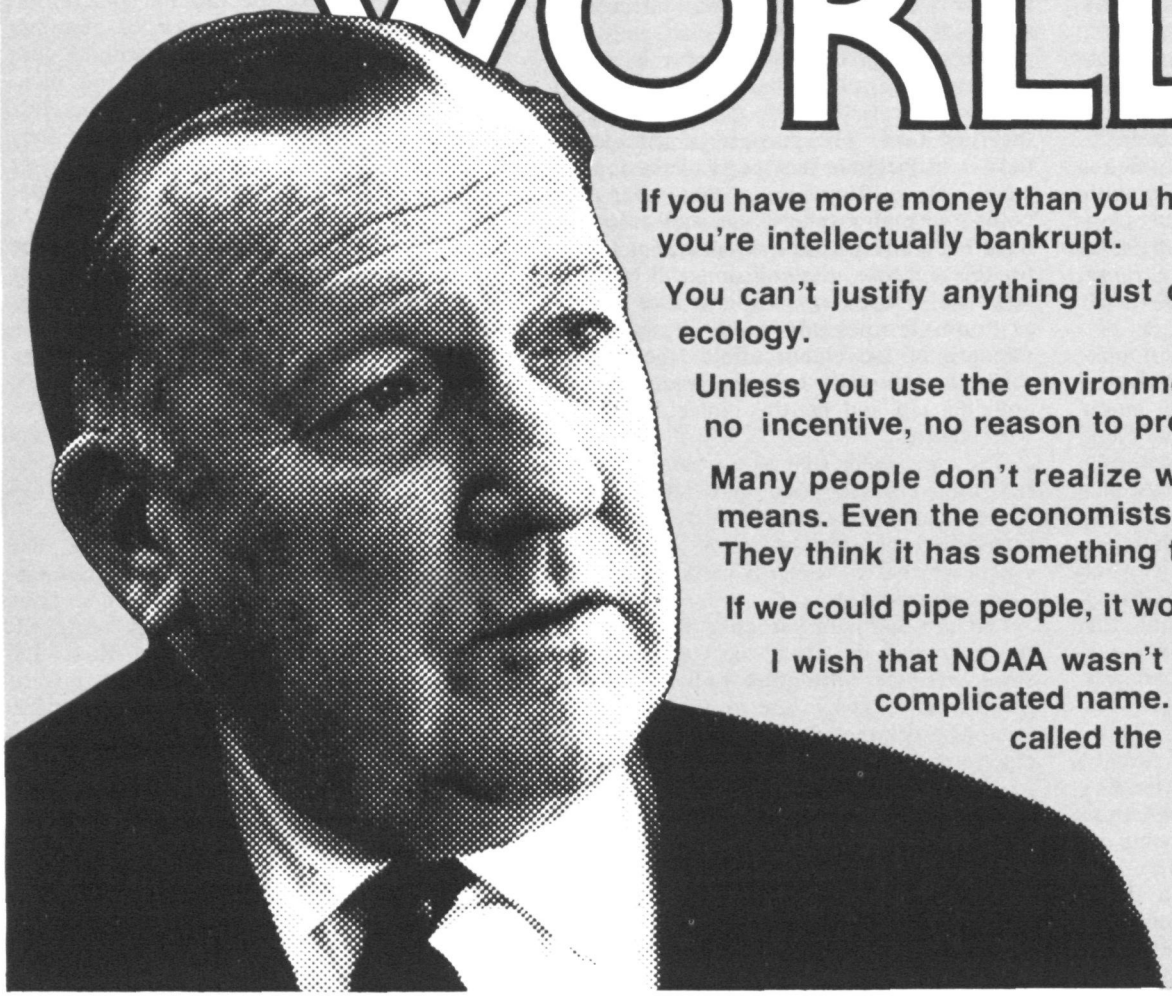
(Left) Downstream end of the flow-drift tube where ions are sampled in the cone-shaped entrance to the ion-detection chamber by scientists at the Environmental Research Laboratories' Aeronomy Laboratory in Boulder. (Above) Cross section schematic view of the flow-drift tube.



Dr. Daniel L. Albritton, a physicist with the Environmental Research Laboratories' Aeronomy Laboratory in Boulder, checks the electrical connections on the flow-drift tube apparatus, a device which can examine, over a broad range of temperatures, many of the chemical reactions that occur in the ionosphere between ions and neutral molecules.

Cabbage, kings, oceans, and a great deal more

SPILHAUS' WORLD



If you have more money than you have ideas . . . you're intellectually bankrupt.

You can't justify anything just on the basis of ecology.

Unless you use the environment, you have no incentive, no reason to protect it.

Many people don't realize what economics means. Even the economists sometimes forget. They think it has something to do with money.

If we could pipe people, it would be far cheaper.

I wish that NOAA wasn't called by that complicated name. I wish it was just called the Air-Sea Agency.

Noted scientist, inventor, and author Dr. Athelstan Spilhaus was appointed special consultant on oceanic and atmospheric programs to Dr. Robert M. White in January this year. His assignment is a broad one—to conduct studies, carry out special assignments, and give counsel on NOAA activities in ocean-atmosphere monitoring, Sea Grant, oceanic research, fisheries, and coastal zone management.

Dr. Spilhaus is known as the "Father of Sea Grant" owing to his concept for the name and activity that later came to be NOAA's National Sea Grant program. He has been a Fellow at the Woodrow Wilson International Center for Scholars of the Smithsonian Institution, President of the American Association for the Advancement of Science, President of the Franklin Institute (Philadelphia), and Dean of the Institute of Technology, University of Minnesota. He is the inventor of the bathythermograph, a basic internationally-known oceanographic instrument, and the Spilhaus Space Clock, and is a prolific author of both popular and scientific articles.

Known to friends, colleagues and students as "Spilly", he was born in Cape Town, Union of South Africa, and received a B.Sc. from the University of Cape Town in 1931. He obtained an M.S. from the Massachusetts Institute of Technology in 1933, a D.Sc. from the University of Cape Town in 1948, and has received ten honorary degrees from universities in the United States and England. He became a naturalized U.S. citizen in 1946.

Dr. Spilhaus began his public service with the U.S. Army Air Force, 1943–46, during which time he contributed to the development of meteorological equipment including radar and radio upper wind finding instrumentation, work for which he was awarded the Legion of Merit in 1946. He was Scientific Director of Weapons Effects of two Nevada Nuclear Tests in 1951, and has received Presidential appointments from Presidents Eisenhower, Kennedy, and Johnson. He was a member of the National Science Board from 1966–1972.

Dr. Spilhaus was interviewed by Ann Cook and Roland Paine for this article.

Q. You have an extraordinary background—scientist, engineer, a person who puts ideas to work—and I think the people of NOAA would be very interested in knowing about your assignment here.

A. Well, my assignment here in NOAA is to be a consultant and advisor to Dr. White. He has given me the freedom so that I can give him my ideas and he can take them or reject them. And that's a very important freedom. I don't have to worry and he doesn't want me to worry whether my ideas or suggestions are necessarily acceptable, because the validity, or the importance, or the originality of a recommendation does not depend on its acceptability. Somebody can have the best idea in the world and the administrator might think it's the best idea in the world from the point of view of pure science—of air and sea—but there are such things as the budgetary process, which gives NOAA its money. There are such things as pressing public needs for NOAA services. And the best idea in the world might not fit these two constraints. That's the very difficult job that the administrators of a government department have and I'm very well aware of it. But I want to keep out of that. I want to keep free and give ideas whether they are acceptable or not.

Q. With respect to some of the particular functions of NOAA that I know you've been involved in: You are the father of Sea Grant. You've followed the program very closely since its inception and I'd be interested in knowing what you think of its progress, what its problems and its possibilities are at this point.

A. Well, Sea Grant is a small but important part of NOAA's total activities. I think it's been extremely successful. I remember that when Sea Grant started we got very little money to start it off. That was when it was in the National Science Foundation, and Bob Abel was worried about the very small initial start, and I said, "Don't worry. If you have little money, it means you've got to have more ideas." I've always thought that the idea-to-hardware ratio, or the idea-to-support ratio, is the thing to maximize. If you have more money than you have ideas, which sometimes happens in government, you're intellectually bankrupt.

Q. And how about Sea Grant growth?

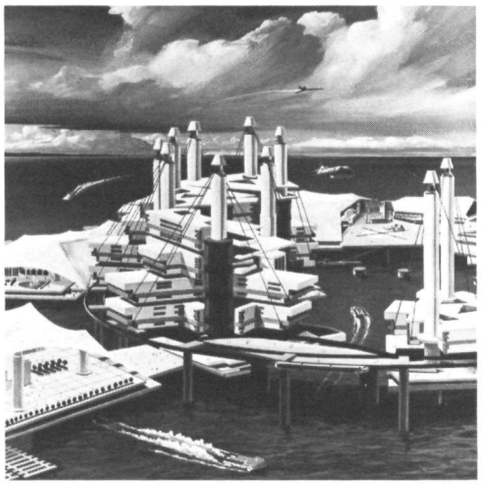
A. I think Sea Grant has grown at a reasonable pace. We could use more money now. For example, Sea Grant has not done enough in ocean engineering. And of course any engineering takes a lot of money. So here I think we could use more. But by and large I am very happy about the Sea Grant program.

Q. Ocean engineering?

A. I think, for example, of cities in the sea.

Q. Some years ago, while you were at Minnesota, . . .

A. Well, I've been suggesting cities in the sea for a long time, but now government



and industry are so big and split that it takes someone who's not involved in specific projects to put them together, to synergize them. Now, in moving out to sea, what do we have to do? We have one group that wants to put nuclear power plants in the sea. I happen to think that's a very good place for them. And we have cities like New York and Los Angeles that are terribly troubled by their airport problems. Los Angeles is going to extend its airport into the sea. Hawaii is going to extend its airport out onto the reefs. So airports are moving to sea. We have problems of deep-water ports, really serious problems.

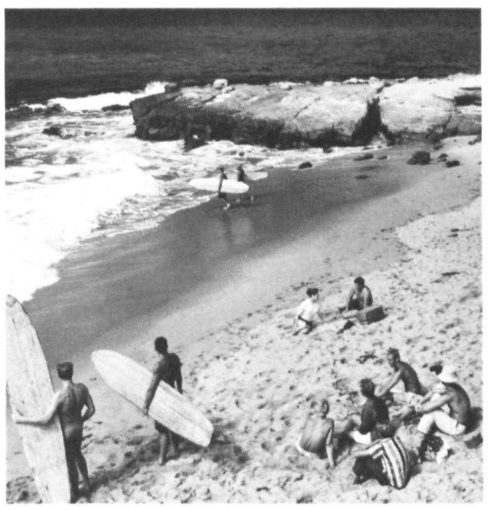
We are far behind, as nations go, in the provision of deep-water ports. The largest ships in the world cannot get into any port in the United States. So we must move ports out to sea. We have concern about pollution and oil spills. Well, these are much more easily controlled if we have oilers offloading and loading offshore, where we could control it with a "pollution brigade" that would be just like a fire brigade. Just like putting out a fire, they'd contain pollution and clean it up. If you put all these things together, you can justify the expense of the platform, whether it be floating or anchored or whatever. And you essentially have a city at sea, if we'd just put the things together.

Q. You mean you can justify offshore ports on the basis of ecology?

A. Oh, no. You can't justify anything just on the basis of ecology. That's what people have been trying to do too much. We've been on an ecological kick. Now, I can say that, because I contributed to environmental awareness way back when I wrote the original paper that the National Academy prepared. I was chairman of their Pollution Committee. When the report came out, they wanted to call it a report on "Pollution." I said I won't do that; it's negative. We called it "Waste Management and Control," because if you manage your wastes and control them, you can't have any pollution. If you use your wastes—and this is one of the important things that aquaculturists are doing, trying to use sewage as food for plants and so food for shellfish (oysters and so forth), so that we build up an ecological system using our own wastes *and* producing things we need. You can't look only at ecology; you must look at economy, too. In fact, I coined a word, which has become quite widely used: ecolibrium, which is a balance between ecology and economy. I would say that NOAA, being in the Department of Commerce, is a sort of EPA, but not an Environmental Protection Agency—NOAA is an Environmental Promotion Agency. Unless you use the environment, you have no incentive, no reason to protect it.

Q. Many of the ocean engineering projects that you have discussed involve what we now think of as the coastal zone. Now we have legislation and an Office of Coastal Zone Management—how do you look upon these developments?

A. Well, coastal zone management is a new phrase for an old problem, and I think it's a good thing that they coined the phrase, because you know the way we proceed we often have to coin a word for something to focus public attention on it. Coastal management is a wonderful step in this direction. But Sea Grant and coastal zone management are in the same business. Sea Grant was originally to integrate efforts of industry, universities, state governments, and federal government in the proper use of the sea for benefits to people, and the proper use of the sea involves the protection of the sea and its resources. Coastal



zone management is just exactly that, too. Coastal zone management is the management of that particularly difficult zone on the earth where sea and land and air meet. One of the most important uses of the coastal zone is for people's recreation, actually. We are just beginning to realize how people crowd onto our coasts. Our east and west coasts are very crowded. And so you suddenly get the realization that whereas formerly we cluttered up the coast with industries and harbors and so forth, we now should move those out to sea and leave the seashore for people's recreation; that's where the balance between economy and ecology comes in. And this is

management; you could call it coastal economics. Many people don't realize what economics means. Even the economists sometimes forget. They think it has something to do with money. Actually the derivation of the word economics comes from "eco," home, and it really means the stewardship of resources in an estate or a zone, like the coastal zone, for productivity. And productivity covers the multiple uses that benefit people. It's just that simple . . . but very difficult to carry out properly.

Q. One of the projected uses of the coastal zone is as a place to obtain energy resources . . .

A. Well, we've gone through a thing called the energy crisis. To call it the energy crisis drew public attention to it. It's not a crisis and it's not over. Many of us saw it coming for years and years and years. Many of us know it will be with us from here on out. Once I coined this phrase, "energy: the fundamental currency of civilization." With enough energy per head of population, all the problems in the middle—cleaning up, providing food, recycling materials, finding subsitutes for materials or resources that we run out of—all of these can be accomplished if we have enough energy, and if we don't have too many people. The terrible dilemma of some of the developing countries, of course, is that their people increase exceeds the rate of increase of their total productivity, and that means that, per capita, everybody gets less on the average. We must guard against that. So then obviously we must search not only for energy in the seas but for many other resources that we're running short of. Good engineering means searching for them so that we do not ruin the store house that we are taking them from. We take the renewable

Photo: Deepsea Ventures, Inc.

catch of fish; we take oil out of the sea without polluting the sea and ruining the fish catch or ruining the recreational value of sea; we take manganese nodules, perhaps, from the sea, and we make sure that that is done in what is now modern, good engineering; cleanly and economically producing things that people need.

Q. I think you've used the example, too, of aluminum, which takes a considerable amount of energy to produce from bauxite, but once you've made an aluminum car, it's relatively easy to recycle . . .

A. Yes, that's correct. Once aluminum's won, you can recycle it; it's a pure metal. We'll be recycling aluminum the way platinum has been recycled for years and years, because it was so expensive—and gold, gold is never thrown away; it's recycled. Now other resources are becoming like platinum and gold, and we recycle them. And I think that we are going to go into a new kind of energy economics where we may have to decide: is it energy-economical to wear a nylon shirt or would it be more energy-economical, even if not money-economical, to wear a cotton shirt? And actually we don't know, because it's not as easy as saying, well, nylon is a high energy-consumptive business, it uses petroleum as its base of the material, and therefore obviously cotton, which grows . . . the free energy of sunshine is cheaper. It's not that simple, because cotton is a labor-intensive business, and in our country every laborer (thank heaven) has a good standard of living, and he uses a great deal of energy. So you've got to count up all the energy that the labor uses, and it's not an easy equation to make. We have been profligate. Energy-wise, we know well that airplanes are the most costly way of traveling. Pipelines—if we could pipe people, it would be far cheaper; rail is next cheapest; and ship is next cheapest. But the funny thing is that rail and ship travel has gone down, and airplane travel has gone up.

Q. Moving farther out to sea off the continental shelf, NOAA and other agencies are involved in what largely is basic research now along the mid-Atlantic ridge, for example. What kind of level do you see for this kind of deep ocean research in terms of its prospective utility to mankind?

A. Well, I think that deep ocean research is terribly important. Everything is relevant to the mission. When you talk about "mission-oriented research," it's research that has an *obvious* application which you can see right at the end of your nose. And then you neglect the research which is far out. That's what we've got to guard against in NOAA. Obviously the coastal zone is immediately important . . . we can see that in front of our nose. And of course we put emphasis on it. But, let us not forget that we must lay the basis for the future when we move out into the deep oceans. We must have that research going on.

Q. To revert to energy—what do you see in the future for direct use of somewhat primitive things such as windmills, placed against say, solar power?

A. Well, I think this is just a progression. Before the invention of heat engines, the power was solar power. Solar power has been with us for a long, long time. It was stored in wood. And wind power was used, and water power was used. Both, of course, are solar power. Water is evaporated by the sun and dumped on high places and then runs down and you get water power. Nothing new about these things. Then heat engines were invented. They were invented after there was a fair amount of coal. So, coal replaced wood . . . we had wood burning locomotives in the United States and then coal burning locomotives. And then came the discovery of oil. And oil was so convenient as a portable fuel that it supplanted the other, and we forgot our coal. And now we're coming back to coal and that is absolutely proper. We must in the United States gasify and liquefy coal and buy time for the development of nuclear energy. And we should certainly use sunshine in new and sophisticated ways. And we can invent better windmills. You mustn't think of a house that's purely heated by sunshine or purely powered by a windmill. I think what we'll find is that these windmills and solar devices will be tied in with our electric networks. They will take part of the load off the electric networks, but when the sun doesn't shine or the wind doesn't blow, you still have a source of energy. So you have a diversified source of energy instead of a single source.

Q. I didn't know that about liquefying and gasifying coal. Is anyone doing that?

A. Well, it all sounds new because nobody reads history anymore but the first gas was not natural gas. The first gas in Europe that lit the gas lights in the streets was coal gas. It was called coal gas because it was made from coal that was burned with insufficient oxygen, giving off a burnable gas and leaving coke which was also useful.

Q. Does this minimize the pollution that comes from use of coal?

A. I'd say certainly; if we find ways to gasify coal and take sulfur out of it in the process, you've got a cleaner fuel than if you burn the coal itself with the sulfur in it. The reason that we will liquefy coal is that we need to have a substitute for portable gasoline.

Q. To come back closer to the water, one of your assignments in advising Dr. White involves fisheries, which certainly have many problems—have you gotten into this area enough to have any thoughts about where NOAA and fisheries might be?

A. Well, I've been thinking of fisheries in sort of an offbeat way. I certainly wouldn't comment on the immediate fishery problems because I think we have people who are right in the business and know much more about the day by day and year by year problems than I do. But I do think about the future. The problem with fisheries worldwide is that we must not move worldwide in fisheries the way we have moved in agriculture. Let me explain what I mean. We are terribly proud of our United States agriculture. And I am proud of it. However, when we produce the steaks with feedlot cattle, we expend in energy economics about ten to twelve calories per calorie that we eat. And when we grow wheat on an intensive basis, considering the energies needed for the tractors, for all machinery and the fertilizers in farm use today, we may spend almost as many or more calories in growing wheat than we get out of it. When we give wheat away to another country, we're giving away petroleum. Can we continue to afford to do that? And should we encourage other nations to use our energy intensive methods which use so many calories per calorie produced? In our charitable desire to transfer technology to other countries, I'm not so sure that in the long run we're doing all them a favor because I'm not so sure the whole world can afford the energy expenditures per calorie that we can afford in our country.

Q. Do you have any ideas for harvesting the fish with lower energy?

A. Well, there is a wonderful idea for harvesting fish. Let's take harvesting krill for instance; as an engineer I am not sure I can devise a machine to collect the krill in the southern oceans around Antarctica as efficiently as a whale does and convert it to protein—we are interested in breeding whales, not killing them.

Q. I understand that the Russians have developed a method for fishing krill.

A. That may be, but at the same time they're still whaling. Why develop a machine when we have a whale that does it very nicely? If we could breed *enough* whales to collect the krill, then later we might be able to take renewable catch each year. One must always weigh the relative merits of biological engineering versus physical machinery engineering. If you've got an efficient natural machine to gather things why develop a mechanical device?

It's like the fellow that invented the lawnmower. He added a thing to catch the grass and then he said, what do I do with these clippings? So he went into his laboratory and developed a way of getting a drinkable fluid out of grass clippings, leaving a sludge. And then he put a motor on the mower, and then because he couldn't go over uneven ground he put kind of feet on it and he took his thing out of his laboratory and it had little taps that the drinkable fluid came out of and it exuded the sludge as fertilizer onto the ground. Then he put a sensor on it so it went around automatically and he didn't have to guide it. It sensed where the grass was longest and it grazed all around. He had reinvented the cow! We've got to guard against the misuse or overuse of technology.

Q. Can you say anything about specific problems or areas you are working on?

A. Well, one little example: I have long had an interest in geodesy. I recently took part in an international symposium of geodesists in Columbus, Ohio. Geodesy in NOAA is a very basic and important part. Why? Well if you talk about developing the resources of the sea you'd better do stepwise what man did on land for a long time. He measured the earth, he surveyed the land, he had to find ways of getting back to a point. If he saw a source of some mineral resource on the land he had a map and he could get back to that. We've got to map the sea in the same way. And we've got to emphasize the mapping of the sea first on the continental slopes, which are easier, but also the deep oceans. We've just got to carry the surveying of the land out to sea . . . deeper and deeper and cover the whole world ocean.

Of course geodesy involves a lot of erudite problems, mathematical problems of the geoid and so forth, and these seem to some people to be very abstruse and removed from reality, but they are actually absolutely basic to the understanding of the earth.

The whole question of our datum from which we measure everything is sea level. But the sea isn't level. And this is a beautiful thing for NOAA because involved in the true level of the sea are tides, the melting of glaciers due to temperature changes, the wind and the storm surges. Both sea and air are involved in this datum that we must have for our surveying. Few people, I think, realize the importance of this and yet it is a basic function that brings many pieces of NOAA work together. Sea and air. I wish that NOAA wasn't called by that complicated name. I wish it was just called the Air Sea Agency. That's what NOAA is about—Air and Sea. There are so many interesting things going on in NOAA, and I'm interested in all of them. I'm just trying to find my way; I'm a new boy and I get involved in one and then another.

Q. One area that started out with some emphasis a few years ago and has leveled off is the manned undersea work.

A. Yes, that is a program that I have been working with quite a bit. I think that basically in concept NOAA's manned undersea operations—I would prefer if they were just called "undersea operations" because I think you should have the flexibility of using a man or not using a man, and again this comes historically out of space. At first for the IGY we were going to put up an instrument, little Vanguard, which incidentally was a most successful instrument, even though it went up after Sputnik. It got tremendous results. For manned spaceflight—at first I was quite critical as this Frankenstein that we'd started in 1955 developed into NASA and a great manned program. I was very stupidly critical. I said, "Gosh, we're spending so much money on these redundant systems to take a man into space. What we could do with that money if we just sent instruments up—couldn't we get more?" Well, I was wrong, and I don't want to be wrong again. The manned space operation, for all it cost, was worth every penny of it, because we wouldn't have gotten any science in space without it. Besides, it was a thing that sort of lifted the human spirit all over the world when we needed a lifting of the human spirit. So I think that we must keep up the effort on Man Under the Sea at as good a level as possible to continually develop the ability of man to work undersea. And the ability of man to work undersea is complementary to using instruments which may for certain jobs replace man undersea. You can develop an instrument to replace man best if you can put down the instrument and simultaneously get "ground truth" with a man's eyeball there. Then later on you can just use the instrument. We must have the ability for man to go anywhere he can. So I'm very keen on the undersea technology, manned and unmanned. They go together, each helping the other.

Q. In one of your articles you said the air and the sea were there for us to use to disperse pollutants. Do you think that deep ocean pollution at present is as critical as some people say?

A. Deep ocean pollution, no. Deep ocean pollution is not a problem; it is a symptom in search of a disease. Coastal pollution is serious and important, but deep ocean pollution now is something we must watch so that it does not become a serious problem.

Q. By watch do you mean take steps to keep it from going further?

A. Not necessarily. One proper use of air and water is to dirty it—but not too much. You can dirty air and water; every use we make of air and water dirties it. In our bodies when we breathe in air—when we exhale it, it's less breathable for the next guy. Water cools our own bodies and carries off poisons; same things that industry does with air and water. But the important thing in this "ecolibrium" position is that you don't put a burden into the air or water that is more than nature, or nature helped by engineering, can clean up. So we must think of using and re-using air and water. Now, when you said, are we polluting the deep ocean too much, I don't know, but I don't think so yet. I think we might be able to pollute the deep ocean a little more and still use it, but when I said we have to watch it, we have to assess what is the burden of specific things we can put into the deep ocean. What is the burden that is tolerable, and so forth. And these are the difficult things to assess. This is NOAA's business. In order to use the ocean, we must know how to protect it. But we mustn't over-protect it to prevent its use.

After all, we are in the Commerce Department, and the Commerce Department's business is business, and NOAA's part of this business is to improve and increase the uses we make of the sea and air while at the same time preserving their qualities for future use—a great challenge.

Sea Grant scientists from the world of biochemistry are working to create

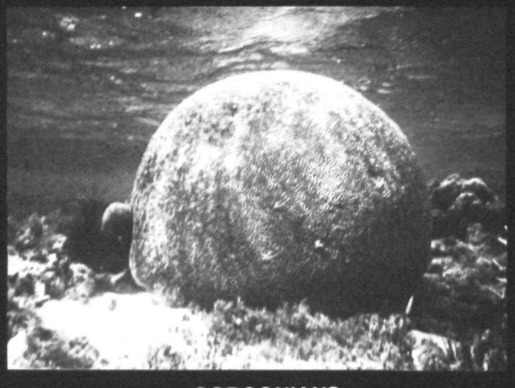
AN OCEANIC MEDICINE CHEST

BY DAVID ATTAWAY*

*David Attaway, a biochemist, is Assistant Director of the Institutional Support Program, Office of Sea Grant

HARD CORAL

BRAIN CORAL



GORGONIANS

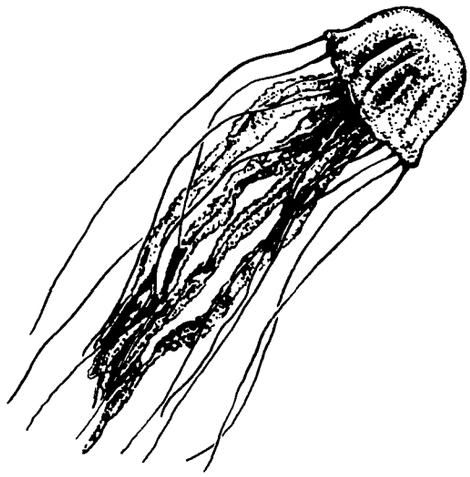
PHOSFLUORESCENT JELLYFISH are pretty, and some of these beautifully eerie animals, which emit pale blue light, may turn out to be useful as well—and just because they can turn on. One of them, known as *Aequorea aequorea*—it has no popular name—contains a chemical called aequorin which causes it to light up. Aequorin emits light in the presence of calcium ions, and has been shown to be an effective reagent for determing the amount of calcium present in very small volumes—even in single cells. The amount of light emitted can be measured with sensitive photoelectric cells and is proportional to the amount of ionic calcium present.

Because of its extreme sensitivity, it can be used to measure minuscule changes in calcium concentrations in a person's body fluids or cells. Such changes frequently are early signals of cellular destruction in the body, and point to the onset of diseases such as metastatic carcinoma, bone dysplasia, cardia dysrhythmias, parathyroid disorder, and others.

Sea Grant investigators Samuel Felton and Kenneth Izutsu of the University of Washington, who developed a procedure for measuring calcium ions with aequorin, have also established a relatively simple procedure for extracting the substance from the jellyfish. It is a procedure which can handle large numbers of the jellyfish that are very abundant in Puget Sound at certain times of the year. Because it may have wide application in studying the role of calcium in regulating the functions of living cells, Felton and Izutsu are working on the possibility of having aequorin test-marketed by chemical retailers who handle specialty items for medical researchers.

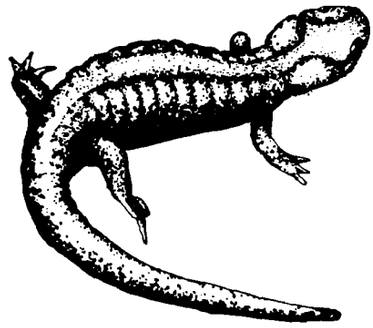
Finding useful marine products in unusual places is the occupation of several chemical, pharmacological, and biological investigators who receive research funds through NOAA's National Sea Grant Program. The search for and study of drugs and chemical reagents in the sea, though only a small part of the National Sea Grant Program, is fascinating and important, and ranges over a number of subjects. Sometimes the work results in chemical compounds and techniques whose applicability is quickly apparent, as in the case of aequorin. Sometimes it provides an answer that is basic rather than applied, but not less important—for example, a new ehcmical linkage in a complex organic molecule whose value is a model for synthesis of related compounds having desirable medicinal or psysiological properties. But all of the work is based upon the ability of marine organisms to fabricate unique substances whose chemical breadth has been inadequately explored.

In landlocked Oklahoma, which is distinguished by being the only inland non-Great Lakes state to have a Sea Grant, Professors L. S. Ciereszko, P. N. Kaul, F. J. Schmitz, and A. J. Weinheimer are working as a biochemical-organic chemical-pharmacological team to isolate and identify marine biochemicals that have strong anticancer properties or useful effects on cardiovascular systems of mammals. It is this latter property which could allow development of new drugs for treating some illnesses of the heart. They and their students collect marine plants and animals for study by skindiving on the tropical coral reefs of the Bahamas, Bermuda, Jamaica, Florida and Eniwetok in the Marshall Islands of the Pacific. The Atomic Energy Commission through the University of Hawaii operates the Eniwetok Marine Biological Laboratory and allows American scientists to work there during the summer months.

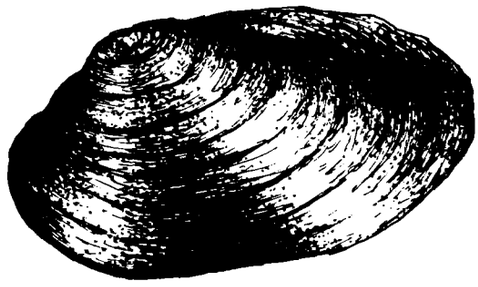


Jellyfish. Contains chemical *aequorin* used to detect minuscule changes in calcium concentrations in body fluids or cells.

Sponges. Compounds isolated from sponge which inhibited growth of cancers.



Salamander. Source of *tetrodotoxin* used as a palliative in terminal cases of cancer.



Clams. Extracts of antiviral and antibacterial substance were shown to inhibit growth of cancer (experimental).

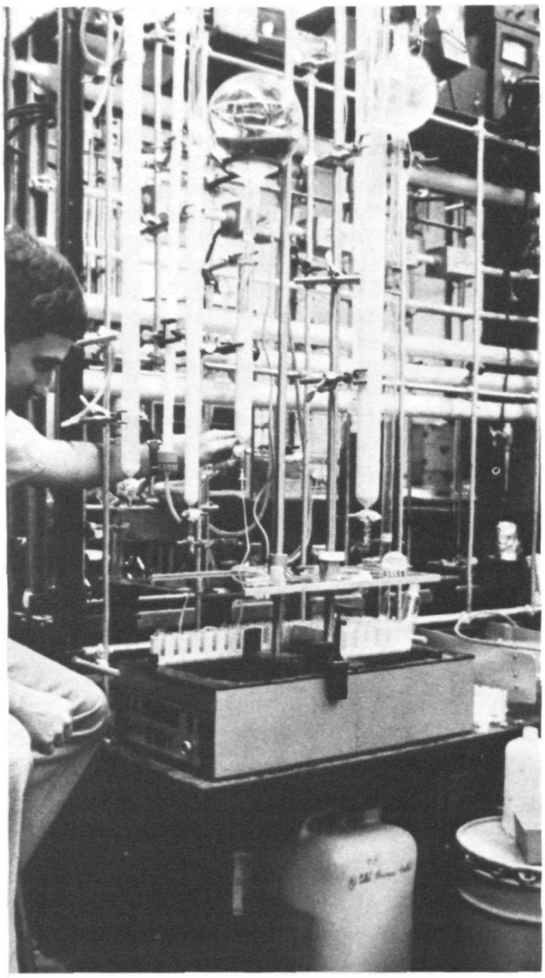
The organisms of most interest to the Oklahoma team now are animals in the phylum Coelenterata, which includes corals, sea whips and sea fans (gorgonias), anemones, and other groups low on the evolutionary ladder. The group is also studying two species of sponges, because extracts made from these sponges lower blood pressure and improve the muscle tone of the heart muscle. Natural compounds having these properties, or synthetic compounds closely related to them chemically, offer promise for use in the treatment of high blood pressure and heart disease. It was from a sponge, *Crytothethea crypta*, that a noted chemist, the late Prof. Werner Bergmann of Yale, and his associates isolated novel compounds which inhibited the growth of tumors. A synthetic compound, D-arabinosylcytosine, was modeled after these natural antitumor agents and has been used clinically for the treatment of tumors.

At the University of Oklahoma prior to its Sea Grant, Dr. Weinheimer and his student Robert Spraggins made the noteworthy discovery that one organic substance which comes from a Jamaican gorgonian, *Plexaura homomalla*, in up to 2 percent yield on a dry weight basis, was closely related to the potent human hormones, prostaglandins. They occur in mammals, however, in only tiny amounts. Although no onw knows the reason for their presence in sea whips, the gorgonians represent a new source of relatively large amounts of prostaglandins for clinical testing and for staring materials in creating new drugs in industrial laboratories.

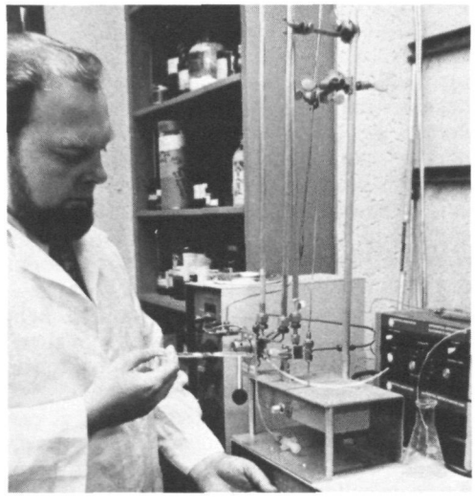
Because prostaglandins have been implicated as essential intermediaries in basic biochemical processes, they may prove to be one of the most important medications in a class with penicillin and the steriods. They are involved at the cellular level in regulating many functions, including gastric acid secretion, contraction and relaxation of smooth muscles, inflammation and vascular permeability, body temperature, food intake, and blood platelet aggregation. The Upjohn Company, for example, markets two naturally occurring prostaglandins for inducing labor and for terminating pregnancy.

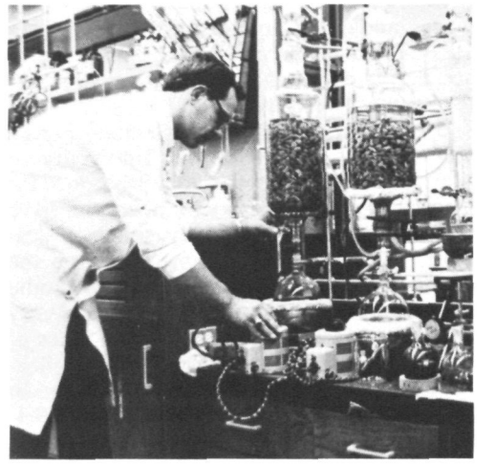
Paradoxical as it may seem, some toxins, venoms, and poisons can act as beneficial drugs in proper dosage. Because of this, certain poisonous and venemous marine organisms offer potential as souces of pharmaceuticals or as models for synthesis of drugs.

A highly unusual and potentially useful substance of this nature was discovered in a



Dr. Steven Zelenski collects chromatography fractions of a sponge extract as part of the Sea Grant program at the University of Oklahoma.





University of Oklahoma Sea Grant researchers work at a variety of tasks designed to extract useful chemicals from marine life. Clockwise from upper left: Sharon Smith records the effects of a coral extract on the heart of a laboratory animal; Dr. Keith Hollenbeak performs a separation on a liquid chromatograph; Dr. James Matson extracts a cardioactive sponge; and Dr. Tom Kanns freeze-dries samples for anticancer testing.

coelenterate, *Palythoa,* in a serendipitous and unpleasant fashion. After an ordinary day of work in their chemical laboratory, Prof. Ciereszko and three of his students each at his own home in the evening, experienced very severe chills from which there was no relief. After a few hours the chills were replaced by fever, also lasting a few hours. All four experienced a "light" feeling in the spine and a tightness in the chest. The undergraduate student involved, William Reeburgh, now a professor of oceanography at the University of Alaska, was out of school for two days with an extremely sore and painful chest.

On comparing experiences, the professor speculated that the cause was the light and powdery biologic material Reeburgh had been transferring to an apparatus for extraction. His assignment in an advanced undergraduate biochemical laboratory was to isolate the waxes from the material, a Jamaican zoanthid, which had been preserved by drying. All four had inhaled some of this powdered material as it dusted into the atmosphere of the lab. Later it was shown that the animal with which Reeburgh was working fabricates the most powerful nonproteinaceous toxin yet known in nature.

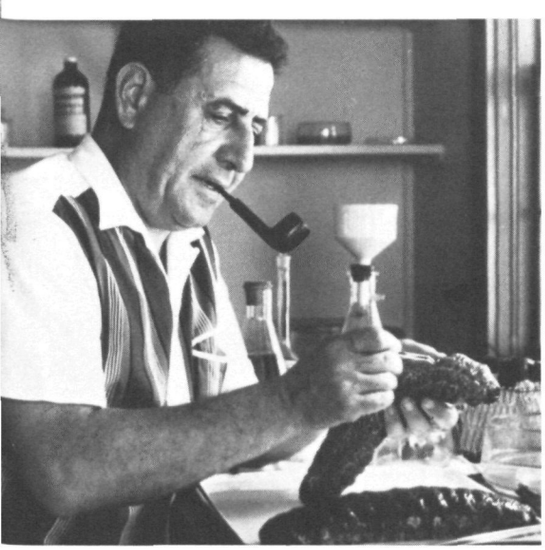
Professor Kaul believes, however, that it may turn out to be a useful medical tool because it can induce heart attacks in mammalians in extraordinarily low dosage and can produce a profound coronary spasm in the perfused guinea pig heart in a dose of 10^{-14} gram. (It would take 350,000,000,000,000,000 of those doses to equal one ounce.) Professor Kaul believes that it was responsible for Reeburgh's very sore chest by causing a continual heart spasm, but that it could be valuable in studying causes and treatment for heart trouble not caused by hardening of the arteries. At any rate its chemistry, which is still unknown, may be very important because it is able to affect biologic systems at such low concentration that it is likely operating at a very fundamental biochemical level.

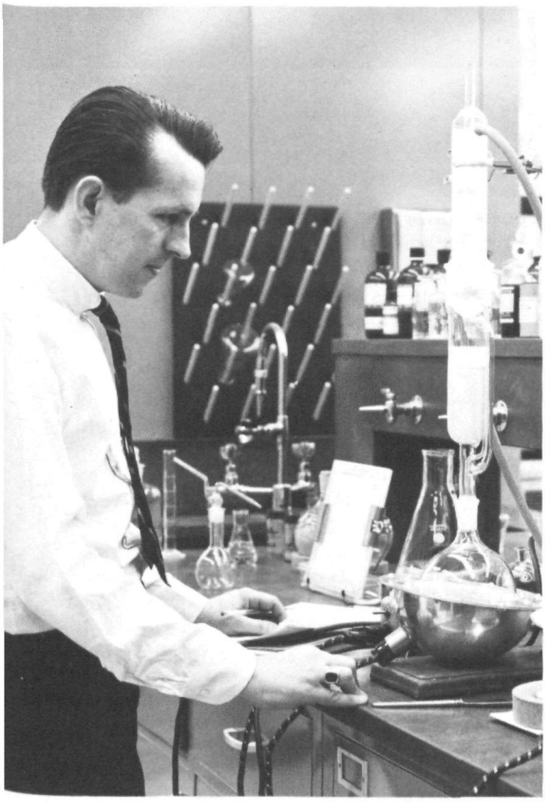
It is unlikely that commercial supplies of marine drugs will come from natural sources, because synthetic products will in most cases prove to be more economical after the chemical structures are established. The discovery of useful natural marine substances, however, provides important stimuli to scientists engaged in drug research. When unusual and novel organic structures are found, artificial analogues or modifications of them are likely to have psysiological or antimicrobial properties suitable for medical use.

New bioactive substances from the sea, or compounds modeled after them, may also find use as herbicides, insecticides, bacteriocides, and fungicides. They can also be very useful in fundamental studies of psysiological and biochemical processes. For example, the phenomenon of hypersensitivity to proteins and drugs after previous exposure—a problem for people requiring renewal doses of some medications—was discovered during studies on lower marine organisms. Other important biochemical phenomena may be discovered and understood by continued study of lower animals, many of which belong to groups occurring exclusively or primarily in the sea. Among the useful results of such biochemical research around the world have been the following:

—A potent neurotoxin was isolated from a segmented marine worm. It was also found to be a powerful insecticide. Because it is chemically unstable, a stable modification was synthesized and is marketed in Japan as the insecticide Padan. The production of Padan in 1972 was expected to reach 1,500 tons because it is expecially successful against the rice borer.

—Tetrodotoxin, one of the most unusual





Sea Grant scientists at the Osborn Laboratories of Marine Sciences work with various sea animals in their search for drugs from the sea. From the top: Dr. Ross F. Nigrelli works with the Bahamian sea Cucumber, Actinopyga Agassize, from which he extracted the highly active substance, Holothurin; Dr. George D. Ruggieri, S.J., observes representatives of various echinoderms (sea urchins and brittle stars) prior to extraction and testing for biological activity; and Dr. Martin F. Stempiem, Jr., extracts antibiotics from marine sponges.

organic molecules known, occurs in certain puffer fish, sunfish, porcupinefish and salamanders and has been studied since the late 1800's, but only recently was its structure determined. This unusual substance is used in Japan as a palliative in terminal cases of cancer because it blocks conduction in nerves.

—The presence of antiviral and antibacterial substances has been demonstrated in a wide variety of molluscs. Extracts of a common edible clam was shown to inhibit the growth of tumors. The structure, usefulness and safety of the active principle as a drug for humans have not been ascertained, however.

—Cephalosporin C, an antibiotic active against penicillin-resistant germs and widely used in medicine—is a metabolic product of a fungus which was isolated from the sea off the coast of Sardinia.

—Kainic acid from the marine red alga, *Digenea simplex,* is used widely in Japan against parasitic round worms, ship worms, and tape worms.

A project closely related to the search for useful marine organic substances which affect biological systems is the work of Professor Henry Rapoport at University of California at Berkeley and Professor Yuzuru Shimizu at the University of Rhode Island, both with the help of NOAA Sea Grants. Prof. Rapoport wants to develop a rapid chemical field test for the presence of toxic shellfish that cause paralytic shellfish poisoning in humans. His group is applying many sophisticated scientific techniques to determine the chemical structures of the poisonous substances that originate in the food of shellfish, the plankton. The poisonous plankters are dinoflagellates, the microorganisms responsible for the "red tides" which occur periodically in our coastal waters and cause shellfish beds in an area to be closed. A rapid and reliable chemical test for the presence of toxic animals could allow uncontaminated beds to remain open and thereby save the fishermen hundreds of thousands of dollars.

It was Rapoport and his associates who determined the chemical structure of one of the paralytic shellfish poisons, saxitoxin. This compound is 100,000 tims more active than known conventional anesthetics, and may offer a chemical model on which new local anesthestics and drugs active on the heart or central nervous system can be based.

In his present studies Rapoport uses as raw material batches of toxic single-celled dinoflagellates which are grown in pure culture by Professor Francis Haxo at the Scripps Institution of Oceanography. They are grown in specially lighted and heat-controlled rooms on whose walls are shelves lined with flask after flask of the phytoplanktonic cultures which require, like most plants, mainly water, light, and air for growth. But they grow slowly and the procedures for producing sufficient quantities of material for the chemists are tedious.

For his chemical procedures at the University of Rhode Island, Dr. Shimizu uses clams that were collected during the period of 1972 when there were red tides along the coast of New England. During that period all New England states prohibited the digging and transportation of clams, quahogs, mussels, and scallops. The Food and Drug Administration ordered a recall of soft-shell and hard-shell crabs distributed by companies in Maine, Massachusetts, and New Hampshire. Schimizu is working to determine the chemical structure of the toxic component and compare it with toxins of other dinoflagellates such as saxitoxin in order that there will be a firm scientific basis on which to devise antidotes, detoxication, and preventive measures.

At the New York Aguarium's Osborn Laboratories Sea Grant researchers George Ruggeiri, Merlin Stempien, and Ross Nigrelli are isolating antibiotics from sponges. Some are as effective against certain types of bacteria as conventional antibiotics. Those natural antibiotics and synthetic analogues modelkd after them are being tested for possible clinical use.

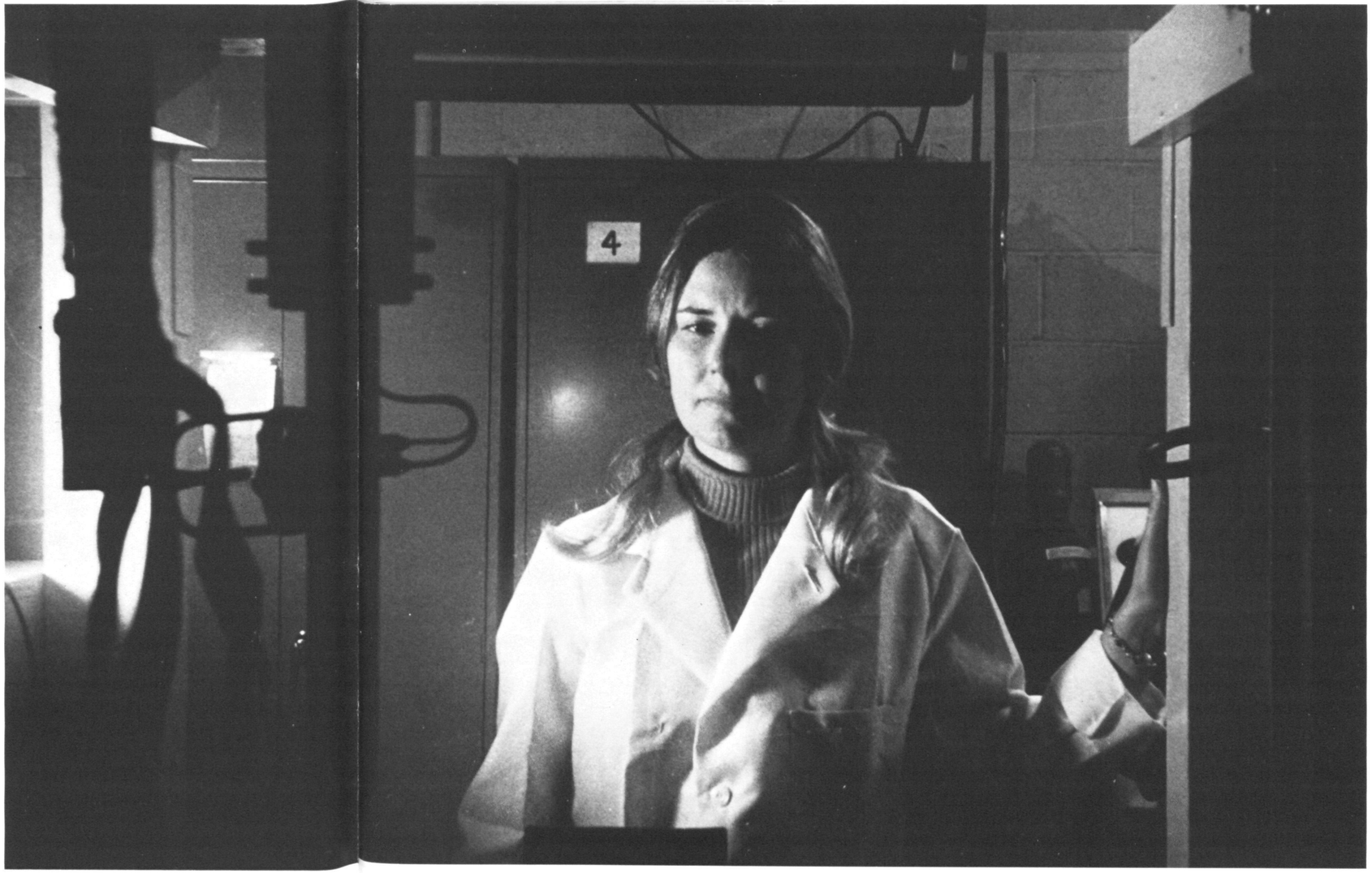
At the Medical University of South Carolina Wilber Walter, with the aid of a Sea Grant, is attempting to identify the component of a fleshy marine invertebrate, *Amaroucium stellatum,* commonly known as sea pork, that is able to inhibit growth of one type of tumor and to kill a type of cancer cell which causes leukemia. Sea porks are in the phylum Tunicatz which on the evoluntionary tree lies between the animals with backbones and those without. When they are inadvertently harvested in shrimp nets they are considered trash—but if their medicinal use can be demonstrated and a new and important drug perfected from them, then a new source of income for the fishery will be created.

From first identification of an exotic compound in a marine animal to successful use in a way that helps man is a long and difficult road. Sufficient supplies of the animal must be obtained for research purposes. The characteristics of the compound must be established, and conditions under which it might be toxic determined. The tortuous process of constructing in the laboratory a synthetic compound that has the useful properties of the natural compound, while avoiding the negative properties, must be undertaken. For the scientist, there are many blind alleys. But when, once in a while, success is achieved and a useful new drug, a medicine or a diagnostic tool, is produced, then the effort has all been worth while. It is successes such as these that Sea Grant is seeking through its support of marine pharmaceutical research. □

NOAA Profile

NOIC Chemical Engineer Makes Her Mark By

WORKING FOR CLEAN WATERS



Photos: Harold M. Goodman

Barbara Pijanowski, peering into window of environmental chamber (above) and concentrating on paperwork (opposite page), pursues profession on land and under water.

In what is still essentially a man's world, Barbara Pijanowski has made her mark as a chemical engineer. Many of her colleagues acknowledge her as an expert in her field, a status to which some of her male colleagues still aspire.

But Ms. Pijanowski (pronounced Pee-yan-of-ski) knows that equality of effort and ability is still not something to be taken for granted and is not unaware of the fact that a colleague recently referred to her in a written communication as "a female chemical engineer."

This "female chemical engineer" also happens to be the only chemical engineer, or chemist for that matter, in her organization, NOAA's National Oceanographic Instrumentation Center at the Washington, D.C. Navy Yard.

The 32-year-year-old scientist is deeply involved in testing and evaluating chemical and biological instruments required to determine the extent of pollution in the nation's coastal waters and estuaries.

"I started in this area about three years ago, when there wasn't much interest," she said. "We began by working with simple instruments that measure dissolved oxygen in water."

In January 1973, she began evaluating more complex packages of sensors, called water quality systems, which measure salinity, electrical conductivity, dissolved oxygen, and pH (which has to do with the acidity of water), parameters which enable scientists to determine, to some extent, the degree of pollution existing in water.

In recognition of the importance of her work, NOIC has now established a laboratory for the use of its water quality team, consisting of Ms. Pijanowski and two electronic technician assistants. NOIC's headquarters has about 50 personnel, of whom 40 are scientists and technicians.

Last October, Ms. Pijanowski spent a week in an underwater habitat off Grand Bahama Island with two other divers, Dr. Tony Llewellyn, a professor of engineering at the University of South Florida, and Mike Sheen, a diver from PRINUL, an underwater habitat off Puerto Rico. Led by Ms. Pijanowski, the three spent the week observing and testing four water quality measuring systems to evaluate their performance under typical field conditions. NOAA's Office of Manned Undersea Science and Technology financed the tests at the Perry Hydro-Lab, located in 50 feet of water approximately 1.2 miles off Bell Channel Inlet, Lucaya, Grand Bahama Island. The lab is supported on a non-profit basis by the Perry Foundation and the Bahamas Undersea Research Foundation.

Testing the instruments in an underwater habitat posed a challenge for Ms. Pijanowski. She was not trained for scuba (self-contained underwater breathing apparatus) diving and that was essential, especially for the project leader.

So she took a scuba diving course in Rockville, Md., and then spent almost every weekend of the summer of '73 amassing the 15 hours of diving required to qualify as a novice scuba diver for NOAA.

"It was an experience I didn't especially enjoy," she recalled, "because the only local places deep enough to practice in were quarries. The water was cold and the muddy bottom was strewn with old cars, tires, and beer cans."

She qualified in September, just in time for her trip to the habitat later that month. In Freeport, she met her two companions for the first time.

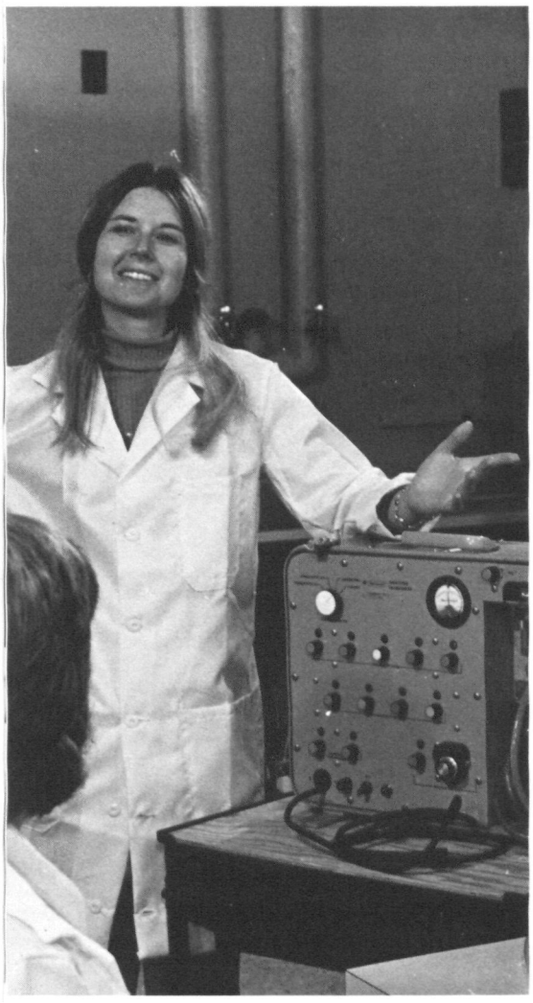
"I was somewhat apprehensive about living in a small habitat at the bottom of the sea alone with strangers," she admitted. "I was afraid we might not be congenial, thrown together for an entire week in such small quarters, but everything turned out well. Actually, we were so busy no one had time to think about personalities."

The one-room habitat is 16 feet long and 8 feet in diameter and was built to accommodate three or four persons. The habitat was filled with equipment, so space was at a premium. The water quality systems rested on a frame on the sandy floor outside and as tests were run on them data was taken inside the habitat.

The three spent considerable time outside, about four to six hours a day, examining the instruments and swimming in the coral reefs among the colorful flora and fish, with air tanks strapped to their backs.

"The life down there is fascinating," said Ms. Pijanowski. "Swimming among colorful coral reefs and the various types of fish, many of them with highly distinctive colors, is so peaceful that it can give you a beautiful feeling of euphoria. We saw no sharks while there, but we did see barracuda, which we had been told were not dangerous. They were curious, but they seemed to recognize us as harmless. They stayed close by, but caused no problems."

The habitat has eight small portholes and a four-foot viewing window. Atop the structure is a light and, when it was turned on, the marine life it attracted kept the aquanauts



Variety marks Barbara Pijanowski's career. Above, she discusses fine points of a salinometer; top right, with film crew, she awaits time to go underseas in Bahamas. Near right, she adjusts chart on control system of environmental chamber; far right, places water quality sensor package into controlled-temperature salinity bath.

glued to the window for hours.

The three slept in two bunks suspended from a wall and on a mat on the floor. Since a radio watch was maintained each night with surface personnel, they took turns sleeping on the floor so that whoever had watch could be near the radio.

Aside from some difficulties with equipment (the air conditioning failed the last day), there were few problems. "One of the men got infected ears," she recalled, "and they sent down some medicine. When that didn't work, the island's diving doctor made a habitat call."

"The only other problem," said Ms. Pijanowski, "was my long hair. Every time I returned to the habitat from outside, I had a real time-consuming job combing it out."

Ms. Pijanowski had wanted to be a chemical engineer since she was 12 or 13 years old, "even before I knew what it meant," she said, laughing. "I think someone must have told me at one time that I was the type of person who would make a good chemical engineer, but then added: 'but you're a woman, so that's probably too difficult.' And being stubborn, I decided that was for me." (Chemical engineering deals with the industrial application of chemistry in areas such as oil refining and sewage and water treatment.)

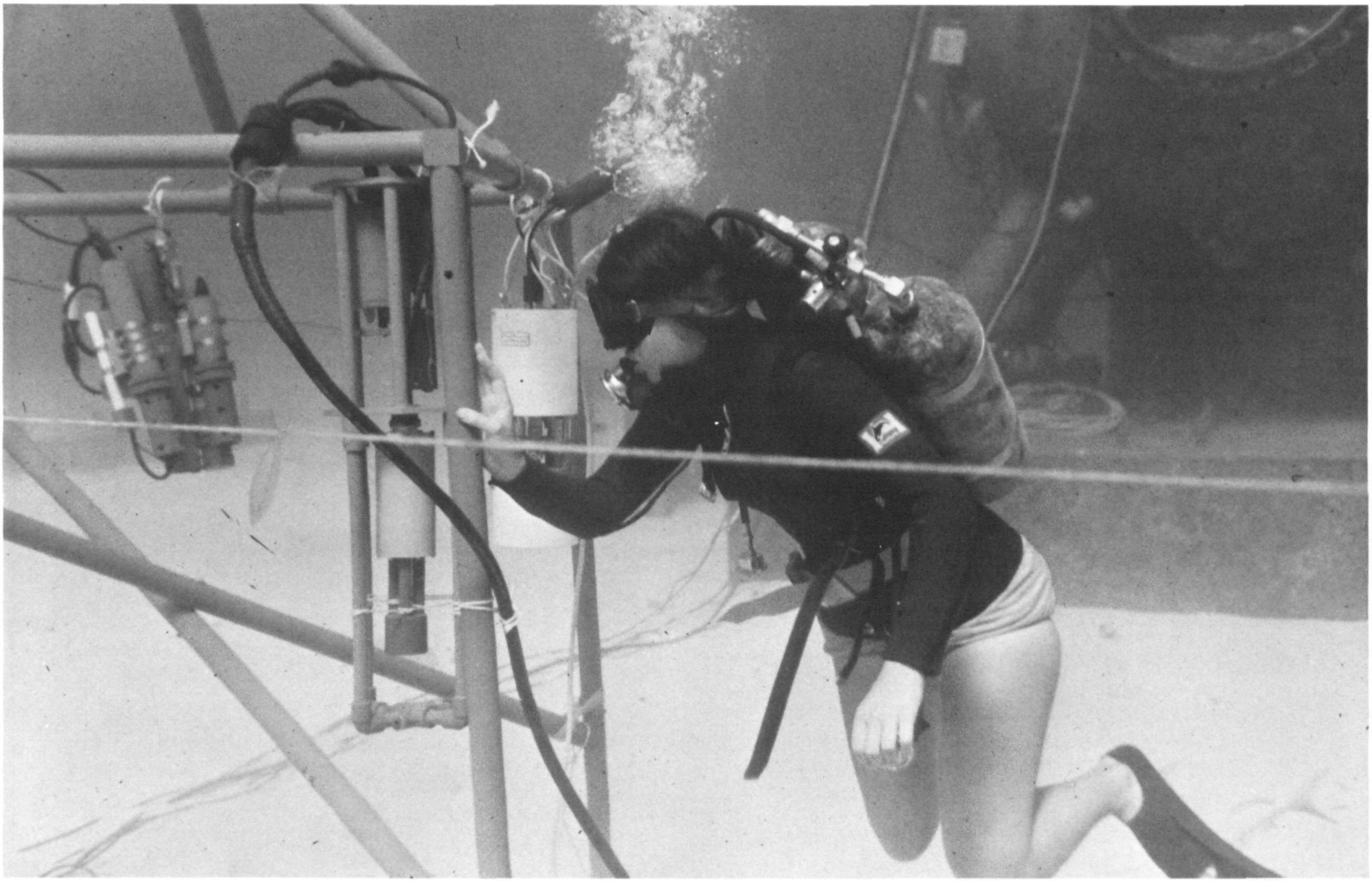
So, determined to be a chemical engineer, she enrolled in Drexel Institute of Technology (now Drexel University) in Philadelphia. She was graduated in 1965 with a Bachelor of Science degree in Chemical Engineering, the only woman in the engineering class. Later, she attended Catholic University in Washington, D.C., which awarded her a Master's Degree of Science and Engineering in Ocean Engineering. She spent the summer of 1967 taking a laboratory course in ocean engineering, sponsored by the National Science Foundation at the University of Hawaii.

Between her undergraduate and graduate studies Ms. Pijanowski's spirit of adventure led her to Ethiopia with the Peace Corps. In 1965–66 she taught physics in a secondary school in Addis Ababa, the capital.

"I had finished school for a while, I didn't have any money, and I liked the idea of being able to travel and to help people," she says.

Ms. Pijanowski returned to the United States somewhat frustrated, although she looks back on her stay in Ethiopia as one of the highlights of her life. She explaines:

"I taught physics in a secondary school in grades comparable to our ninth to twelfth grades, and the students ranged in age from 13 through 22. Frankly, I didn't do too well, because I wasn't a teacher, and I had



Barbara works on test equipment outside Hydrolab habitat off Freeport, in program which aids NOAA is evaluating fitness of gear for marine use.

difficulty in communicating basic ideas.

"It wasn't because the students didn't speak English," she added. "English is taught in Ethiopian schools beginning with about the second grade, along with the native language, Amharic. But it is taught by Indians, who speak British English with Indian accents. I spoke American English with a Philadelphia accent, and there's a big difference."

She also felt that the curriculum in Ethiopian schools was not suited for the students in that it did not prepare them for life in a developing nation. "Going to Ethiopia was like stepping back in time 500 years," she explained. "The courses in physics were quite similar to those in the United States, but not applicable to life in much of Ethiopia. What good did it do to teach them how electric trains run or electric doorbells operate, when most Ethiopians had only a single light bulb hanging in the center of their huts or no electricity at all?"

But life in a strange land still had its attractions for a young girl fresh out of college. During school vacations, she traveled about the country which was ruled by a descendant of King Solomon and the Queen of Sheba. "My proudest remembrance of Ethiopia is my lion bite scar, the result of a disagreement with a friend's pet cub."

After her return to the United States, Ms. Pijanowski went to work for the Naval Oceanographic Office in Suitland, Md., where she was employed as a physical oceanographer. She left after nine months, "because I was anxious to get into oceanography, but all I did there was process data."

It was then that she completed her education at Catholic University and the University of Hawaii and went to work in 1967 for NOIC, then part of the Naval Oceanographic Office, as a chemical engineer. When NOAA was formed in 1970, NOIC was transferred to the new organization, but remained physically in its same location.

When pollution control became a major issue, Ms. Pijanowski was provided with a small staff and placed in charge of a project to test and evaluate chemical instrumentation. As the only scientist in NOIC qualified to do so, she quickly became the focus for work in this area.

"We acquire commercially available, off the shelf, chemical and biological instrumentation and test and evaluate it for the scientific community," she explained.

"Initially, the water quality systems were tested in the laboratory, but we felt that field tests were necessary for a true evaluation of the instruments." The Hydro-Lab expedition was part of the field-testing program.

An educational television film has been produced, showing Ms. Pijanowski at work in the habitat with her two colleagues and in her laboratory. It is one in a series of instructional films involving various aspects of career development. The series will be shown in U.S. and Canadian schools each year for about seven years, to an estimated audience of 35 million school children. Ruth Pollak, of the Northern Virginia Educational Television Association, which is producing the films, termed Ms. Pijanowski "an excellent model" for the film because "it introduces one of the more contemporary careers, involves ecology, and suggests that careers in engineering and oceanography are as open to women as to men."

While this premise may be subject to some argument, Barbara Pijanowski feels it is true, provided (and she stresses this) women make up their minds "they can do as well as men and really believe it and stick to it."

The "stick-to-it" part also has to be emphasized, she said, because "women have to work as hard or harder in fields such as engineering and oceanography," essentially "male dominated areas," if they want to succeed.

"It doesn't hurt to have a stubborn streak," she commented, and Ms. Pijanowski is the first to admit she has that.

A century-old relationship continues to grow

NOAA and the City of Seattle

BY CARL A. POSEY

THE FIRST SEAGULL, in Haida Indian myth, was the son of a chief, transformed into a bird when a raven too weary to carry him farther dropped the young man on a reef. The Haida story ends with the transformation. But one wonders where the young man-become-first seagull went from there. Where did he go to learn how to be a seagull? How did he evolve from mere changeling into the canny clam-cracking creature we encounter almost everywhere air meets water?

NOAA, whose works are nearly as familiar as gulls along Puget sound, and which has an abstract gull-form as its symbol, has also been faced with the choices and learning processes which go with sudden transformations. The four years since NOAA's formation have been spent somewhat as the metamorphosed chief's son must have spent his, giving form and substance to the large, shadowy shape of things as they would be for a unique creature of ocean and atmosphere. For NOAA, this process has been particularly intense in and around Seattle.

The relationship between what is now NOAA and Seattle goes back a century or more, when men and ships followed the chaos of national expansion with the order of surveys and charts, and fisheries scientists began looking at that other western gold, the kind that lives in the sea.

Over the years, NOAA developed in the northwest something like a frontier town, with the action—in this instance research and surveys—followed by the families of supporting services which are an organization's city halls, fire departments, and employment agencies. In Seattle, this part of NOAA is called the Northwest Administrative Services Office, which provides administrative, procurement, and personnel services, hosts representatives from NOAA's general counsel's office and an extension of the agency's finance division back east, and generally fills the gaps which occur when an organization has a large operation far from its headquarters.

Dale C. Gough, recently appointed director of the Northwest Administrative Services Office, described the Commerce Department agency and its Seattle presence this way. "The greatest concentration of NOAA people outside of the Washington, D.C. area is in Seattle. Our office serves about 1,500 NOAA people along the Pacific coast, about 800 of them in the Seattle area, and about half of this number employed aboard NOAA ships. With our salaries, the contracts we let, the goods we buy, we constitute about a $30-million-a-year research business here."

NOAA, now dispersed in seven locations around the city is working through the Northwest Administrative Services Office to consolidate its various facilities into a single site which would provide a unique and needed research center for the Pacific northwest.

It has been a tradition that Seattle be the hub from which expeditions radiate out into Alaskan waters and the eastern North Pacific, and a place to which vessels and people retreat before the harsh northland winter. But those critical processes which guide the evaluation of institutions have begun to change this.

In the case of NOAA, the strongest of these forces has been the growing general concern for environmental quality, and the growing realization that very little is known about man's true impacts and interactions with the "natural" world. This general concern, and the dearth of comprehensive information, have encouraged an agency like NOAA to begin asking the questions from which new missions grow. The result has been a sharper look at how man and environment change one another.

Probably nowhere else in America does environmental concern spin the plot more absolutely than it does in this northwestern corner of the nation. This is the community that cleaned up Lake Washington. This is the community which has begun to examine its accommodations with the life and waters of Puget Sound, and to wonder what the impact will be of the ocean leg of the Trans-Alaska Pipeline System, or TAPS, which may have its southern terminus in the Sound.

But there are environment-minded cities all across the United States. What makes Seattle different?

Mainly, that Seattlites and their city look *ahead* to environmental impact, not back to the wreckage of their unique and lively estuary, or urban sky. Because they anticipate, they may never have to ponder ecological ruins in their green, watery world.

NOAA, then, has begun to look back toward Seattle and Puget Sound, and the Seattle experience has begun to broaden the agency's range of products and services.

Dr. Robert E. Burns, who directs the Pacific Marine Environmental Laboratory here, notes that these changes flow in part from the times being right, and from the important opportunities offered by Puget Sound.

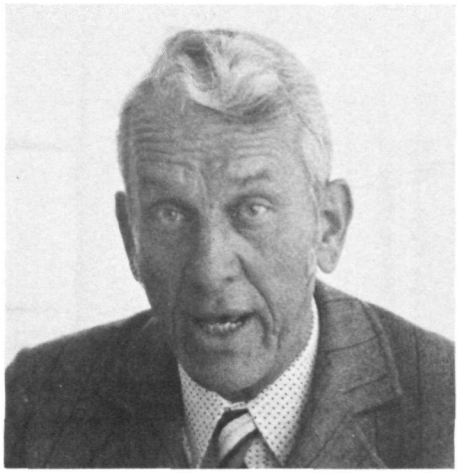
"I can remember proposals for estuarine and environmental studies drafted nearly a decade ago," he says, "that just didn't get anywhere at all. Back then we were concerned with the oceans and major expeditions, because the United States had very little in the way of a coherent national oceans program.

"Well, this ten years' experience probably means we can do a better job than we could have then. There is national experience in approaching marine environmental problems. We've got more oceanographers now and more people are familiar with hydrodynamics and physics and chemistry. And we have a capital facility we didn't have then."

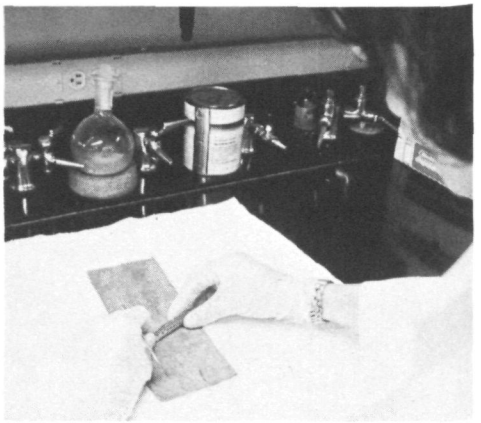
The laboratory, one of NOAA's Environmental Research Laboratories, was formerly a deep-water operation, concentrating on major expeditions and the geophysical and geological side of the oceans. Now it is shifting its interests to include chemical and biological oceanography, and concentrating on problems that are more marine environmental than "hard" science. Part of the impetus here comes from concern about oil spills in the Sound.

"By oil spills," Burns explains, "we don't mean only the spectacular breakup of a supertanker in the Strait of Juan de Fuca. The uncertainty of determining where and when such an event would occur, and how much oil it would release, is too great to permit such systematic research. Initially we are mainly concerned with the effects of *chronic* oil spills—usually small ones—from refineries and other fixed sites. Then we are looking at some of the physical and biological factors which influence the paths this oil would take into the Puget Sound ecosystem, and how tides and currents interact with winds to move the stuff around."

Although the laboratory continues to run some wide-ranging projects—a current deep-ocean mining environmental study in the equatorial Pacific is a case in point—the



(Above) To many, NOAA in Seattle means NOAA in fisheries. Donald R. Johnson, regional fisheries director, is mainly concerned with the harvesting segment of the fishing industry, and the management and conciliation of regional and international fisheries.



The Northwest Fisheries Center conducts research aimed at solving fisheries problems, including the interaction of hydrocarbons and other pollutants and marine organisms. (Left) Here, Dr. Usha Veranasi of the Center's Environmental Conservation Division feeds spin-labeled hydrocarbons to captive fish, which are subsequently de-spined by Tracey K. Collier (above). The effects of the

emphasis is increasingly upon the coastal lands and waters closer to home.

"The opportunity in Puget Sound is unique," Burns says. "Right now, there are a few local spots with problems, but, by and large, the Sound is still golden. It is the last opportunity south of Alaska for the United States to look at an estuarine area that hasn't been extensively changed and to keep the Sound from going the way of the estuaries that have been developed."

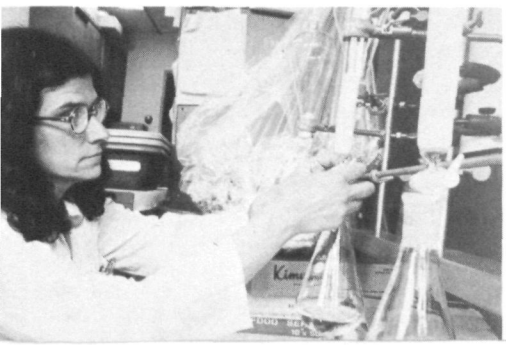
A byproduct of this changing point of view, according to Dr. Stanley R. Murphy, who directs the University of Washington's Marine Resources Division and coordinates the University's portion of the NOAA-administered Sea Grant program, is a restoration of classical oceanography's interdisciplinary quality.

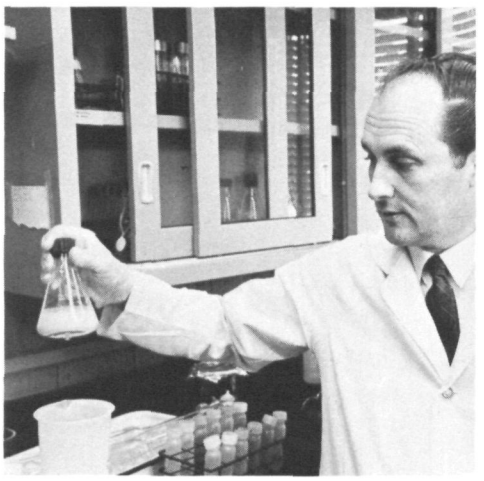
"Oceanography began," he says, "as physicists, chemists, biologists, and geologists working separately, deciding they'd better get together because you can't understand one type of marine environmental information without understanding other related ones. It may be that the most important thing going on here at present is our present tendency to look at the marine environment in a broader and broader sense."

Sea Grant provides federal funds for selected programs in the marine sciences and related fields, mainly at universities like Washington where the marine sciences have traditionally had strong stupport. At present, the approximately $1.35 million in federal Sea Grant money, which is matched by university, state, and industry funds, makes up about 10 percent of the overall University of Washington effort in marine sciences. In a sense, the Sea Grant funds make projects that are close to happening, happen. Of course, the Marine Resources Division goes beyond Sea Grant as well, including a National Science Foundation-funded study of Arctic ice dynamics.

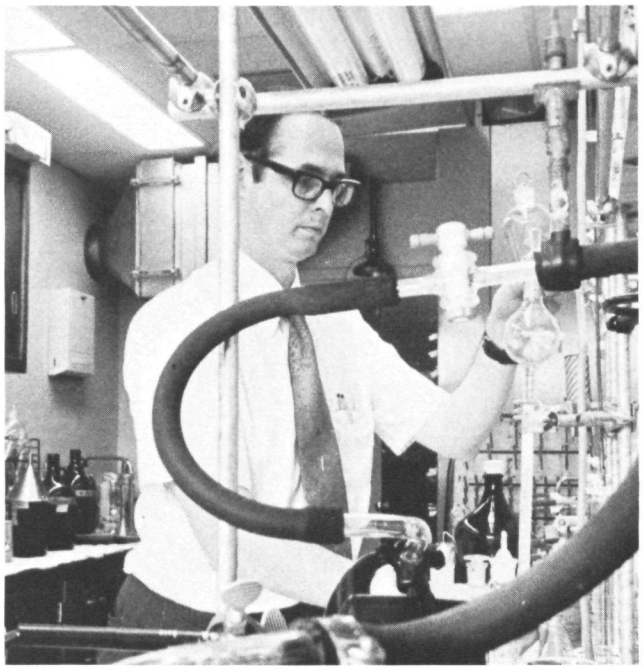
"We're an interface group," Murphy notes. "If we can find a place in the university where there is established expertise for taking on a particular problem, then we encourage them to get involved in Sea Grant. If there isn't this kind of expertise, we see how it can be added on. And if there is a total vacuum, and the need is great, we take it on ourselves, although we are concerned more with program management and information services than with research."

One of the grass-roots efforts that began in the northwest is NOAA's Marine Advi-





At the nearby Fisheries Technology Laboratory, which shares the Northwest Fisheries Center facilities, research chemist Alice S. Hall (far left, above) uses an atomic absorption spectrophotometer to quantify mercury residues in fish tissue. Dr. Virginia F. Stout (far left, below) purifies fish oil extract to determine the concentration of the insecticide



hydrocarbons on cell membranes in the fish spinal cords are measured by Dr. W. T. Roubal (above, right). Related efforts in the Division include analyses for petroleum hydrocarbons, being made here by Robert C. Clark (right), and electrophysiological studies of certain organisms like the crab being monitored by Douglas D. Weber (far right).

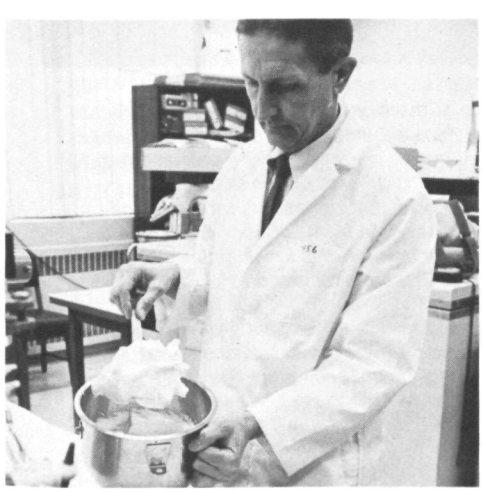
sory Service, which evolved out of earlier efforts of the fisheries service and local Sea Grant and survey people to get the technical word out to the people who need it most—fishermen, marine resource managers, and others who use or get a living from the sea.

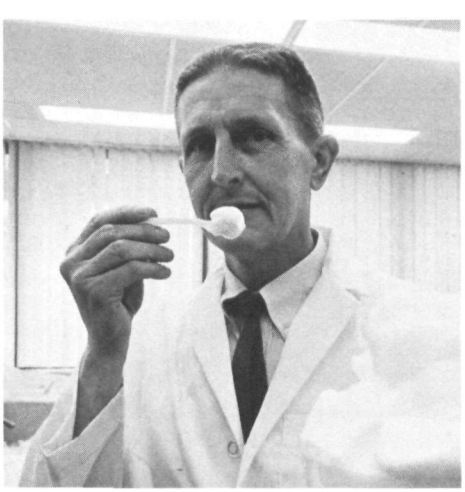
The coastal zone management development grant of some $400,000 which is coming to the state from NOAA will also have its effect on how Sea Grant activities are conducted here. Coastal zone grants are used initially to help states prepare plans for managing the coastal zone, and then to put the plans into action. In Washington, the plan has evolved from the state's Shoreline Management Act and will be administered by the state's Department of Ecology. Sea Grant support here is helping local people respond to the requirements of the management plan, and will probably provide research funds for some related projects as the plan is translated into a land-managing reality for the citizens of Washington.

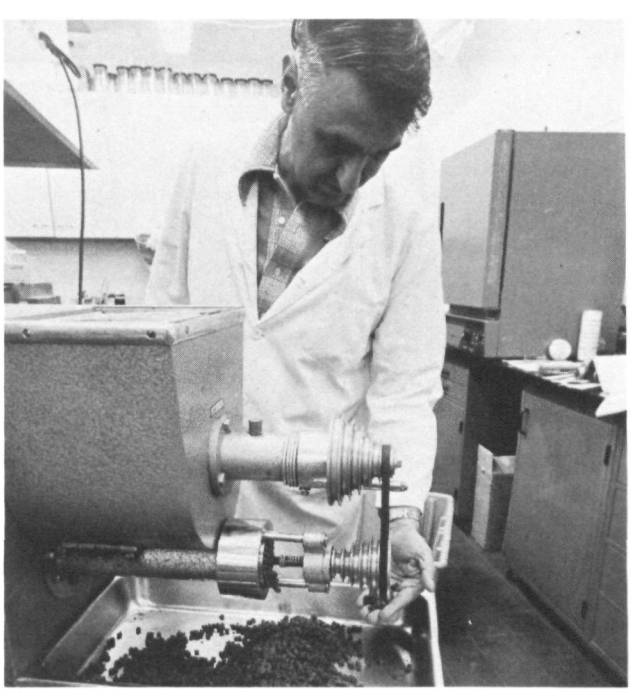
Such descriptions as there are of the state's coastal waters and Puget Sound have come from the NOAA element that is perhaps more familiar to Seattlites than any other: the chart-making, tide-monitoring National Ocean Survey. With origins rooted in the early days of the nation, this part of NOAA is a kind of scientific legend of itself, for the young, expanding nation was followed by ships and patient, technical men, doing the hydrographic work that turns unknown seas into shipping lanes and harbors.

In one sense, Seattle remains a base for the wide-ranging surveys and fisheries studies conducted by NOAA ships from the Pacific Marine Center, a ship and equipment base on the east shore of Lake Union. From here, the ships fan out on their long missions. This working season has seen the OCEANOGRAPHER, largest in the NOAA fleet, working out of Daker, Senegal, in the Global Atmospheric Research Program's Atlantic Tropical Experiment. RAINIER and FAIRWEATHER began their season off Washington, then moved to Alaska later in the summer, and the COBB has been involved in fisheries gear research. Once underway, the ships are typically quite independent. They work in areas where there is no way to resupply them easily, and they must occupy their working grounds for months at a time.

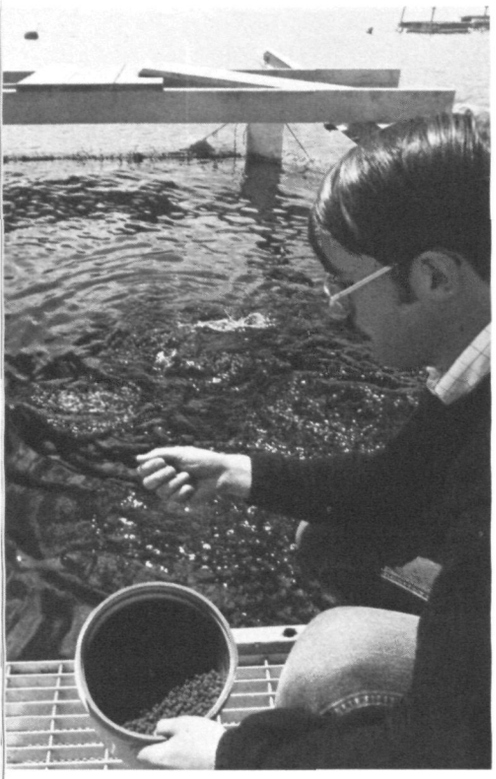
Rear Admiral Herbert R. Lippold, Jr., the NOAA officer in command of the Lake

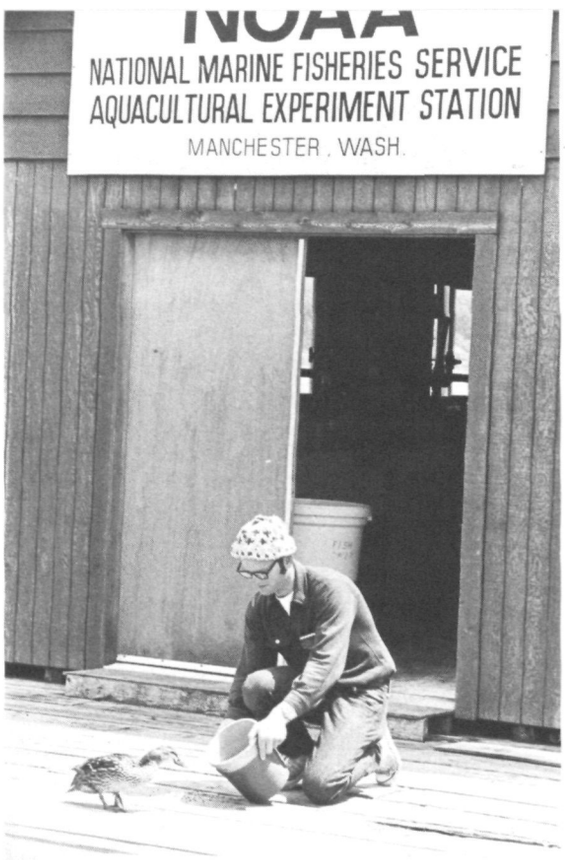


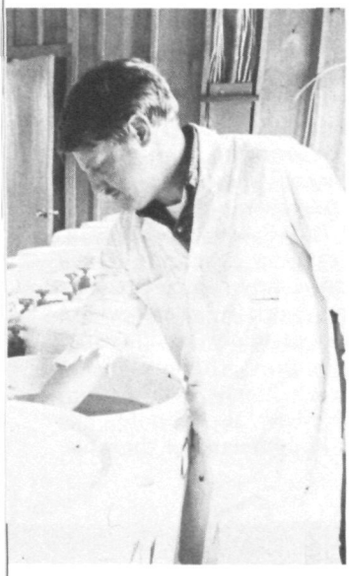


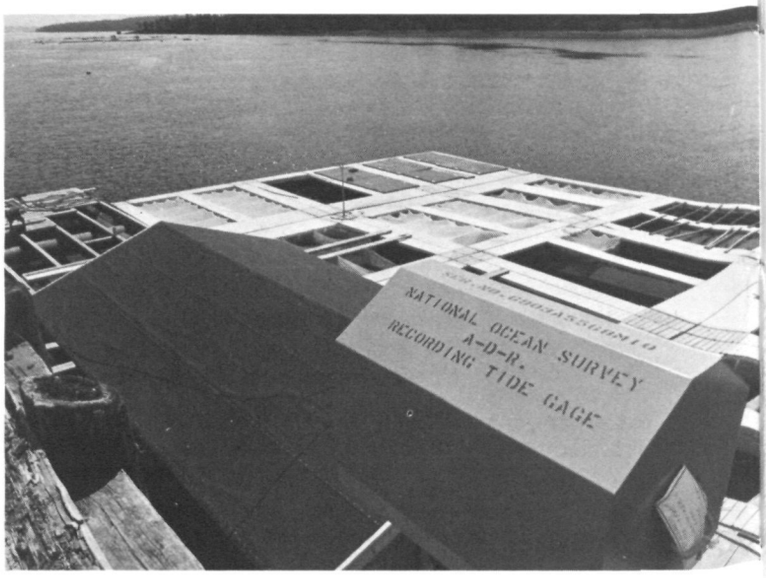


dieldrin, and microbiologist Jane A. Meyers (left) holds test tube of bacteriophages or bacterial viruses for the Laboratory's C. botulinum *experiments. (Above left) Dr. Melvin W. Eklund, the research microbiologist who directs the* C botulinum *project, is shown with preparation of* clostridium botulinum *spores to be used for inoculation of processed fish flesh to ensure safety of the process. The Laboratory is also concerned with making fish-protein-enriched foods people like to eat, like this topping whipped by by Dr. Herman S. Groninger, Jr. (above), and these food pellets for pen-reared salmon, being prepared by research chemist John Spinelli (far right).*

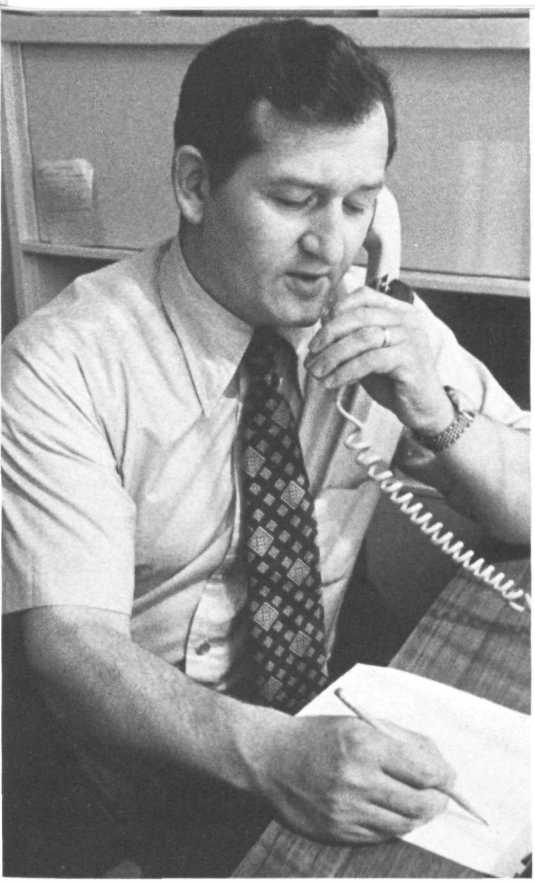


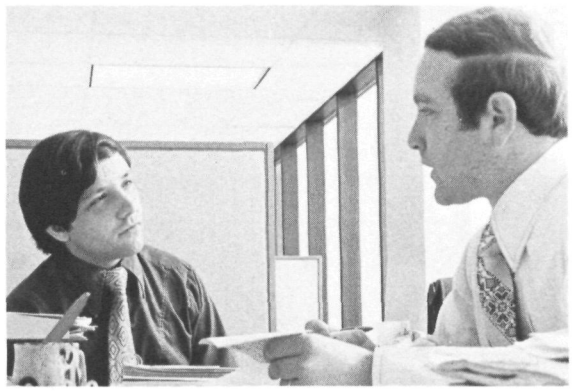






Salmon in the Northwest Fisheries Center's aquaculture experiment across Puget Sound at Manchester seem to like the pellets offered by NOAA Ensign Kurt Gores (top left), as does this wild (but unbashful) mother duck getting a handout from fisheries biologist Earl F. Prentice (top) who is investigating the spot shrimp in these indoor pens as a supplementary crop for salmon farms. Because pen-reared animals are more prone to disease than their wild cousins, a salmon and shrimp disease investigation is also conducted at Manchester, where veterinarian Lee Harrell (center, far left and left) studies salmon fry to develop vaccines, some of them "grown" as antisera in rabbits. (Center right and below left) The object at Manchester is to learn what is needed in these experimental aquaculture pens to develop a successful aquacultural industry, already beginning in facilities like this Dom-Sea farm in Puget Sound.





NOAA-Seattle is the largest contingent of NOAA people outside the Washington, D. C. area, and their "city halls, fire departments, and employment agencies" come from the Northwest Administrative Services Office, or NASO. (Above) From left, retired NASO director John M. Patton, Jr., Sand Point Coordinator Robert Griffith, secretary Elizabeth Valdeverona, and personnel chief Gordon Shadoan talk things over. NASO also hosts representatives of the agency's General Counsel's Office and a Field Finance Office. (Far left) Clayton Terry is finance chief. (Left) Attorney Stephen Powell (at right) and assistant John Dunnigan are NOAA counsels.

Union base, says that while Seattle will continue to be a base for distant operations, there is an increasing emphasis on new work in Puget Sound.

"With large ships coming into the Sound, we may have to revise our nautical charting requirements, and expand and refine our tide and current measurements. Some of the old surveys around here were run with handheld leadlines, which give you a point, not a depth profile like the acoustic sounders do. There may be some holes and mounds that warrant showing, insignificant to a shallow-draft vessel, but important, say, to a supertanker maneuvering in these waters.

"The same is true of circulation measurements. We get fifteen-foot tides in some parts of the Sound, and these set up strong currents. In the old days, we just needed the top few feet of flow. Now we need to look at more exact values for levels down to fifty feet or better, because these currents and countercurrents can be critical to a deepdraft vessel trying to maneuver in restricted waters. And if there are oil spills, additional current measurements will give us a better idea about where the oil is going to go. And out tidal work is also becoming more refined. We used to put out only times and heights of high and low waters. Now we're beginning to publish hourly heights for selected areas."

The occasional stately progress of an ocean survey ship from Lake Union to the Sound and to the sea is a familiar sight in Seattle, and may seem to be pretty much what it has always been. What may be less apparent is how much better these ships and people are at doing the hydrographic work.

"The big development has been in the area of electronic position fixing," Lippold says. "In the old days, a very good celestial fix, under the best conditions of visibility, gave us the ship's position to within about a mile. Now, using the Navy's satellite navigation system, we can get to within about a hundred yards, anywhere in the world ocean. For inshore surveys where we can work line-of-sight, we worry about positions that are not fixed to within about five meters.

"And the ships are becoming more and more automated. For example, even the launches now are equipped with small computers. All the hydrographer has to know is where his lines are being run. The computers and precision depth profilers have eliminated thousands of hours of tedious hand work, and the associated possibility of error.

"It's a whole new ball game."

Another, relatively new NOAA facility in Bellevue has also begun to make its mark on how and how well researchers take information from the sea. An outgrowth of the National Oceanographic Instrumentation Center in Washington, DC, the Northwest Regional Calibration Center is one of three such centers in the United States—the others are in San Diego and on the Gulf Coast—designed to permit onshore tests of a wide range of oceanographic instruments in a variety of simulated ocean environments. This effort, operated for NOAA by the Oceanographic Institute of Washington, should improve the quality and consistency of measurements taken at sea, and help produce a more coherent look into hard-to-measure oceanic processes.

It will also help with the work of comprehending the rich, hidden life in the sea. Although Seattle is not the fishing center of action it used to be—Bellingham is now Puget Sound's leading port in fresh fish landings—it continues to be a city where lots of fish are caught, landed, bought, sold, and consumed, and a major conduit through which frozen and processed fish products penetrate the interior of America.

As a center of action for fisheries services and research, however, Seattle continues in the national vanguard. It is home to the Northwest Regional Office of NOAA's National Marine Fisheries Service, and two research centers housed in a large laboratory near Montlake. Between them, these three local elements cover most of the aspects of northwestern fisheries, and some global ones as well.

Donald R. Johnson, regional fisheries director, is mainly concerned with the harvesting segment of the fishing industry, principally the hunters and harvesters of salmon, shellfish, king and tanner and Dungeness crabs, shrimp, and some bottom fish, most of them Alaskan fisheries, accessible to Puget Soundbased fishing boats. The range of responsibilities is broad in the extreme. It includes participation on international fisheries commissions, producing the familiar marketing "pink sheet" for the region's fishing industry, and conducting processing-plant inspections as an aid to consumers. The Seattle office also advises the industry on what new products are available, and what products are in large supply, as, for example, in the development of a market for pen-reared salmon.

The problems are as wide-ranging as the job, including surveillance of fisheries activities covered by international treaties (sur-

veillance missions are made aboard Coast Guard ships and aircraft), enforcement of treaty standards, and resolution of conflicts within regional and local fisheries, which can be chaotic without being anyone's fault.

"For example," Johnson says, "the large Pacific coastal Dungeness crab fishery is complicated by a biological characteristic of the animal itself. When crabs moult, as a part of their growing process, they shed their old shell and grow a new larger one which is soft for a time. Now, unlike crabs on the east coast, softshelled Dungeness crabs have no market value. Until the new shells harden the meat is watery and not a good product and the animal is extremely vulnerable to injury.

"The shell-hardening process and the development of good meat in the crab is a relatively rapid process. However, the time of moulting and shell-hardening varies to some extent from location to location, especially from north to south, throughout the range of the crab from northern California to Alaska. So, if you open the season too early, you're fishing those softshelled Dungeness crabs and you have high mortalities and a poor product. If you wait too long, you miss the holiday market season, which is economically important in this fishery. Also, the fishing season usually opens earlier in Oregon than in Washington, so that some animals are taken off the Washington coast before Washington fishermen get a crack at them. It can get extremely complicated, even in one fishery."

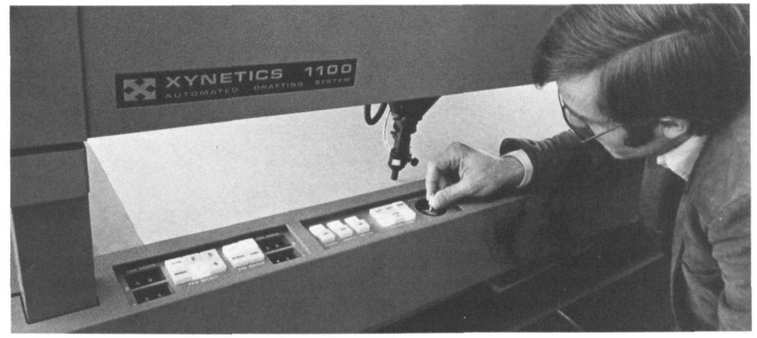
Much of the research that goes toward sorting out this area's fisheries problems is being done by NOAA's Northwest Fisheries Center, which reaches as far inland as Idaho in its salmon activities, and into the remote Pacific for some other species, and has research facilities at Auke Bay and Kodiak, Alaska; and Pasco, Manchester, North Bonneville, Mukilteo, and Sand Point in the State of Washington. Principally engaged in resource assessment, salmon aquaculture and research, and gathering data on fisheries for use in developing United States positions in international fisheries negotiations, the center has also placed some new emphasis on environmental studies, according to its director, Dr. Dayton L. Alverson.

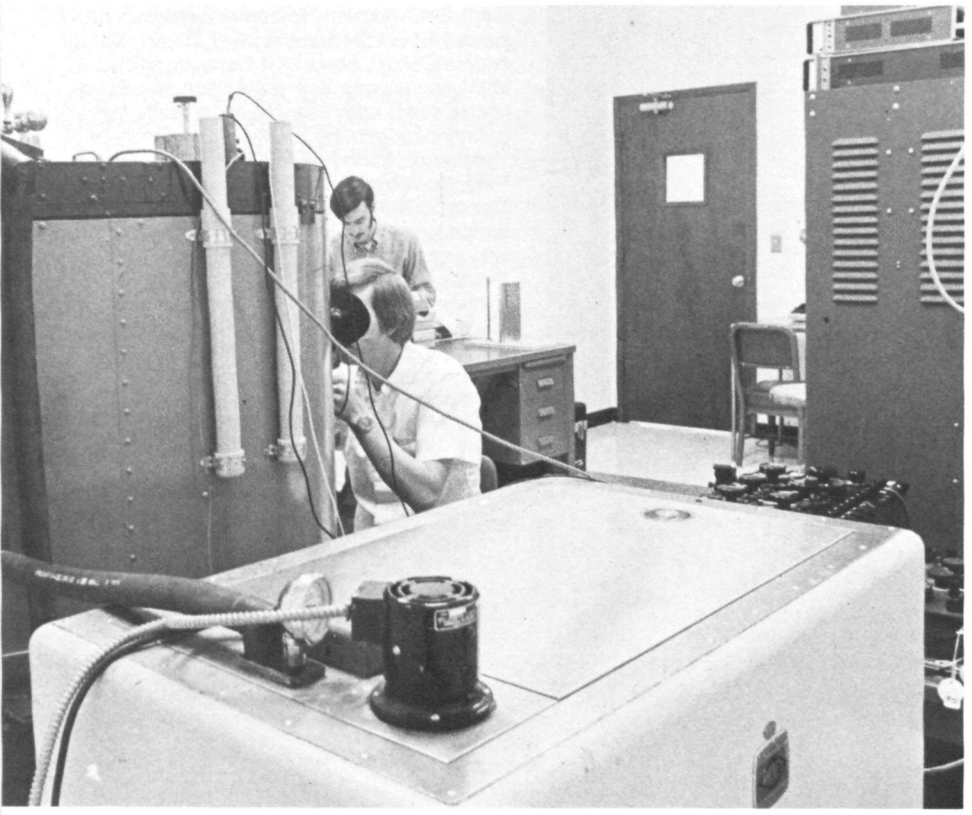
"We're more involved now than previously in environmental investigations, and the impact of pollutants on aquatic life," he says, "although we've always had a strong program in that area. We've formed a special division here which is specifically concerned with the effects of environmental degradation on aquatic life, so that our environmental work has a clearer focus than it once did.

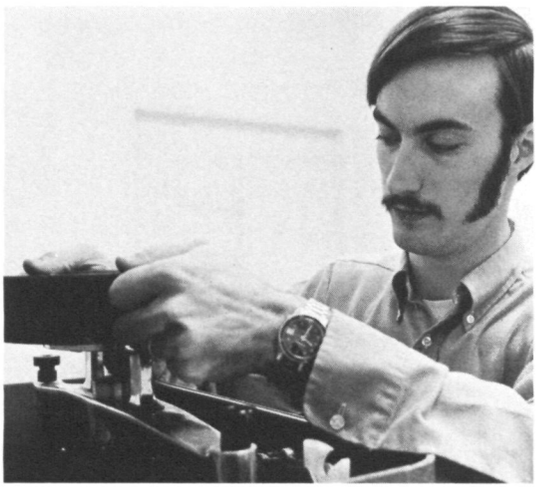
"We have a strong program here at the center of looking at the fate of hydrocarbons as they go into the animal, where they lodge, how the animal accommodates them, whether the toxic hydrocarbons are detoxified and how they are, and how they affect the physiology, vulnerability to disease, and mortality of the fish. The Mukilteo work is studying the effects of thermal discharges

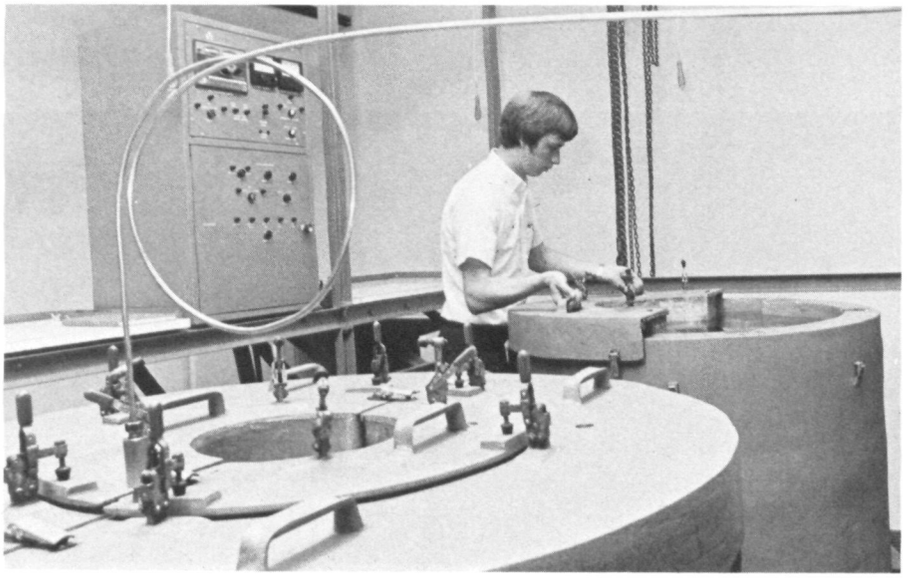
(Above) Ships from the National Ocean Survey's Pacific Marine Center often seem the dominant feature in NOAA's Seattle presence. Here, all of the NOAA survey and fisheries ships are shown at their Lake Union base. The modern office building across the lake houses the Northwest Administrative Services Office and the NOAA headquarters representatives it hosts, the Northwest Regional Fisheries headquarters, the Weather Service Forecast Office, and a number of other Commerce Department activities.

(Left) Rear Admiral Herbert R. Lippold, Jr., the NOAA officer commanding the Pacific Marine Center, notes that the electronic revolution aboard new-generation ships and shorebased, computer-driven systems, have greatly changed the quality and quantity of material produced by hydrographers. (Below) Here, from right, software engineer Larry W. Mordock, NOAA Lcdr. Melvin Maki, and computer technician Douglas Doles, check operator communications terminal in Pacific Marine Center's new computer room. In photo underneath, Mordock sets up new system's mechanical cartographer, which plots data taken by ships like Fairweather *(lower left). (Bottom) Scientists and scientist-divers from the Northwest Fisheries Center conduct gear research aboard NOAA's* John N. Cobb.









At the Northwest Regional Calibration Center—one of three such centers in the United States—oceanographic instruments are put through their paces by devices capable of simulating a variety of oceanic conditions. (Above left) John Swieso and Richard Guenther make a record calibration measurements on reversing thermometers. (Top right) Richard Guenther adjusts weights on a "dead weight tester," used to apply pressure to sensors being tested, while Knona Liddell (above) measures the salinity of a water sample. (Left) In the larger tank system, the Center can test instruments like the S-T-D (salinity-temperature-depth), over the full range of oceanic temperatures, salinities, and pressures.

and other environmental alterations on selected species."

The other major change in the Center's activities is a new stress on protection of man's distant oceanic cousins. The Marine Mammal Division located at Sand Point is primarily concerned with studying northern fur seals of the Pribilof Islands and eastern North Pacific Ocean, with an eye to balancing the annual harvest of these animals with population levels.

In recent months, however, the marine mammal facility has increased its investigations of whales to provide information on which United States participants on the International Whaling Commission can base their positions. The facility is also involved in the United States-Soviet marine mammal working group, one of a dozen groups set up under the bilateral environmental agreement of 1972.

Whales, unlike mammals such as seals, that "haul out," are difficult to find, count, and study. Much of the Marine Mammal Division's work is done in the field, and takes the form of air and sea surveys, counts made from shore, and the like. The scientists also receive data on whale sightings and catches from each whaling nation and attempt to develop from that the global populations of various species of whales.

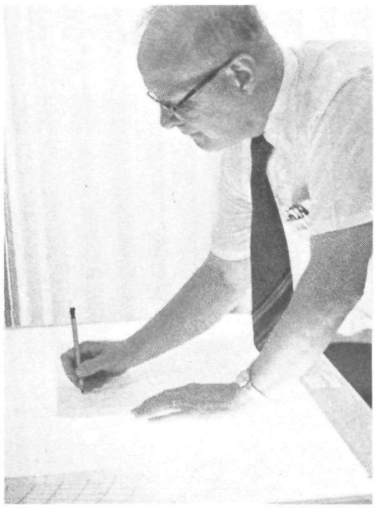
"These animals are extremely vulnerable to commercial overutilization," reports Dr. George Y. Harry, director of the Marine Mammal Division. "They have reproductive cycles of two or three years, depending on the species, and go through peculiar cycles. For example, they may breed, have a long gestation period, and then nurse for a year or more. When they are fished down below a certain level, it takes them a very long time to repopulate.

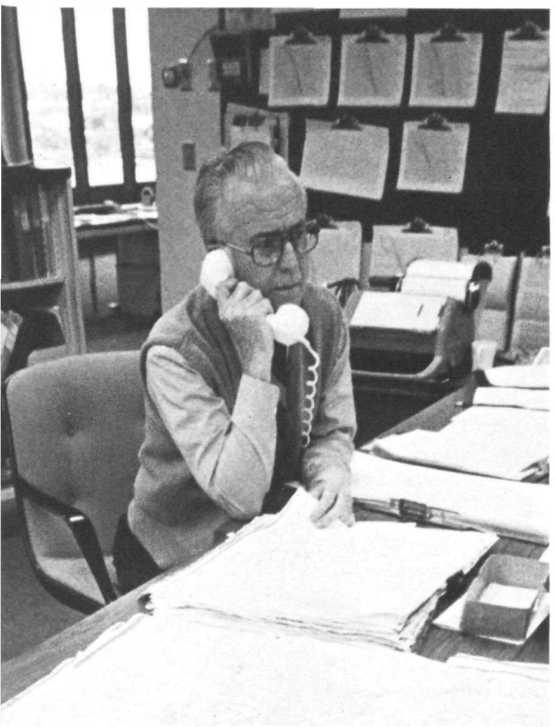
"There is a lot of sentiment attached to whales, and there should be, I think. I think everyone who works with them has to admire them, they're such gigantic creatures; they're just unique, there's never been anything like them. So you have to get some kind of attachment to them."

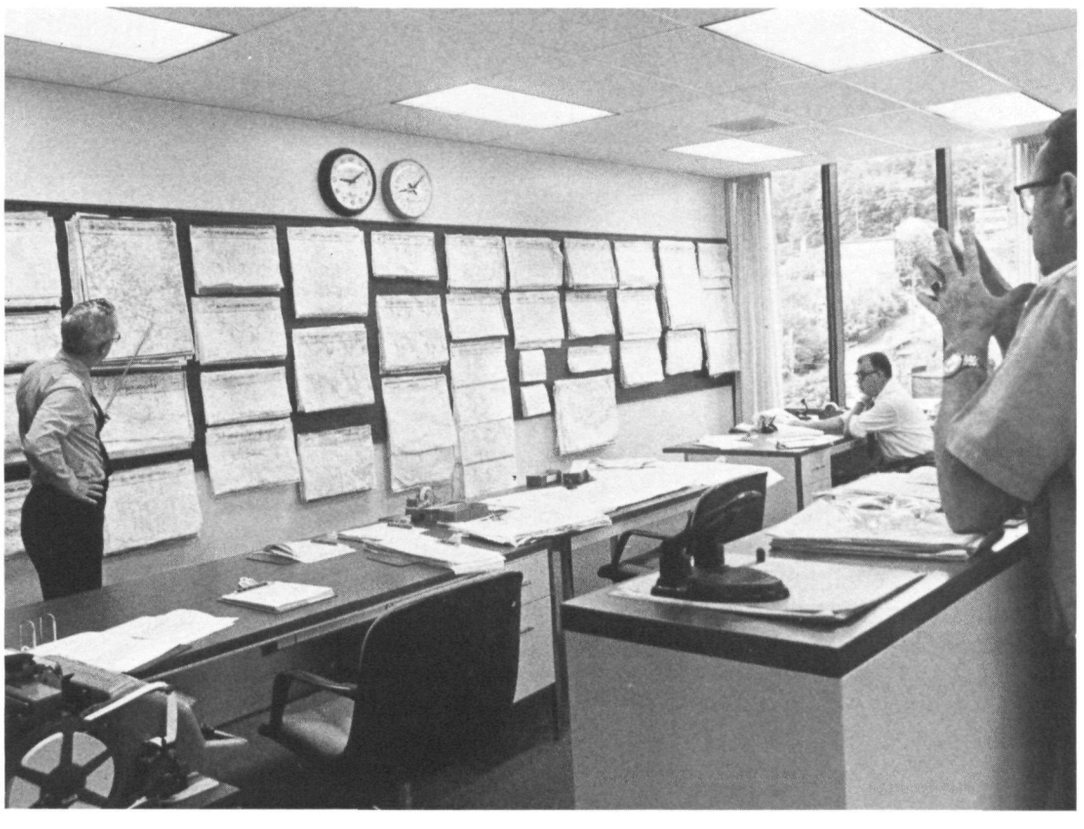
The other fisheries research effort here, the Pacific Fishery Products Technology Center, is concerned with the fish after it gets on deck. Its efforts have concentrated on developing underutilized species, particularly bottom-fishes, and on improving the ways present fisheries products are used. The problem of making an appetizing product from some of the less familiar species has led to application of machines to mince fish flesh and remove skin and

The Seattle Weather Service Forecast Office moves to the rhythms of the region's wet, variable weather. Here, (right) James A. Mitchell cuts a new NOAA Radio Weather tape for the VHF-FM automatic broadcast, (next right) Chauncey T. Beach traces upper-air soundings at a light table, and lead forecaster Victor C. Bundy (below) works out the myriad details of a morning prediction. The state of the weather is the subject of the morning briefing, conducted by Bundy and attended by on-duty meteorologists who include Edgar C. Johnson (center) and Meterorologist-in-Charge A. L. Zimmerman (at center right).

A cooperative effort with environment-minded Washington state saved the Seattle urban air-quality balloon sounding program. Here, Washington state meteorologist Jim Frost (below) releases a NOAA low-level sounding balloon, which is tracked by theodolite and plotted in an effort to map the currents which control the quality of urban air.

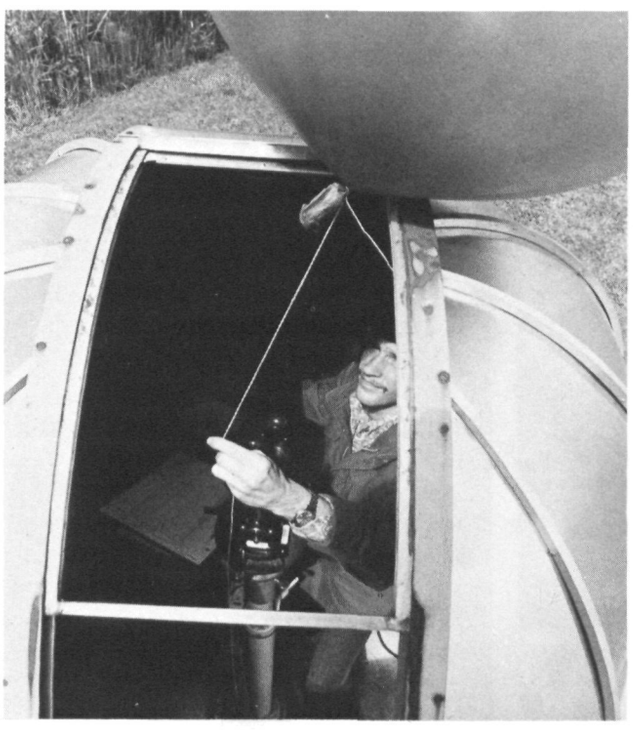


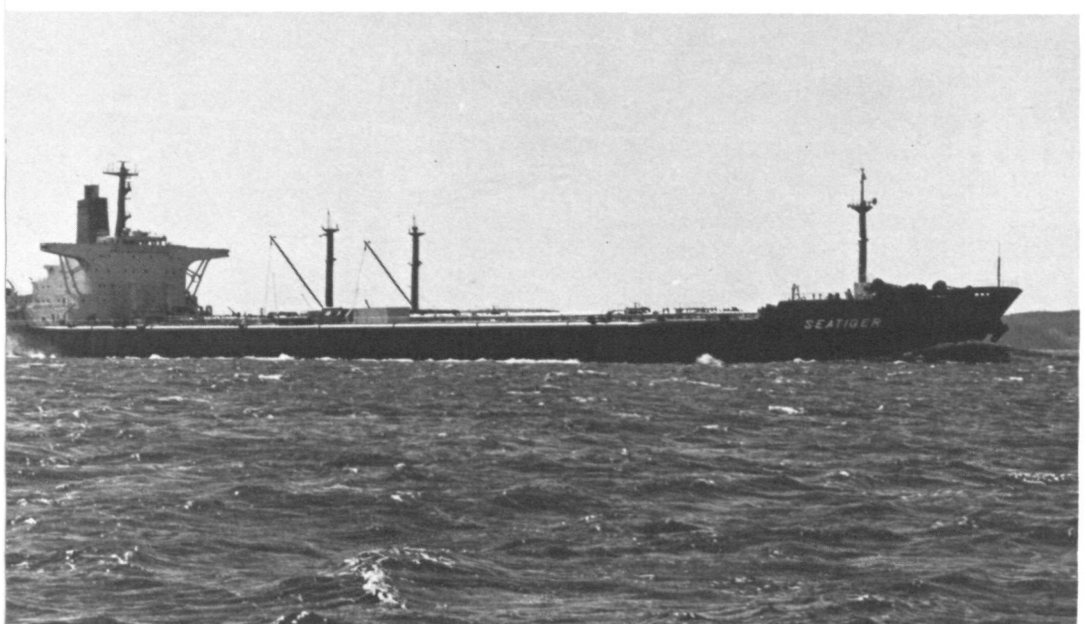




bones. Present work is devising ways to process the minced flesh to improve its color, flavor, and keeping quality, and ways to use this versatile form of fish in fish spreads, dips, and sausages, and as functional and nutritious replacements for part of the red meat in such foods as frankfurters. In fact, taking the fillets from fish and leaving the rest is not the best use of the resource, according to John A. Dassow, deputy director of the center.

"We've had advisors from Japan here to give us the benefit of the experience of a nation which must use its food and fish resources very efficiently. When you fillet a fish, you're wasting perhaps twenty-five percent of the resource. If you mince the flesh, you cut that loss in half. What we're looking toward is a wide variety of convenience foods and processed fisheries products.

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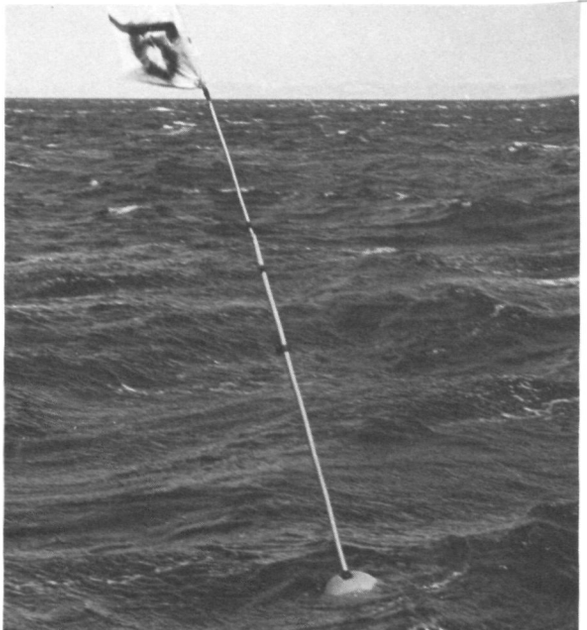
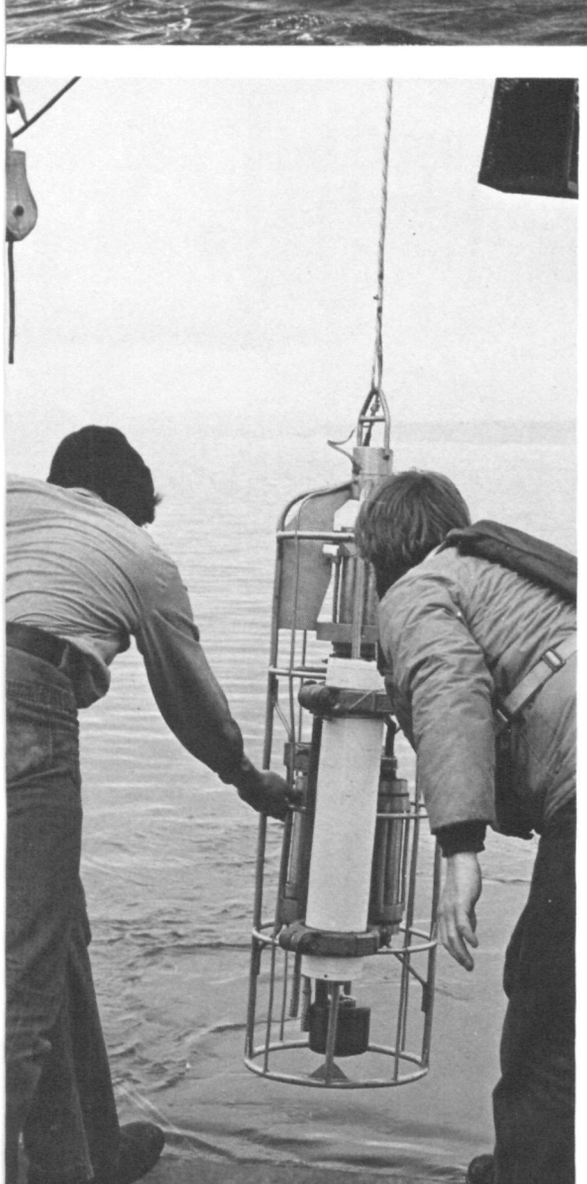





FISH
ICE

(Above) Stripping female salmon of eggs to be fertilized, hatched, and released from Donaldson's hatchery at University of Washington. (Top, far left) PMEL-Estuarine Program. Oil tanker inbound through Rosario Strait to supply refineries to Cherry Point. (Top left) Drogues identify trajectories of individual water parcels. Movement of contaminants can often be inferred from drogue data. (Far left) STD (salinity-temperature-depth) recorder is lowered over the side to investigate the layering and stratification of waters in the study area. (Left) Eugene A. Johnson gathers information for his now published Directory of Emergency Services for fishermen along the North Pacific Coast (Lower left) Rich Brown was employed in the spring of 1972 by Sea Grant marine advisory program. His work led to the establishment of a design section with six students during the autumn quarter in the School of Architecture.
Here (from left) Robert Palmateer, Sea Grant seafood processing specialist, Rich Brown, and University of Washington Professor Tom Bosworth critique Veleta Witcraft's model proposed for a Clallam Bay processor.

"The other major aspect of our work here is to improve the way we use existing fisheries. Trawlers, which harvest bottom fish from northern California to Alaska, offer us a chance to do more with what is brought in. You may trawl for a certain species of fish but you come up with many more. When you get down to looking at your resources, as we in the United States are doing more and more these days, you have to think about what you will do with the leftovers. Research in fisheries is no longer a case of someone saying, 'I'm going to take this species and study it until I know everything there is to know.' Now we're concerned with taking a broader look at how we're using the species we take from the sea. That is, given a resource, a fishery of such and such a species, what are we going to do with it?"

Besides the technology of using fish flesh more efficiently, scientists at the center are working on fish protein isolates—protein additives that can improve foods for humans—and in developing better fish-derived feeds for pen-reared species such as salmon.

They are also searching for what they call "bioactive compounds" in aquatic animals. Toxic substances used by some creatures for defense can be powerful drugs, and in many instances, the drug-secreting animals can be raised and harvested at less cost than synthesizing equivalent substances in a laboratory. At the far end of this spectrum, microbiologists search for the reasons some bacteria are toxic to man, while other seemingly identical bacteria are not.

And they are studying the way contaminants added to the environment by man—for example, DDT and polychlorinated biphenyl pesticides—and metals contributed jointly by man and nature move through the food webs of various species. Here, the work is concerned not just with measuring amounts of metal in a given sample, but also with helping define exactly what the public health hazard is from such materials. It is worse in some types of fish than others, for example. But why? Workers in the Seattle laboratory, and at laboratories in College Park, MD, and Gloucester, MA, are trying to find out.

Even the casual observer of Seattle must notice that all the water is not in the lakes or the Sound. It also fills the sky. There is a lot of weather in this corner of the land, and Seattle is a weather-conscious city. It is the water in the weather, taken with community's geographic location, that makes it different weather-wise from most cities. Here aviators worry not so much about rain as about ceiling. People who use the water keep an eye out for the freak winds which rocket around the Olympics and whip up the waters of the Sound. The winter storms that visit the area are born over the Gulf of Alaska, great wet low-pressure systems which can soak Seattle and blast it with gale winds and still carry a cargo of water large enough to blanket the American heartland. And there are the winter and spring floods here, when the Cascades give back too much of their moisture, too rapidly.

At NOAA's Seattle Weather Service Forecast Office, meteorologists monitor the ebb and flow of massive quantities of weather data coming in over facsimile and teletypewriter wires, representing the composite view—the assembled puzzle—and computer analyses on which local weathermen base their forecasts of atmospheric things to come. Their 24-hour watch on regional weather brings them telemetered river height and rainfall information from automated gages along the rivers draining into Puget Sound, and reports from other National Weather Service facilities around the Sound—a radar unit at Auburn, an upper-air station at Forks, airport stations at Boeing and Sea-Tac International Airport.

Their output is a kind of counterpoint to the inflowing information, spread over a thrice-daily cycle of reports and forecasts, some of them for the general public, some tailored to aviation, some to mariners, some to farmers, some to the people who watch for fires in the dry summer forests. They also issue watches and warnings for severe weather and flood conditions, at a rate which might surprise some area residents. Last December and January, for example, 300 such special bulletins went out, half warning of gale and storm wind conditions, a fourth of them warning of river basin flooding, and the rest covering such meteorological hazards as heavy snow, avalanches, freezing rains, and storm tides.

But the quality of the atmosphere above Seattle has been as important to local citizens as the waters and lands of the Puget Sound estuary, and the same forward-looking imperatives have developed for the airy half of the environment. According to A. L. Zimmerman, meteorologist-in-charge of the Seattle forecast office, the level of interest is unusually high, and concern seems broadly shared.

"We've found," he says, "a commonality of interest among a number of environmental programs out here that has its effect on NOAA, and on the state and local agencies which share environmental responsibilities with NOAA. And there is an unusually large community of meteorologists here, working with the Environmental Protection Agency, the State Departments of Ecology and Highways, the Puget Sound Air Pollution Control Agency, universities, and private meteorological consultants, which gives us a much broader base for any type of environmental investigation.

"There has been a much higher degree of interest in meteorology by the whole community than I would have expected in the Puget Sound basin. We don't have a lot of air pollution here, although we do have occasional air stagnation episodes which require some kind of restricted activity in the urban area. But mainly I think the people here want to know how to handle these episodes when they do occur, and also develop ways to keep us from having any more pollution than we presently do. Our meteorological support program anticipates."

Anticipates. It seems a key word around Seattle. □

NOAA'S AMAZING THINKING MACHINES

From about 1760 until his destruction by fire in 1854, a chess automaton named Turk amazed the more gullible entertainment seekers of two continents by consistently beating almost everyone who would spend a few coins to sit down and play with him. No less a practical strategist than Napoleon Bonaparte pitted his skill against the formidable machine (he lost), and it was not until the 1930s that "The Turk's" secret was revealed. A small man, cleverly concealed among the cogs and gears exposed to the audience, was the actual chess master. The Turk was a hoax—a quasi-computer programmed with perfidy to take advantage of man's awe of the unknown, especially where intricate "thinking machines" are concerned.*

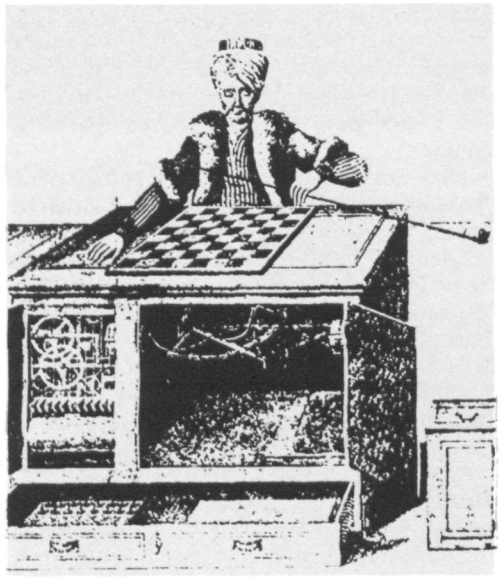
To the average citizen, the world of computers is confusing and sometimes a bit frightening. He is the recipient of bills and checks produced by machine. His credit rating—his good name, as it were—is dependent upon the heartless output of a computer. Sometimes he is victimized by a faulty program and the machine's human masters seem helpless to overcome some mechanical prejudice.

It's not the machine, of course. Rarely does a computer make an error (though its masters may). The wonderful machine takes meaningful values—fed into it in simple numeric form—and, handling them at close to the speed of light, performs tasks as varied as the entire spectrum of human endeavor.

Nature's poorly-understood but certain logic makes the environmental sciences particularly suited for study with the subjective "mechanical brain."

NOAA, with its heavy dependence on computer products, has built on its experience with 167 computers (144 are agency-owned) to make the best possible use of these modern machines.

The greatest demands made on NOAA by both the public and businesses are related to the weather. Therefore, it is only natural that the National Weather Service, through its National Meteorological Center (NMC) in the Washington, D.C., suburb of



Suitland, MD., has the use of NOAA's biggest computer installation. It is NMC's task to produce short-range forecasts (two and five-day) several times a day.

The basis of all forecasts is observations—you must know what it's like to tell what it's going to be like. A torrent of data arrives at NMC from observation posts all over the world—from radiosondes suspended beneath balloons ten miles up, from environmental buoys bobbing on the high seas, from hundreds of manned and unmanned land weather stations—all taking basically the same measurements at the same time. From the National Environmental Satellite Service's (NESS) polar orbiting and geostationary satellites come an incredible amount of weather data. A portion of this data is fed into computers by NESS to produce satellite pictures of weather phenomena ranging from large-scale storm systems to local cloud clusters. (You have probably seen the weather satellite pictures on the local TV weather news.) Quantitative measurements are also extracted from the satellite data by NESS to generate an edited input for the numerical forecast.

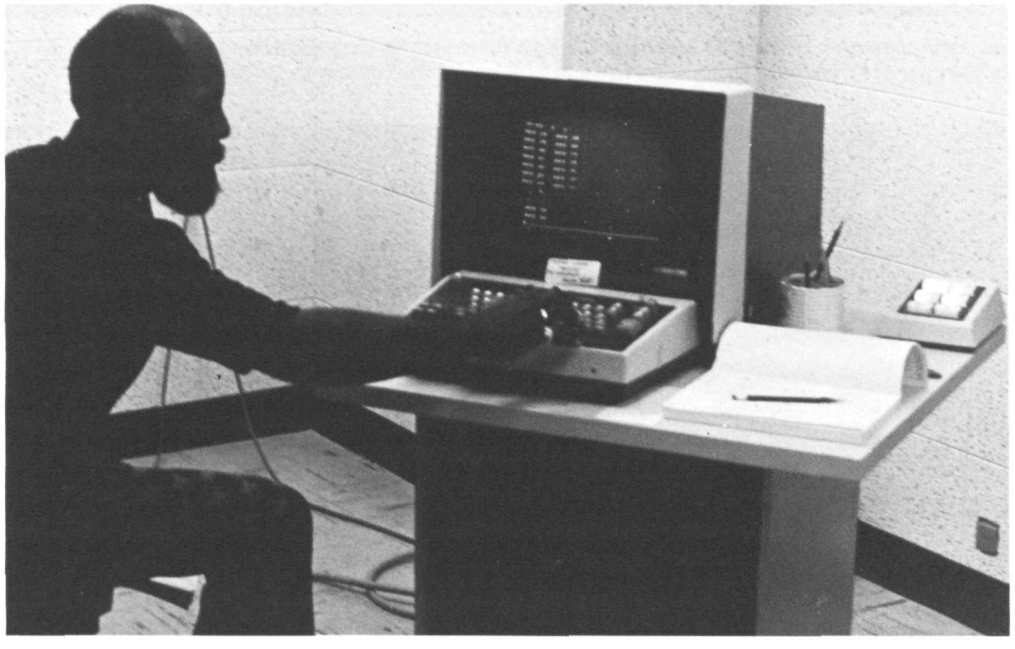
Pouring in through a maze of communication circuits, this vast yet orderly flow of data is fed into IBM 360/40 computers at NMC. Then the stream of information, now altered into computer-to-computer language, moves on to the NOAA 360/195 computers at Suitland where a forecast is made using various dynamical forecasting "models" or computer-descriptions of what atmospheric reactions *should* take place as a result of various input data. The computer output, then, is a forecast presented to in-house forecasters and transmitted to field forecasters for interpretation and further development.

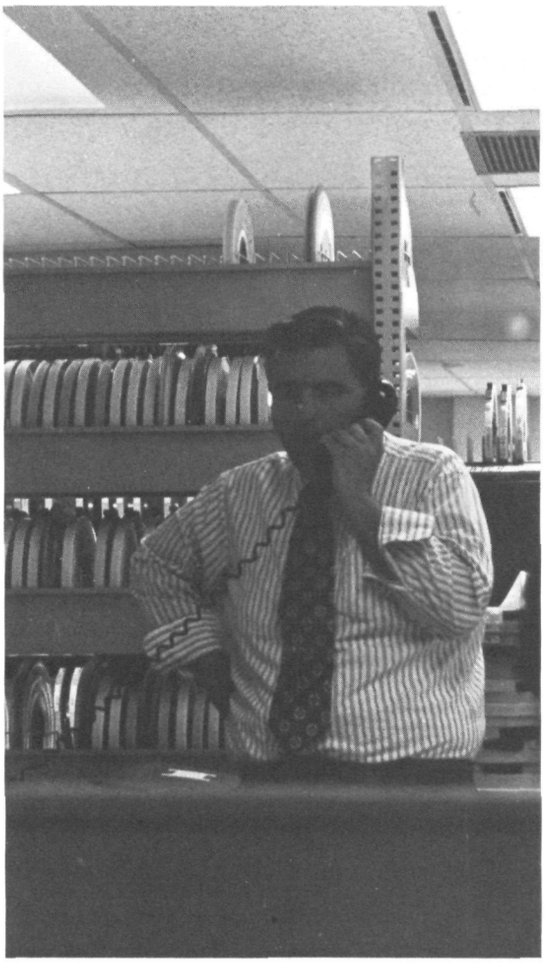
At the same time, the computer is also retransmitting the analyses—the initial data—out to the forecasters in the field. The initial forecast, the initial analysis for the current time, and various forecasts for up to 48 hours or more—go back out. The job is enormous—especially if it were to be performed by human agents—but well within the capability of the big computers, each of which can handle up to 50 billion instructions per hour.

In addition to forecast and "raw data" products, the NOAA computers produce a variety of surface and upper-air maps—drawn with a speed and sureness which would put the Turk's purposely stiff chess piece movements to shame—showing isobars (lines of equal air pressure) and isotherms (lines of equal temperature) and contours (lines of equal height). Twice a day synoptic maps for a number of atmospheric levels are machine-drawn, from the surface to 16,000 meters (53,000 feet). These very high altitude maps are used by military aircraft, since most commercial airliners are limited to a maximum of 12,000 meters (40,000 feet).

When the Anglo-French supersonic transport *Concorde* visited the U.S. in the summer of 1973, NMC was called upon to prepare a special forecast for its flight from Paris to Dulles International Airport, Washington. This was needed because the flight plan called for an initial cruise altitude of 56,000 feet, gradually increasing to 65,000 feet. Other special forecasts were generated for each Apollo mission, beginning several days before blast-off. These were needed to minimize the likelihood of a weather-related mishap during either launch or splashdown.

* *Even today, computers can play only slightly better-than-average chess.*





Will Boone (left) runs a CDC U-200 remote job entry terminal connecting users in Georgetown with others at Suitland's CDC 6600. Above (left), Sam Whittle of CEDDA at his PDP 11. Directly above, Jim Kersse ealing with his IBM 360/65 in Georgetown.

Photos: James Disbrow

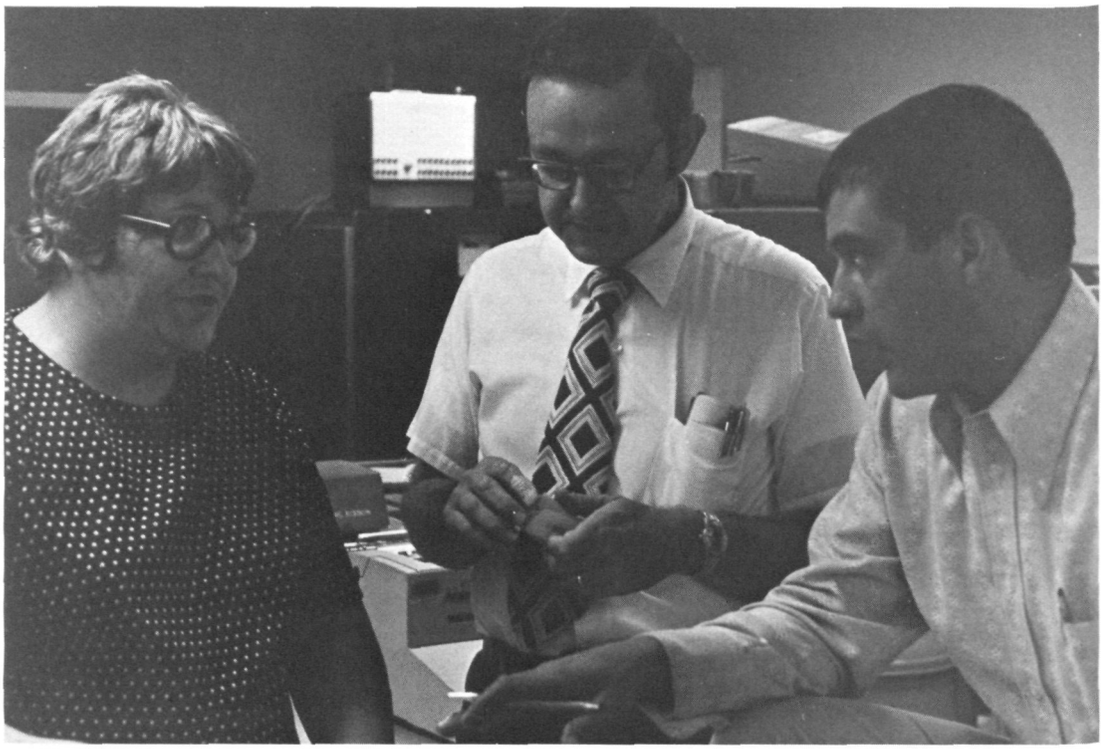
Historically, the synoptic maps at NMC had station readings—wind direction and speed, precipitation, pressure, temperature, dew-point, etc.—laboriously plotted by hand from teletypewriter reports. Today, the computer does most of this.

Observations worldwide are made at 0000 (midnight) and 1200 (noon) Greenwich Mean Time (or Zulu, as it is often called). The analyses and forecasts are available less than 3½ hours later and are transmitted to users less than five hours after the observations were made. (The time in between is used by meteorologists to "massage" or refine the machine forecast.)

Another, larger, user of computers in NOAA are National Weather Service hydrologists. River forecasts—from one- to five-day short term through 30-day forecasts and long range seasonal water supply forecasts—are highly dependent on computer operations. Computer speed and accuracy are vital to flood forecasting. Augmenting meteorological guidance received from the NOAA computers are computers at Weather Service river forecast facilities around the country programmed to solve hydrologic problems after being fed observed rainfall and stream data. Weathermen are working toward greater use of completely automated land and sea observation platforms. Such unmanned stations are queried at regular intervals by a central computer and their wind, pressure, rain and temperature measurements are stored along with similar data from other observation posts. So far this developmental effort has about 20 land stations "on line." Eventually, there will be about 50, as well as many more sea platforms, most of them being in relatively inaccessible spots.

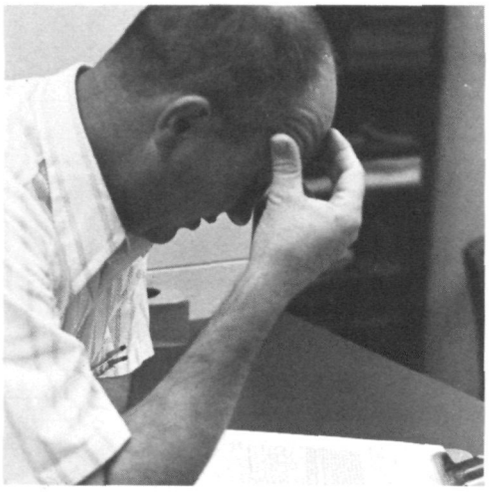
Ocean-going cargo and cruise ships depend upon various kinds of forecasts prepared by the National Weather Service, some transmitted by radio, others by satellite. Thirty-six hour wind-driven wave and swell forecasts are sent out routinely to help merchant vessels plan a fuel saving route where they will have the calmest seas possible. Aquanaut Jacques Cousteau benefited from these. His safe passage to port in the violent Antarctic after storms knocked out one propeller and crippled the other was credited to NOAA's sea height forecasts and satellite pictures.

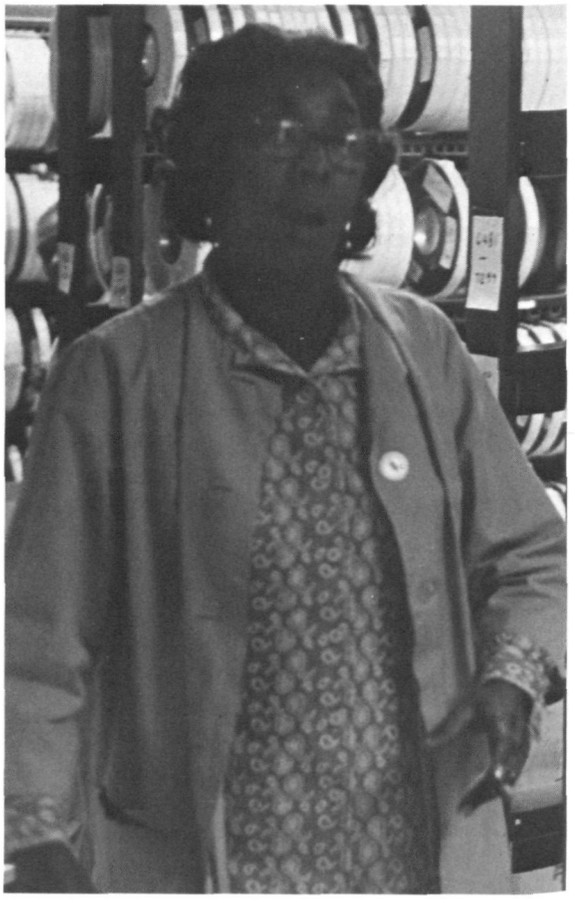
Overall control of NOAA computer use rests in the Office of Management and Computer Systems (OMCS) in Washington, D.C. The main NOAA-operated computer systems are at Suitland—two IBM 360/195s and a CDC 6600—and at the Page Building—one IBM 360/65. With this array of computers, OMCS ranks among the largest of all the U.S. Government's non-defense computer offices. It is also the focal point in NOAA for all computer procurements



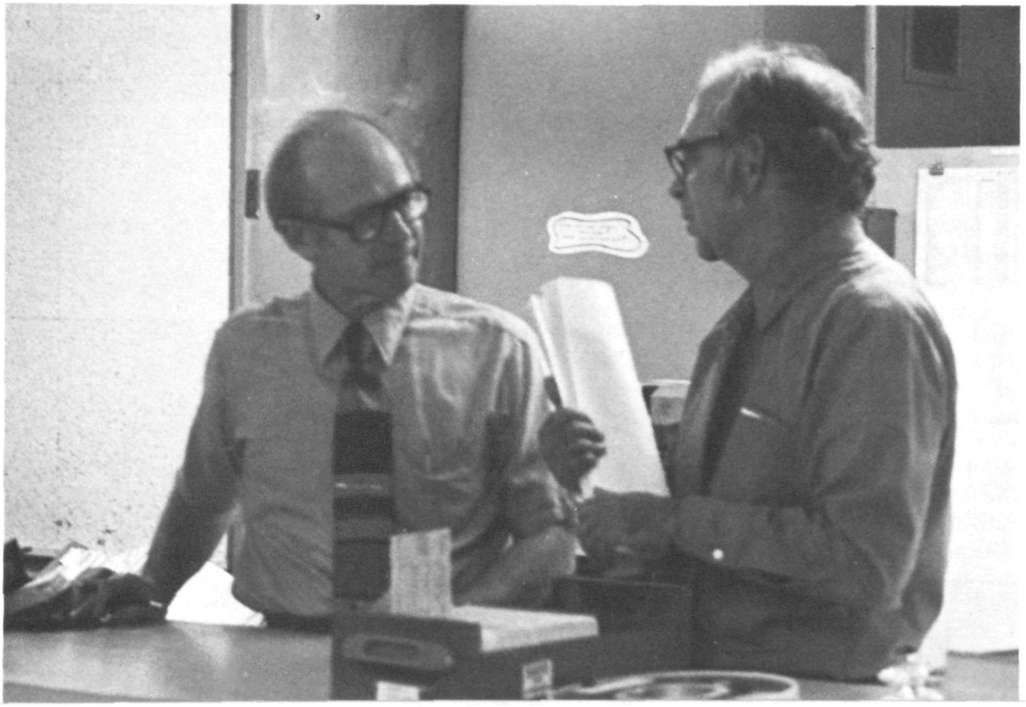
Discussing operations of the IBM 360/65 at the Page Computer Services Branch of NOAA's Office of Management and Computer Systems are (from left) Gloria Hall, Dick Holms, and Fred Long.

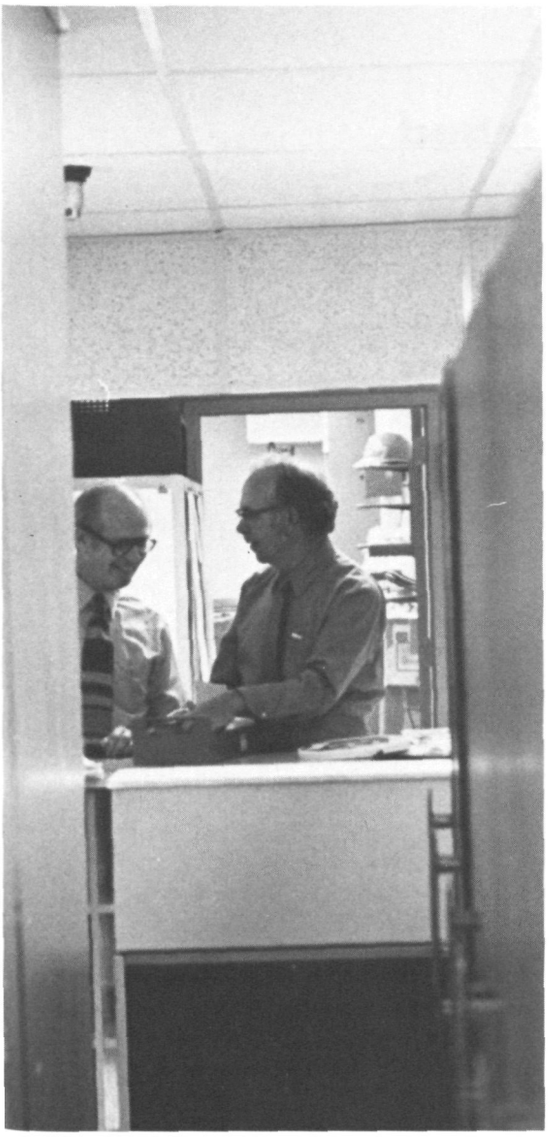
George Murphy (top), Margaret Miller (above), and Brice Winn (right) reflect the gamut of moods experienced by those working with NOAA's computers.

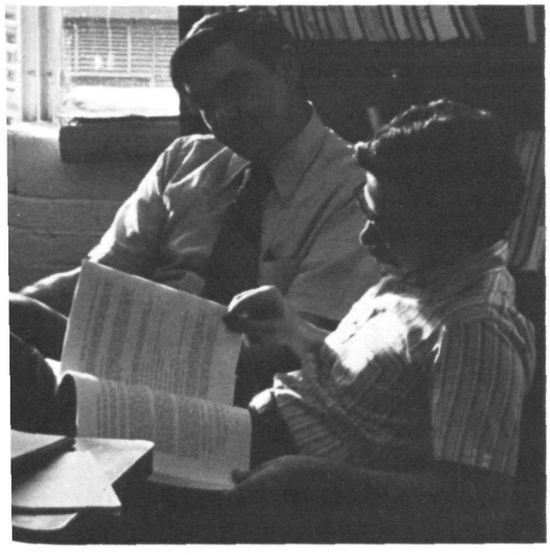




At left, two experts from the National Weather Service meet at a program submission counter in Suitland. Frank Lewis, chief of the Computer Systems Branch of the Techniques Development Laboratory talks to Harold A. Bedient, chief of the Data Automation Division, National Meteorological Center. Above is Beverly McCannon, Tape Librarian for the IBM 360/65, who controls over 15,000 magnetic tapes.







The subject is always the same-computers and how to make them work better for NOAA-at informal conferences such as these. (Top) Frank Lewis and Art Bedient are involved in the coversion of programs from the CDC 6600s to the IBM 360/195s. (Above) Bob Salm and Bob Danson search a manual for the solution to a systems problem.

and computer related contracts.

To help those not located at Suitland who need computer services, OMCS has established a network of over 25 remote entry terminals around the country—for example, terminals have been installed at the Weather Service's River Forecast Center at Tulsa and at the Environmental Research Laboratories in Miami. These terminals permit rapid movement of information submitted for computer processing.

The biggest task of the National Ocean Survey is the preparation of nautical charts for the coasts, bays and estuaries of the U.S. and its possessions. This requires detailed and accurate bathymetry (measuring and recording of depths). In the distant past the traditional method of taking soundings was by a lead weight, with the measurements being entered on the charts by hand. With the coming of the sonar fathometer, depth readings were greatly speeded, but hand entering was still necessary. Finally, tape recorders made possible not only storing the data, but, through a computer, actually printing the depths on a chart.

NOS now has (or plans to have) computers on all of its larger ships. The recorded tapes are edited and processed on board, with readings coordinated with precise navigation systems. Tapes from the ships are then sent to centers at Norfolk and Seattle to be machine plotted and all data verified. Finally, they arrive at NOS headquarters at Rockville, Md. for eventual inclusion in revised charts. Tide tables are stored and published by computer and are regularly updated.

Another use of the computer by NOS is the complete storing and composition of the Coast Pilot, a detailed navigation guide for amateur and professional mariners. Thus the various regional editions can be updated and issued more often. One innovation the computer has made possible is the development of different chart scales without laborious hand labor. Another fascinating NOS project, which is just beginning, is to automate production of aeronautical charts for pilots.

The Environmental Data Service sooner or later is the recipient of the knowledge gathered by NOAA activities, from the edges of space to the bottom of the sea and into the earth itself. Most of the climatological (weather) data is stored at Asheville, N.C. while oceanographic data held at EDS's National Oceanographic Data Center makes use of the computer pool run by OMCS. In the main, EDS computer usage is for data requests from other parts of the government, from universities, and from businesses. EDS also stores textual information on what is known about the environment as well as where the data can be found.

The Environmental Research Laboratories, 11 of them, are the most widespread computer users in NOAA. With several of the laboratories, as well as their headquarters, located at Boulder, Colo., it is logical that two CDC 3800 computers are installed there. The Boulder machines also service a branch of the National Bureau of Standards there. Another major ERL complex at Miami, Fla., has the use of a UNIVAC 1108.

An ERL facility that relies almost entirely on computers in its daily operations is the Geophysical Fluid Dynamics Laboratory in Princeton, N.J., one of the Environmental Research Laboratories. It has NOAA's most extensive mathematical models of the ocean and atmosphere systems. For some time GFDL has rented computer time to solve complex equations, but now is awaiting installation of one of the most powerful computers of this day and age. This system, being developed by Texas Instruments, will be 20 times as productive as some computers being used by NOAA for similar work today.

GFDL is not a forecast center, but like the National Meteorological Center it is developing a series of more and more complete and complex atmospheric models which should lead to better short range, five-day, and even longer range forecasts and outlooks. The amount of data cranked through just a 24 hour forecast in their developmental effort would take an ordinary computer days to complete. The new computer will shorten the task to that close to one needed by a production program.

Some of the input data for GFDL is coming from the Global Atmospheric Research Program (GARP), a massive effort to gather information in little researched areas of the world. A part of GARP is the GARP Atlantic Tropical Experiment (GATE) from which literally billions of observations are being stored on magnetic tape for later reduction and analysis. The initial part of that task will be done by shipboard minicomputers but the more extensive processing will be done back in Washington on one of OMCS's computers.

Serving commercial and sport fishermen is the National Marine Fisheries Service. At present the OMCS computers produce statistical summaries and marketing news to help the fishing industry gauge its efforts. Still in its infancy is computer use for prediction of tuna runs. So far, NMFS has been transmitting water temperatures to the fishermen to help them locate the tuna. A broader based program, with data stored and analyzed by the U.S. Navy's computer in Monterey, California is under development.

Last and not least is fiscal management, for the budgeteers and their work determine to a large extent what data will go to the President's Office of Management and Budget and eventually to the Congress for approval of just how much of the taxpayers' money is to be spent on what programs. And, of course, on the individual level, each NOAAite is figuratively computerized for personnel and payroll purposes.

So almost every segment of NOAA—its personnel and products—is touched and affected by computer technology. But the computer is the servant, not the master. As with the "Turk," the machine does the man's bidding for man's gain, be it for a few coins at a game of chess or the opening of new horizons to understanding the environment in which we live.

Earth's magnetic field disturbed

THE BIG SHOW ON REGION 433

NOAA Corps Lt. Carey Fuller, at solar forecaster's console at Space Environment Service Center in Boulder, Colorado. Another view of the solar observatory used to monitor sun in hydrogen-alpha light, above. At right, Region 433.

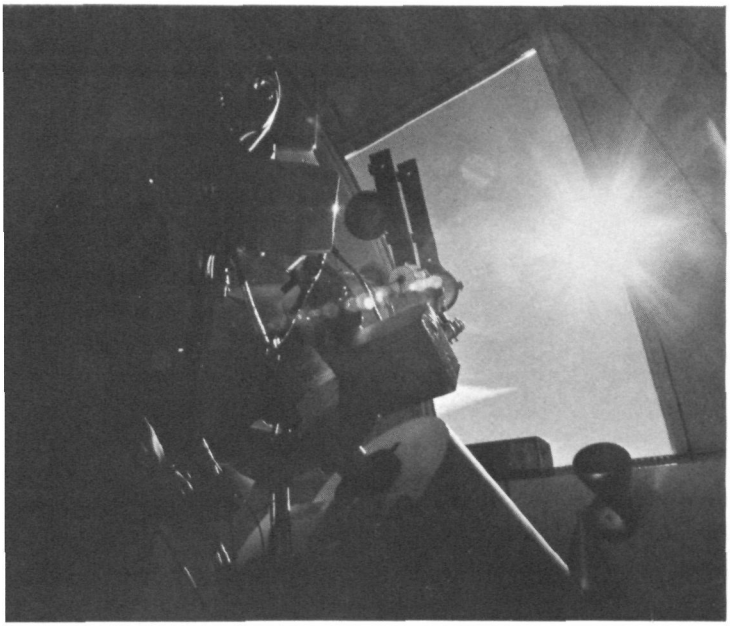
THE SUN OPENED JULY with a spectacular display of solar fireworks in what became the largest outbreak of solar activity since the great flares of August 1972.

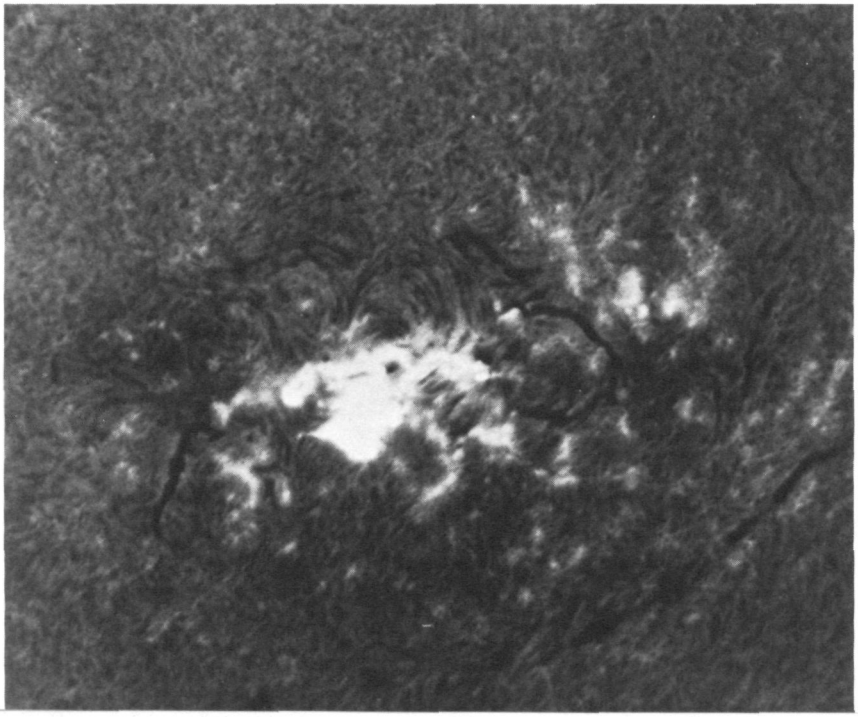
The active region on the sun-designated Region 433 was detected June 28 by observers in NOAA's Space Environment Laboratory in Boulder, Colo., as the bright, sunspot-flecked ribbon of activity just south of the solar equator rotated into the earth's field of view. By July 3, the active region had grown to cover an area of some 1.1 billion square miles.

Before it turned away from our part of space, Region 433 produced a total of eleven major X-class flares, the last two coming at 4:11 a.m. mountain daylight time on July 7 and at 7:49 p.m. mountain time on July 8.

Increased radiation from these and other flares in this series caused severe disturbances in the earth's magnetic field; displays of northern lights visible as far south as Omaha, Neb.; widespread radio interference; and telephone outages in some midwestern circuits.

Region 433 completed what astronomers call "limb passage" at 5:00 a.m. mountain daylight time on July 11 and diminished further while on the far side of the sun.





July 4, 1974
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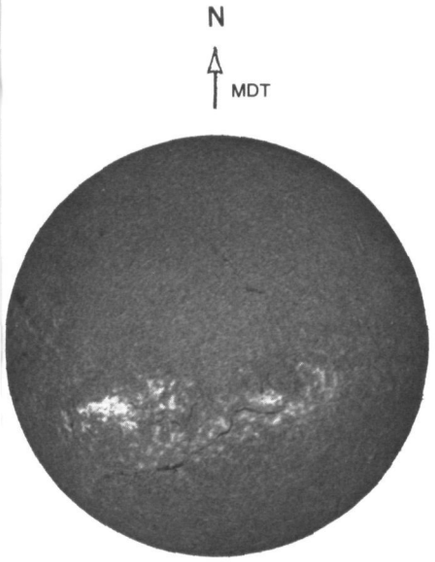

July 1, 1974
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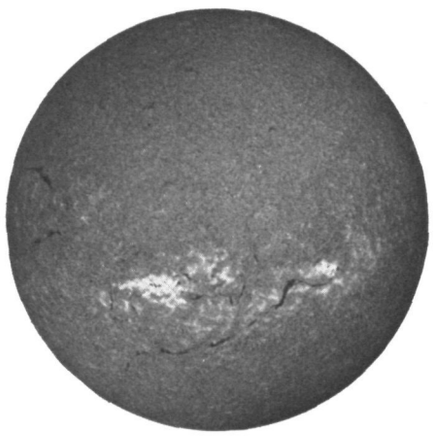

July 2, 1974
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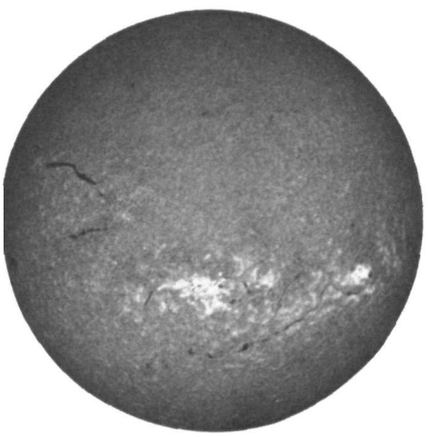

July 3, 1974
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Although the present solar activity was not visible until June 28, it was associated with the same region of the hot solar atmosphere which produced the major flares of August 1972. At least, that is the indication of a two-year study of the sun's magnetic "weather" made by Patrick S. McIntosh of the NOAA laboratory, and is one reason why scientists at the Space Environment Services Center consider this region a potential source of major activity.

Because the hot plasma circulating in the sun carries an electrical charge, its movement creates powerful magnetic fields which occur in complicated, constantly changing patterns. By monitoring these patterns the way meteorologists monitor the prevailing winds on earth, McIntosh has produced a series of maps which show the magnetic equivalent of global weather. As these structures become more complex, solar activity around them appears to increase.

"The active region under observation," McIntosh said of the July activity, "is located within a sharply defined boundary between regions of positive and negative magnetic polarity. This same boundary was also associated with the August 1972 activity, but has drifted slowly westward along the sun's equator to its present position.

"It is the only active boundary on the sun at present, possibly because of where we are in this eleven-year solar cycle. In 1972 there were five active zones, all marked by these 'frontal systems' in the magnetic field. In 1973 there were three. Now we are down to one, possibly because solar 'weather' improves as the cycle moves toward its minimum.

"Although we still can't say *why* these relationships apply, we think now that there is continuity in the solar atmosphere's magnetic field patterns, not unlike the continuity we see in our own atmosphere. We should be able to develop this continuity and day-to-day observations into a powerful forecasting tool."

Solar scientists, McIntosh points out, are just now getting into the new information provided by the recent Skylab missions and by other spacecraft-carried sensors, so that theory is changing rapidly.

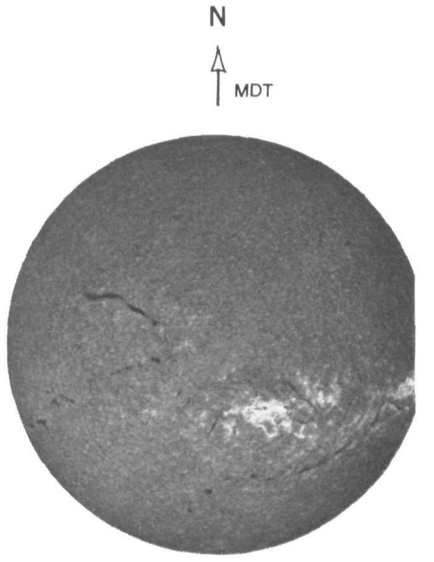
For example, interplanetary sectors—broad regions radiating outward from the sun separated by "spokes" of reversed magnetic polarity—seem to be rooted in the front-like magnetic boundaries on the solar surface. As these sectors rotate past the earth, they are followed by alternately disturbed and quiet periods in our geomagnetic field.

From this and other data, solar physicists now believe that the front-like magnetic patterns on the sun enclose areas in which the sun's magnetic field has coiled inward, bottling up the seething gases of the solar atmosphere, then releasing them in the form of flares and the associated bursts of radiation, energetic particles, and gusts of solar wind.

"It's nice," says McIntosh, "to be able to do some real-time testing of these evolving theories."

The July activity also gave the first Synchronous Meteorological Satellite—SMS-I—its first trial by solar fire. The satellite, launched last May into an orbit which keeps it always over a point about 22,000 miles above a point on the earth's equator, carries a Space Environment Monitor, which senses the flow of energetic material from the sun, and relays that information to ground antennas. Launched and still operated by the National Aeronautics and Space Administration, SMS-I will become the first Geostationary Operational Environmental Satellite—GOES-I—when it is turned over to NOAA's National Environmental Satellite Service.

The Space Environment Laboratory receives data from the new satellite continuously, in real time, at an antenna located north of Boulder. The data are run through a computer program and displayed on a television screen at the solar forecasters' console. Because the earth does not eclipse the satellite in its high, geostationary orbit, solar data can be obtained continuously, serving the round-the-clock watch on the sun kept by NOAA scientists in Boulder. □



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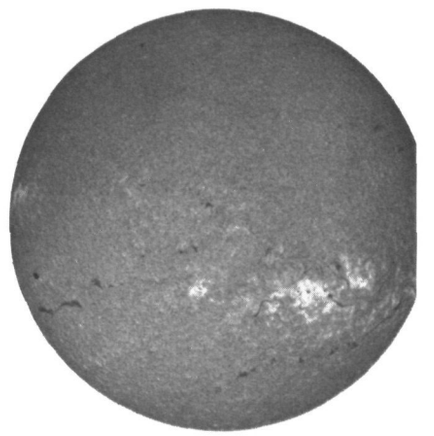

July 5, 1974
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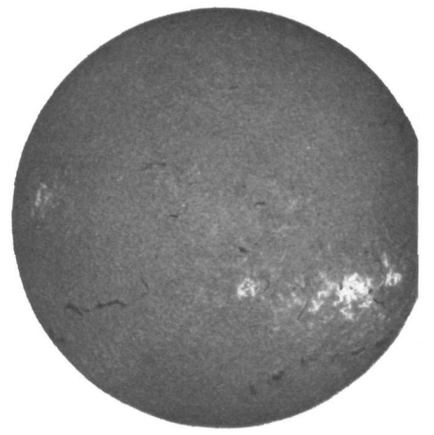


July 6, 1974
9:18 A.M.

NOAA Photos

Two states were enriched

WHEN FISHERMEN JOINED FORCES

BY R. STEPHEN SCHNEIDER*

Great Lakes skippers board a quillback on the Pacific with Oregon captain Don Christenson.

THE OLD TIMERS call them fishing machines, those new charter boats on the Great Lakes. Their hulls are built of Fiberglas, designed for the chop of the Lakes. They have sonars to locate fish, and even tell you what *kind* of fish you have found. They have depth reading temperature sensors, downriggers, and carry light rods and line to emphasize the sporting qualities of fishing for the lake trout, the coho, the chinook, and now the Atlantic salmon.

But the old timers tell about the days, back in the 30's before the collapse of the old charter boat business, before the development of all these new gadgets, when you wound 1800 feet of stovepipe wire (that was before monel) on a bicycle wheel, attached a big silver spoon, and had customers take turns chugging the 600 or 700 feet of wire you let out in the hope of hooking a delicious lake trout. To avoid tangling lines, you often put only one line over. Each time you lifted the heavy rod, the lure might jump 25 or 30 feet and snag another line, and then the stovepipe wire would kink and snap. That was why you turned on 1800 feet of it, so you could quickly re-rig after a broken kink.

When the customer caught a fish (or lost one) he went to the back of the line to wait his turn for another try. And the charge for this was only $5.00 a day, with a fish guaranteed. But that wasn't to last long.

R. Stephen Schneider is Director of Advisory Services, University of Michigan Sea Grant Program

When the sea lamprey (Petromyzon marinus) first slithered quietly into the upper Great Lakes in the 1920's, those men who made their living by chartering their boats for Great Lakes fishing were blissfully unaware of the impact it would have on them and their livelihood. Within a few short years, certainly by the time of the Second World War, these men had found employment elsewhere, for the lake trout had succumbed to the ravenous appetite of the marine invader, to commercial fishing, and to the success of the sportsmen's own effort.

There was simply too much pressure on this delicious fish. The time came when 14 boats fishing out of Raft's camp at Northport, on Lake Michigan, went out for 15 continuous days and boated only two fish. It was clear then that it was all over. Those few who didn't quit the business drifted up to Lake Superior ports, where the fish decline was a few years behind that in Lakes Michigan and Huron.

But is was only a hedge against time. By the 1940's the fish, the fishermen, the charterboats and their captains had practically disappeared from the Great Lakes. A way of life and an industry which had supported some and delighted others had vanished. Years passed, and it seemed that the charterboat business in the Great Lakes was now a part of history, something for our fathers and grandfathers to tell us tales about.

An unlikely hero, a chemical known as 3-trifluoromethyl-4-nitrophenol (commonly called TFM), was discovered in 1958 to be effective in lamprey control. The former Bureau of Commercial Fisheries (now NOAA's National Marine Fisheries Service) worked over nearly seven years before coming up with this chemical which would pave the way for the restoration of the lake trout and the whitefish, and the introduction of the coho, chinook, and Atlantic salmon. Sea lamprey larvae which are exposed to a concentration of from 1 to 6 parts per million of TFM for a period of eight hours are killed.

A program for TFM treatment of the some 300 lamprey-larvae-containing streams feeding into the three upper Great Lakes was begun in 1958 by the Great Lakes Fishery Commission, an international agency established by the United States and Canada for the conservation and development of Great Lakes fishery resources. The treatment began in Lake Superior where the lake trout population, although in rapid decline, was still present. By 1961, the major streams had been treated and by the spring of 1962 the spawning lamprey had fallen to one fifth the average catch of the preceding five years. The first round of stream treatments was completed on Lake Michigan in 1966.

The stage was set, and in 1966 coho salmon, raised from eggs supplied by the Oregon Fish Commission, were released in the Great Lakes by the Michigan Department of Conservation (now the Department of Natural Resources) and the sport fishing boom was on. Thousands were lured onto the big lakes for the first time by the temptation of landing a big fish. In the following years, the Michigan DNR planted more coho, followed by chinook salmon and, recently, Atlantic salmon.

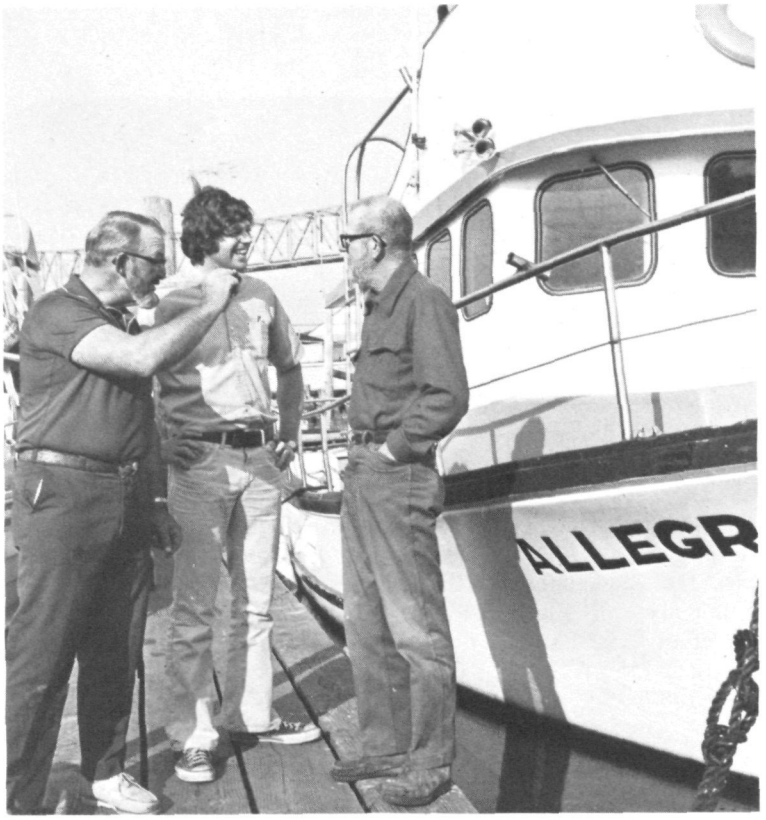
Along with this boom in fishing, this "coho craze", came the rebirth of the charter boat business. More fish than ever before were there for the taking, and people were willing to pay to catch them. Charter boating was reborn.

There were mistakes at first. Some people in their enthusiasm bought new boats to charter and then discovered that the business was too uneven to maintain the payments. Not enough was known about the fish; where to catch them and when. A number of charter boat owners dropped out of the business, but some learned the ways of these new species and developed new ways to catch them. They had boats specifically designed for the Great Lakes, and installed sonars to locate and identify fish. They installed depth reading temperature sensors to locate the depth and temperature which various fish prefer. Gone were the old wire lines, and in their place were downriggers, used to hold light monofilament line at a specific depth and allow it to snap free once the fish bit. Light rods, light lines: the clients loved it. The charter captains are an innovative lot, constantly experimenting with new ways to catch trout and salmon based on a better understanding of the habits of the fish.

In Oregon, where Michigan's first coho eggs came from, it has been a different story. While charter boating there has had its ups and downs it has had nothing like the total collapse of the charter business in Michigan. There has been a continuously rich resource in Oregon, and those in the charter boating business have had many years of experience to build their businesses on. Many services are offered the customer which are not available in the Great Lakes.

Early in 1973 the idea came to an advisory service worker in the University of Michigan Sea Grant Program: with similar resources to be harvested in Oregon and Michigan, and with different traditions in the methods of harvesting, the time seemed ripe for an exchange of ideas between the two fishing communities. Counterparts at the Oregon State University Sea Grant Program agreed. Michigan and Oregon charter boat captains agreed. And two tackle manufacturers, the Shakespeare Company and the Wright and McGill Company, not only liked the idea but generously supported financially an exchange of charter boat skippers between the Great Lakes and the West Coast.

Author Stephen Schneider, obviously enjoying his research, shows chinook salmon. Big fish like this have greatly increased Great Lakes sport fishing and brought back charterboats.



Returning from the Great Lakes, Capts. Gordie Simpson (Left) and Ted Bohlman (right) recount trip to Sea Grant Agent Al Otness of Oregon State University.

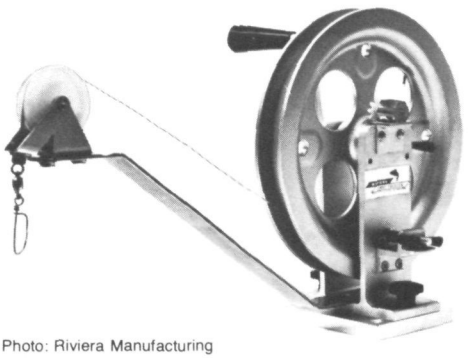
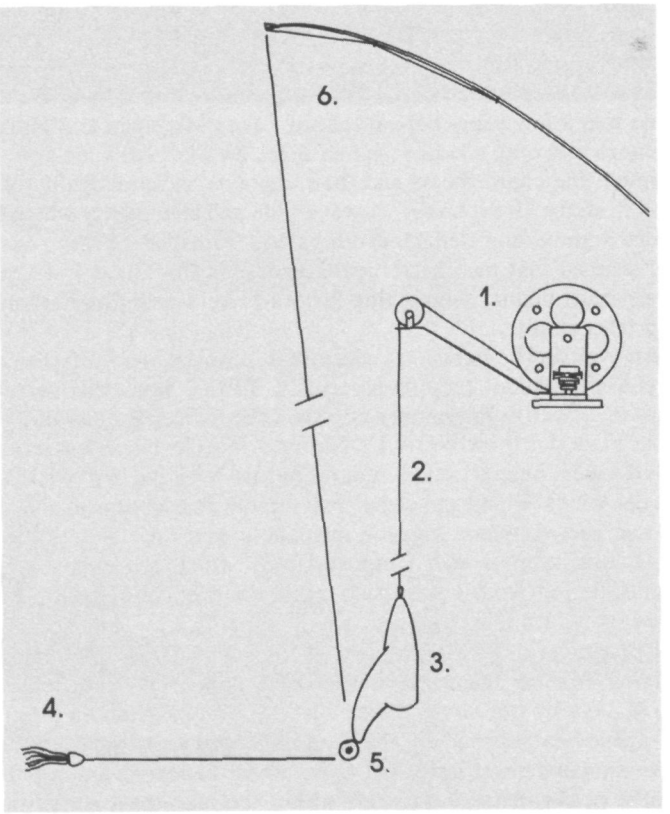
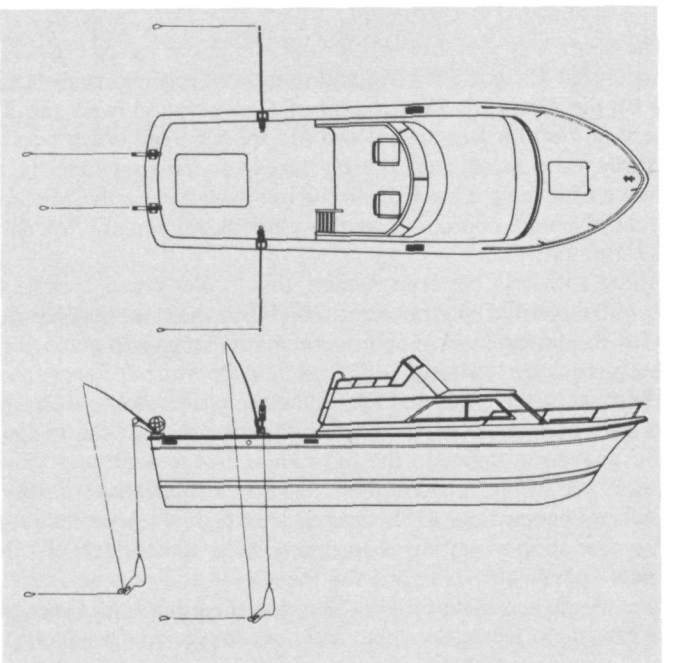


Photo: Riviera Manufacturing



Art: Riviera Manufacturing

Basic deep trolling system includes (1) deep troller, (2), line, (3), weight), (4) lure, (5) line release, and (6) fishing rod and line.



Two or more deep trollers allow fishing at different depths for different species. Several strikes at one depth indicate concentration of fish.

In the fall of 1973, three Oregon charter boat captains stepped off a plane at Traverse City, Michigan to begin a long week of fishing, crewing and skippering on Great Lakes charter boats. Don Christenson, operator of Sea Gull Charters at Newport, Oregon, was first off the plane, followed by Ted Bohlman, operator of Astoria Thunderbird Charters, and one of Ted's captains, Gordie Simpson. Each day started early, most about 5 in the morning, with a ride to a new boat, an introduction to another skipper, and a trip out into Lake Michigan to learn the ins and outs of this particular "fishing machine." The evenings were spent recapping the day's experience, with perhaps a discussion with a local equipment manufacturer about his brand of equipment. And then to bed, because they had to start off early the next morning.

The Oregon skippers were excited by what they saw and what they learned. The Michigan skippers had arrived at an innovative combination of equipment and method to effectively catch trout and salmon. Depth reading temperature sensors tell how deep the fish are likely to be. Downriggers put the lures at the correct depth. Sonar alerts you to the presence of fish, and even tells you what kind. And light rods and monofilament allow the customer to enjoy playing the fish once it is hooked.

As a result of this trip, the Oregon skippers vowed to return to Oregon and rig out their own boats with downriggers, sonars, and depth reading temperature sensors. And they promised the Michigan skippers just as rewarding a time when they traveled to Oregon the following spring.

The second part of the exchange, with Michigan skippers visiting Oregon, took place in June of this year. Captain Ben Seehock, President of the Michigan Charterboat Captains' Association, was accompanied by Norm Newman, President of the Michigan Steelheaders and Salmon Fishermen's Association, and Jim "Torpedo Lee"

Oregon fishing boat captains (from left) Ted Bohlman, Don Christenson and Gordie Simpson study equipment on Great Lakes skipper Jim Bennet's craft.

Hulet, a Shakespeare field tester. Their first taste of the might of the Pacific came when they motored out of Astoria, Oregon with Captain Ted Bohlman on the *Allegra*. The Columbia bar, that incredible welling of rough water caused by the meeting of Columbia River waters with Pacific ocean waters, must be crossed every day by Ted before he can get out to the fishing grounds. The Michigan skippers spent the day working Ted's equipment and learning about the amazingly rich fishery resource of those waters, and the evening evaluating the events of the day. The working arrangement that Ted's charter house has with a local motel, restaurant and marina was of particular interest. Side trips to a fish hatchery and a commercial canning operation, along with a fisheries laboratory and a fine marine museum highlighted the next day.

The following day they were able to inspect an operation that aroused considerable interest in all of them: they visited a small custom cannery, a service unavailable in the Great Lakes. The custom cannery will freeze, smoke or can the sportsman's catch so he can take it home ready to eat. The cannery will also trade the sportsman's catch for already canned salmon, and charter skippers keep a supply of cans on hand to trade with those fishermen who so desire. Only a small canning fee is charged for this service. The Michigan skippers determined to investigate the possibility of getting such an operation started in the Great Lakes upon their return.

Next on their agenda was fishing out of Newport, Oregon with Don Christenson. The bar is much less violent in Newport than it is in Astoria, and the weather that day was calm. The salmon were scarce, so experiments with various fishing methods began, Finally, bottom fishing was tried. The method seemed incredible to the Great Lakes skippers. You just lower a treble hook on a sinker to the bottom and jog it up and down. No lure, no bait, just the hook. Life is so abundant there that they were soon bringing in a variety of bottom fish, all of which tasted delicious when served up that evening.

On the last day before return, the skippers took a ride on a party boat for salmon out of Depoe Bay. The party boat left early, and was full. There were ten poles being trolled, which were kept from tangling by a complicated rig involving use of outriggers. The captain kept the boat in motion at all times, even when a fish was hooked, to avoid line tangling. The Michigan captains felt that the Great Lakes was not yet ready for this kind of operation.

In the analysis of the exchange, it was felt that the two fishery resources were not as similar as they seemed on the surface. Even though Oregon had provided the initial coho eggs for Michigan's planting in 1966, the fish seemed to have different habits in the Great Lakes than they do in the ocean. They certainly must be affected by the different food available, along with the other differences in their environment.

Along with the differences in the fish, the Great Lakes skippers noted the apparently richer fish resources in the Pacific. The Oregon Fish Commission maintains a much larger stocking program for salmon than does Michigan. But even without salmon, the ocean teems with catchable and edible life. The Michigan skippers decided to put most emphasis on their return to trying to establish some of the many support services for the business, such as the custom cannery, which had been established over many years on the coast. The Oregon skippers seemed most impressed with the effective combination of equipment and method which had been developed by the Michigan skippers, and are testing it on the Oregon coast.

The exchange was, of course, just the first step: the determination of which ideas were valuable to the other area. Sea Grant, with its charge of providing informal education to the water user, will continue to refine and disseminate this information for everyone's benefit. □

There's never a dull moment for

THE SURVEY'S TRAVELING SALESMEN

BY RAYMOND WILCOVE

In a typical year, the National Geodetic Survey will range over 80,000 square miles in 15 to 20 states, erecting as many as 400 tall portable towers in the process. In NOAA, geodesy is a major undertaking.

All the more remarkable, then, that a small team of six men paves the way for these Survey caravans, their wives and children, as they go about the business of measuring the earth we inhabit.

These roving ambassadors are split into four teams (G-31, 32, 33 and 34); they consist of Eugene Beauchamp and Verlin Novak; Jerry C. Layton; Charles J. Lesley; and Wesley O. Means and Daniel Frazier; and the entire Nation is their stamping ground.

Their task is reconnaissance. In the Survey, the are known as recon men.

When a decision is taken to survey a given area, the recon men advance the field party. They determine where surveys will be conducted and obtain the permission needed from property owners.

They are followed by the field foreman, who locates a trailer court or other accommodation where the party, its trucks and trailers can set up headquarters, arranges for a phone, opens a post office box, and starts negotiating with lumber and hardware stores where supplies will be purchased. Sometimes he talks to local school authorities about admitting the nomadic Survey children to their classes.

But where the field foreman goes, the recon man has been, soothing the irascible, pleading with the stubborn, persistently, patiently, and occasionally at the risk of life and limb opening the door for the party.

A recon team's first job is to study a map of the area, which could include several states, listing sites where bronze markers had previously been placed.

The survey team will probably remeasure some of the sites (this is known as "reoccupying" the station) so that the new survey can be properly referenced to the existing network.

The route will probably also include areas not previously surveyed and the recon team will then determine the sites to be measured. If the survey involves distance measurements (as distinguished from altitude), the team will also determine the size of the steel towers that will be erected to permit sighting over trees, hills and other obstructions and to compensate for the curvature of the earth.

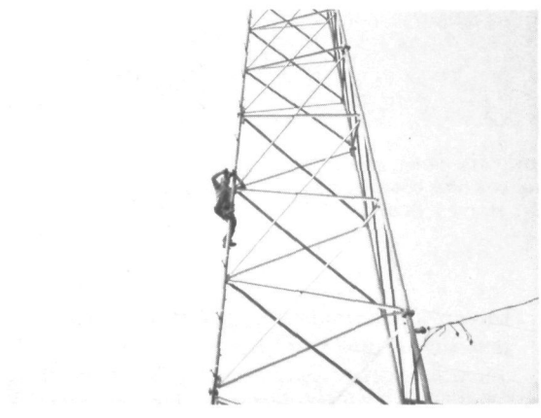
Upon arriving in the area, the team will probably visit the local courthouse and scrutinize the land records to determine the owners. An effort is made in picking the sites for measurements to utilize public land, such as national forests, parks and schools, but in many instances this is not available and the work must be done on private property. When this is so, the recon men must visit the owners and obtain their permission for the survey party to work on their land.

In a majority of cases, this poses no problem. In the west, with its wide open spaces, Lesley estimated that 99 percent of the property owners give their consent. But in the more populous areas, in the east and







(From left to right, top) Digging for station mark at Mound 1883. Old station mark at Mound 1883. Top part with inscription has broken off, but underground mark is undamaged. (Center) Recovering reference mark at station Mound 1883. Sighting visible objects to determine height of tower. Cross taping to locate mark. (Below) Checking station on map. Tower is up!

in urban centers like Chicago, Los Angeles and Seattle, about five percent refuse and another 15 to 25 percent "give us a hard time before we can convince them."

This is when diplomacy, persistence and tact are required. The recon men must convince the property owner that it's in his interest to have a marker on his property or, if that fails, to appeal to his sense of duty or patriotism. Quite often the latter is quite effective. "Many people like to think they're doing something for their country," said Lesley.

Not all difficult cases are found in populous areas. There was the time a recon team went to see a property owner in a rural area of Tennessee and found him sitting on his porch with a rifle in his lap. Another government agency was trying to expropriate his property for a reclamation project and "he wasn't about to let them do it."

"We approached him cautiously," recalled Lesley, "and told him, 'We'd like to talk to you.' "

"You from those reclamation people?" he asked belligerently.

"No, sir," we replied. "(You've got to be polite)."

"What do you want to talk about?"

"We told him and he motioned us forward with his rifle."

"We were about 10 feet from him when he barked, 'That's far enough.' "

"He was a hard customer," remarked Lesley. "but after we explained what we wanted, he agreed and we all ended up drinking iced tea together."

Many owners expect to get paid for the use of their land. Their attitude is similar to that of the man in Ohio who said, "Everyone else is getting something from the government, so why shouldn't I?"

When the recon man explains that the party is not authorized to pay for the use of property, the answer may be a firm 'no.' That's when the recon men use their powers of persuasion. "They'll listen for a while," said Lesley, "but they're really not interested. They'd rather tell you about their problems than listen to yours, like their taxes and inflation. We listen and once they get that off their chests, they often change their minds."

Sometimes, but not often a property owner will volunteer the use of his land, as once occurred in Nebraska. The recon party had selected a site for a marker on an adjoining property. As the survey party began digging a hole for its survey monument, he approached and inquired, "you digging for gold?"

When they explained, he told them, "You're wasting your time; they're building a road through here in about a year," and invited them to put their marker on the front lawn of his home. Later, when an azimuth mark had to be installed, he invited his friends over to watch the team make its star observations and they all ended up in his house for refreshments

Another property owner invited a party in for a cold beer on a particularly hot evening. They gratefully accepted. "But he

Lonely as a cloud, one of the traveling Surveymen gazes out over wide open spaces from vantage point atop his truck.

used a trick glass," recalled L. Gilbert Burdine, "and when I lifted it to my lips expecting a nice long refreshing drink, all I got was enough to wet my whistle."

Some property owners, especially farmers, object to survey parties on their land because of possible damage to farm equipment striking the bronze markers and the cement posts on which they are fastened. In such cases, the marker is placed underground, sometimes as much as 14 inches, with directional finders (reference points) some distance away near the edge of the property where they do not interfere with the plowing.

Others object to having towers erected on their property, pointing out they could be liable for damage suits if someone climbed a tower and fell off. In these instances, the party is authorized to offer insurance, at no cost to the property owner, usually up to $100,000, against damages. One farmer wanted to be insured for $1,000,000, but finally settled for $300,000. The policies are furnished under a blanket agreement between the National Geodetic Survey and an insurance firm. The premiums are low, for very few accidents of this nature occur.

In contrast to those who object, Lesley recalled the man who was eager to have a tower erected on his land. It turned out that he was a ham radio operator and wanted to test his antenna atop a tall tower. The antenna worked just fine and he said he would like to buy the tower, but the party wasn't selling.

A property owner often objects to having a party on his land because of possible damage to his crops and other vegetation from the heavy trucks and tractors the parties use to transport their equipment. To cope with this, each party is authorized to pay for the damage it causes. One farmer, when he heard what the party was prepared to pay to drive through his stand of corn, volunteered to drive his own horse and wagon through his corn crop.

On another occasion, a man in Putnam County, N.Y., made them this proposition: cut a 20-foot-wide swath up a half-mile stretch of a mountain so he could drive his jeep there and they could erect their tower. They agreed. "There weren't many trees and with a chain saw it didn't take us long," explained Lesley. "We have to be flexible if we're to get our work done."

At times, preparations made by a recon party fall apart when the survey party arrives and through no fault of its own. it happened in Missouri. Permission had been received to erect a tower, but after it was erected, the owner changed his mind and demanded it be taken down. The tower was torn down the next day.

There are other surprises, the four-legged kind, like the bear that treed a recon man in Alaska. "I didn't know what his intentions were," explained the surveyman, "and I didn't wait to find out." It wasn't until after he'd clambered into the tree that he suddenly realized that bears also climb trees. Fortunately, the grizzly lost interest.

And then there are dogs. "When we arrive at a place in our truck and find it guarded by a dog, we just honk our horn and wait for the dog's owner to come out," said Beauchamp. "If he doesn't, we may call him on the phone, if he has one, or come by again. But one thing we're not about to do is tangle with his dog."

There are also the kind that slither along the ground, like alligators and crocodiles. One man had his leg crushed years ago in the Philippines by the jaws of a crocodile.

The recon men like to deal with men rather than women, but deny it has anything to do with male chauvinism. "We try not to deal with the wife," explained one, "because if she gets our message garbled, her husband may just say 'no' and not even give us a chance to explain."

Balancing the scale, a wife recently proved a great help when her husband was recalcitrant. They found the husband in the field where his wife had directed them. He said he'd have to think it over, to come back tomorrow. But the next day he hadn't made up his mind, so they returned still again. He was still mulling it over when they left, somewhat discouraged. As they passed his house, his wife emerged, curious over the repeated trips to see her husband

"Why," she explained, "he doesn't even own that piece of land. It's mine. You go ahead and use it."

Recon parties have to exercise extra caution around tax time. Rodney Lee recalled that in Tracy, California, a recon party had gotten permission from a power company to use the land. But it turned out that the company only had a right of way through the property and the owner had not been consulted.

"When the survey party arrived, he ran them off his property," related Lee. "He was already sore at the government because of the taxes he had to pay. Since he had a gun, they didn't argue with him."

The party escaped unscathed. But others have not been that fortunate. In the 167-year history of the Survey there have been those who, in the line of duty, took with them a load of buckshot as they fled a wrathful property owner. And there were two who almost had their heads blown off when they stumbled accidentally on a still and were mistaken for revenue agents.

It is not by chance that the survey holds in high esteem its unusual traveling salesmen.

WESTFIELD STATION

RECONNAISSANCE PARTY G–31
Old descriptions for station WESTFIELD 1875, 1891 and 1935 which will be used again to build a tower; permission having been granted by Mr. C.M. Bacon, a descendant of the original owner who gave his assent to establish a station in 1875.

Book 279 Page 10

WESTFIELD Middlesex County, Conn., R.E.H., 1875., W.C.H., 1891.

Station is on a bare hill commanding a fine view of the country to the eastward in NW part of Middletown Township., 3 miles west of and adjoining lands owned by Ebenezer Bacon, whose house stands at the bottom of the hill, NNW from the station, on the road by which the station is reached. Hill slopes evenly in all directions. A stub with nail in top is driven into the ground by the fence at a distance of 14 feet 8 inches from the station. Station was marked by a rock some what oval in form buried 2 feet below the surface of the ground. The rock is about 18 inches by 12 inches with gently rounded surface. Center marked by a drill hole 1 inch deep. The drill hole was surrounded by a triangle. At surface station is marked by stub and copper tack.

In 1891 some difficulty was experienced in recovering this station, all surface marks having disappeared. To aid in its future recovery distances were measured to a number of trees. From station, which is 13.25 feet W of a N-S fence, to an old apple tree which is 103.5 feet W from this fence (at point N of station), 381.6 feet, to a hickory tree SE of apple tree, 283.7 feet, to hickory tree S of W 153.75 feet, to another hickory tree S of first, 156.0 feet, to another still farther S 166.75 feet, to an apple tree, SW 178.4 feet, to another apple tree NE of preceding one 141.0 feet, to another apple tree just E of the preceding one, 132.25 feet, to another apple tree just E of the preceding one, 13.75 feet W of fence, 128.5 feet. This last tree is 33 feet N of a fence running E from a N-S fence, which is 191 feet N of a fence running W from the N-S fence.

Book 279 Page 10

WESTFIELD Middlesex County, Conn., R.E.H., 1875., Recovery by G.C.M., 1935.

The station was recovered as described and remarked as follows: A standard disk was set in the drill hole in the boulder and lowered 18 inches for a sub-surface mark. A standard mark was set in a 12 by 12 inch square top concrete post flush with the ground. Reference mark No 1 is a standard disk set in the top of a 12 by 12 by 30 inch concrete post flush with the ground N 85° W of the station. Reference mark No 2 is a standard disk set in the top of a 12 by 12 by 30 inch concrete post flush with the ground near the fence N 10° E of the station. All marks are on the property of Mr. C.M. Bacon, who lives in the old Bacon Homestead. The homestead has been in the Bacon family for eight generations.

The station is reached from the Main Street in Middletown, go westerly on Washington Street Route 14 for 0.4 mile, turn right on Route 72 (Berlin Road), go 0.75 mile to Westfield Street, go westerly on Westfield Street for 2.0 miles. The station is on the bare hill ¼ mile to the south of this point.

Object	Distance Meters	Direction
HOFFMAN (Middletown)		00° 00′ 00.0″
CATHOLIC CH		60 10 31
R M NO 1	20.66	243 48 41
R M NO 2	24.54	344 28 21
R M NO 1 to R M NO 2	34.86	

(Left) Mr. C.M. Bacon and Eugene A. Beauchamp of the National Ocean Survey with map showing the location of the station on Mr. Bacon's land. (Above) Mr. C.M. Bacon, 67 years old, holding grandson Jamie, seven months old. Jamie will be the tenth generation living on the old homestead.

Little known, seldom eaten, but caught in vast numbers—lowly menhaden is

The Fish of a Thousand Uses

BY JACK GUINAN

What is the fish that U.S. fishermen catch in greater numbers than any other?

Answer: The menhaden.

The what?

That might have been a quiz show reaction, though it wasn't. Because the menhaden is one of the least known but most abundant fish in the ocean, making up about 40 percent of the volume of total domestic catch of fish and shellfish in 1973—nearly 2 billion pounds were taken by U.S. fishermen out of a total catch of about 4.7 billion pounds.

The reason few Americans have even heard of it doubtless is because very little is eaten in its original form. Most of the menhaden catch goes into industrial products of various sorts. But so important is the species that the late Rachel Carson, while an employee of the U.S. Fish and Wildlife Service, once wrote that 'almost every person in the United States has at some time eaten, used, or worn something made from menhaden."

Depending on where one lives along the Atlantic or Gulf coasts, where the fish are most abundant, the menhaden may be known, among other names, as pogy, mossbunker, or fatback. A prominent fisheries scientist (Goode) who studied menhaden soon after the Civil War estimated that there were at least 30 common names by which this fish was known. Scientists know the Atlantic menhaden as *Brevoortia tyrannus*, and the Gulf species as *Brevoortia patronus*.

Dr. Goode also said on one occasion that "the menhaden's place in nature is not hard to surmise; swarming our waters in countless myriads, swimming in closely packed unwieldy masses, helpless as flocks of sheep, near to the surface, and at the mercy of every enemy, destitute of means of defense and offense, their mission is unmistakably to be eaten."

Menhaden make a valuable contribution to our economy. The products for which it is used include fish meal, oil, and solubles—products that are used in dozens of ways. The fish meal is high in protein, minerals, and other essential nutrients, and is an excellent additive in poultry rations and for feeding hogs and other animals. The oils and solubles are used in manufacturing paints, resin, lubricants, caulking compounds, soaps, cosmetics and other pharmaceuticals, and even for tanning leather. Thus menhaden is a source of employment for thousands of people, not only on the vessels and in the plants where the fish are processed, but in virtually hundreds of related industries.

History tells us that American Indians taught early settlers to place a fish in each hill of corn. In fact the name menhaden comes from "munnawhatteaug", a Massachusetts tribe word meaning "that which fertilizes." It is not known whether all settlers followed this practice, but the information did lead to using menhaden for soil enrichment when crops became poor. The use of menhaden as a fertilizer was the first stage in the development of the fishery that was to become the largest in volume in North America.

Menhaden is one of the numerous members of the herring family, as are Maine sardines, shad, and alewives. The menhaden's extreme oiliness and many small bones prevented the species from reaching popularity as a table fish, although an attempt was made during World War II to process and can menhaden as a food fish for humans. This did not develop as hoped, but the value of the fish meal today is so important to our poultry industry that this fish can be regarded as just about one step removed from the chicken and eggs on our tables. When you eat poultry raised by using fish meal additives you are in a sense consuming a little menhaden too.

Fishing seasons vary according to the area. The summer season along the Atlantic runs from early May through October, while the Atlantic winter season extends from November until about mid-January. On the Gulf coast, the menhaden fleet begins operations in April and usually ends the season in early October.

Menhaden vessels are easy to distinguish because of their size and distinctive appearance. They range from about 85 feet to 200 feet long and are built of wood or steel and range from 50 to 700 tons. Previously a towering mast topped by a crow's nest was used to scan the seas for menhaden, but in recent years nearly all sighting is done from spotter planes. The location and direction for setting the net are given by radio. The catch is stored amidships with the aft built low to facilitate launching and retrieving two smaller "purse boats." These are about 30 feet long, diesel powered, and carried in davits (curved uprights which extend over the side of the larger vessel.)

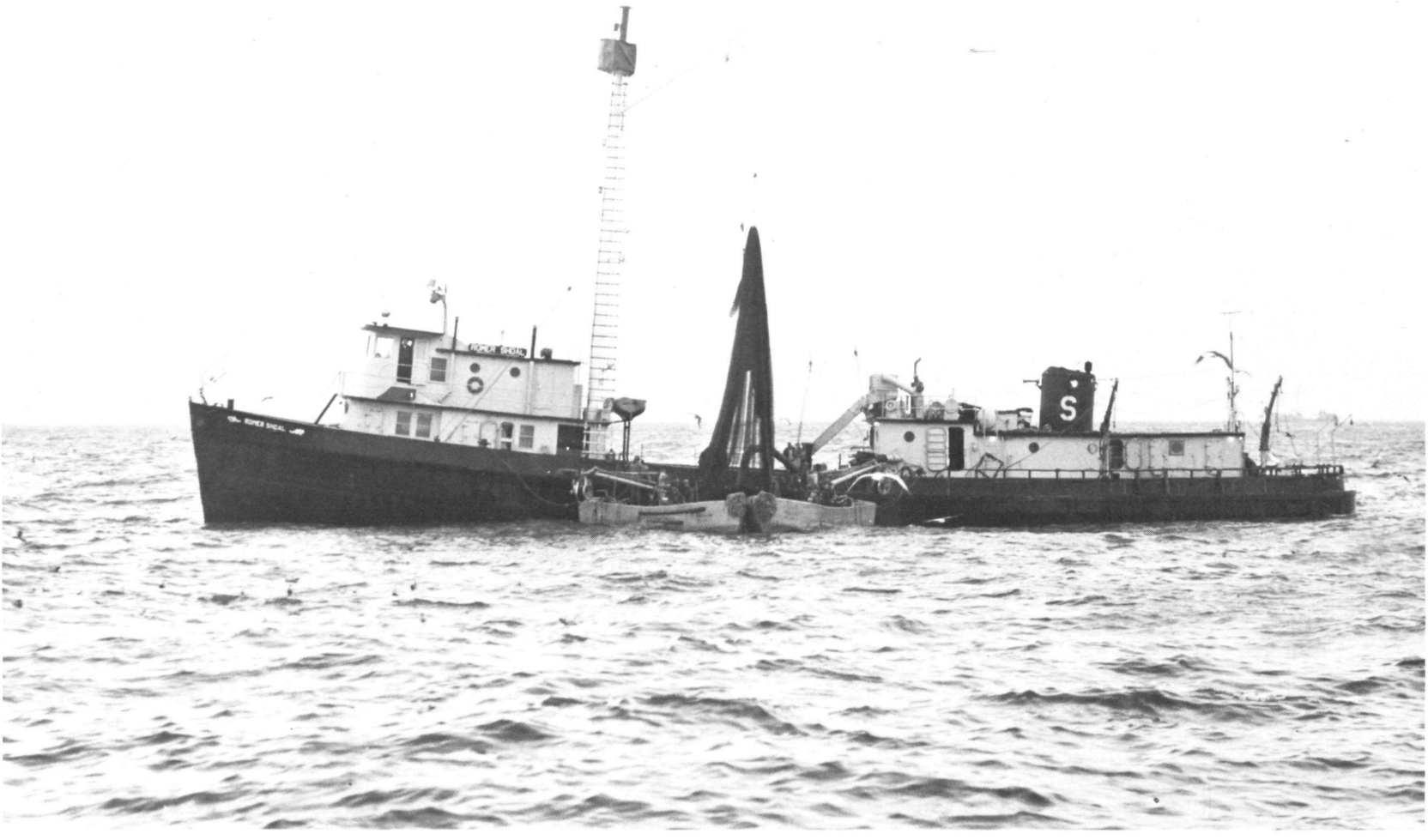
The crew of an average menhaden vessel consists of a captain, mate, pilot, engineer, cook, and about 10 net handlers.

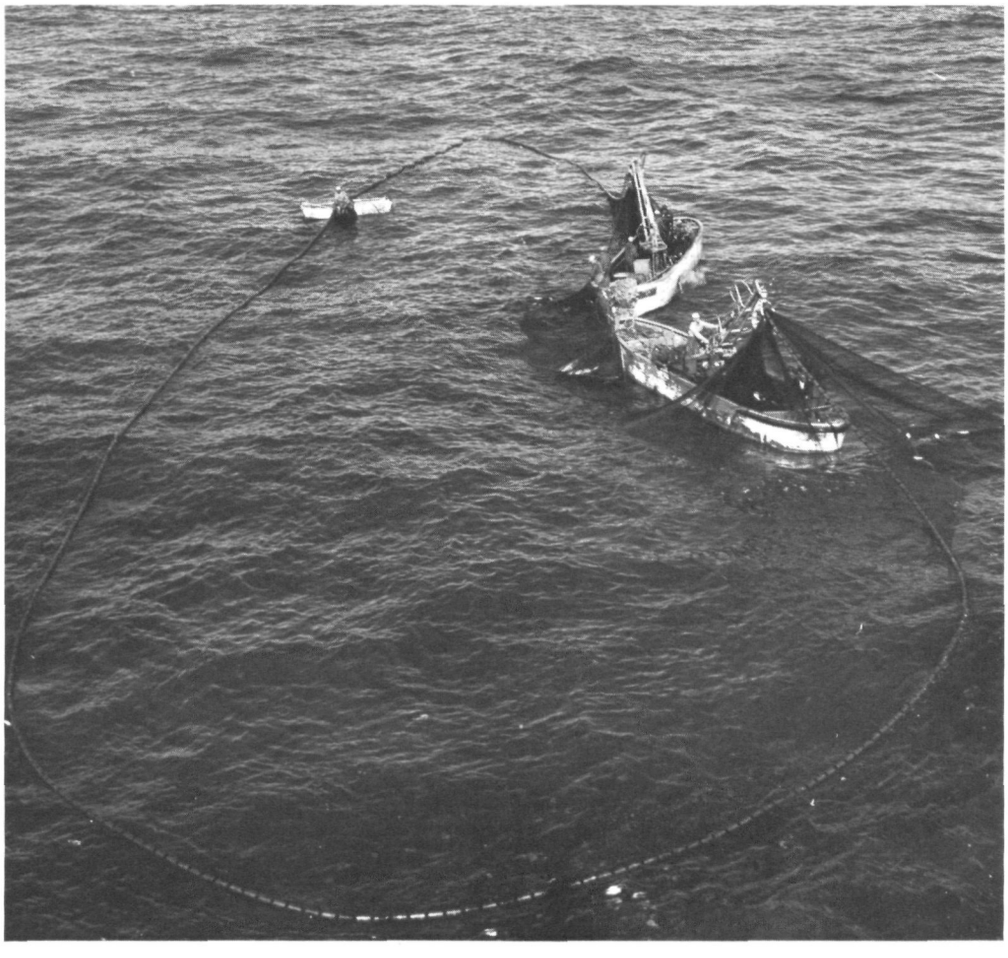
The vessels usually go out before dawn, guided to the fish by pilots in spotter airplanes, which have been widely used throughout the industry since about 1946. The menhaden fishery is conducted close to shore, with most of the catch being taken less than 10 miles from shore.

When the captain feels that a school is large enough, he orders the purse boats lowered. These boats get their name from the purse seine that they carry—huge nets that have been used in the menhaden fishery since about 1850. The net is equally divided between the two smaller vessels which are lashed together as soon as they are launched. The purse vessels move to the school of fish, separate, and swing into a big circle, surrounding the fish. The top of the net is equipped with floats, while the bottom is weighted with lead and brass rings. When the purse boats meet at the far side of the school, the ends of the seine are made fast, and the bottom is drawn together by means of a rope passed through the brass rings. This pursing effect traps the fish in the bowl shaped net.

The expensive nets, some 1200 feet long and about 60 feet deep, can encircle an area the size of two football fields. Nets are sometimes damaged when sharks are caught with the menhaden and cut their way loose. Other than the unwanted intruding sharks, the nets seldom bring up anything but the surface feeding menhaden, which aren't as speedy as the game fish that swim away before the purse is closed.

Formerly the men sang in rhythm as they pulled in the net to concentrate the fish in





Top, a menhaden carrier vessel pumps fish into hits hold. Two purse-seine craft lie alongside. Net is hauled up to concentrate fish for pumping. At left and directly above, purse-seine boats at work.

U.S. FISH CATCH

	All Fish and Shellfish	Menhaden
1964	4,540,622	1,569,965
1965	4,776,766	1,726,089
1966	4,365,894	1,307,710
1967	4,054,557	1,163,708
1968	4,159,702	1,375,100
1969	4,336,803	1,545,529
1970	4,917,220	1,837,493
1971	5,017,999	2,196,029
1972	4,710,400	1,938,767
1973	4,732,100	1,890,347

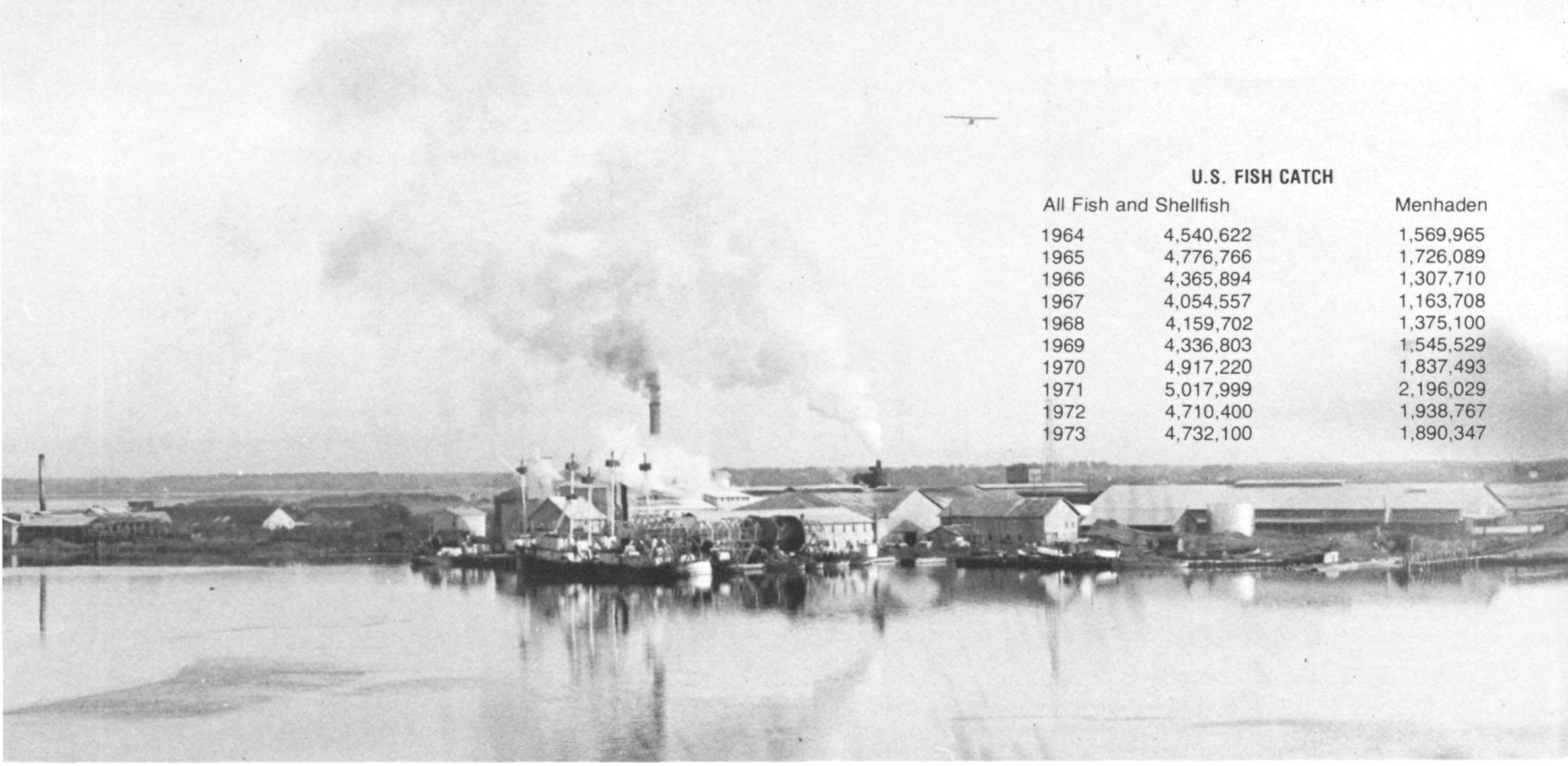


Photo: Bob Williams

From the menhaden vessel, the catch is transferred to reduction plants such as the one at Beaufort, N.C., (top). Above, an unloading hose from the plant is attached to a purse seiner's hold pipe through which a slurry of menhaden and seawater will be pumped ashore.

the "bunt" or stronger part of the seine. In recent years hydraulically powered blocks, one in each purse boat, hauled the surplus net into the boat to concentrate the fish.

Eventually the captain gives the signal which brings the mothership to the purse boats. Part of the seine is secured to the larger vessel with the purse boats moored in such a way that the three craft form a triangle. The fish are pumped from the net into the hold of the carrier vessel and the excess water goes overboard. Prior to 1950 the fish were "brailed" from the net to the hold with a huge dip net.

Each complete operation—from the sending out of the purse boats to loading the fish aboard the larger vessel—is known as a "set." In an average day a menhaden vessel makes from three to six sets, depending on the size of the schools of fish and the success of the fishermen in capturing them. When the vessel is loaded and the trip to the processing plant begins, the nets are washed with brine to help prevent deterioration.

To unload menhaden vessels, the holds are partially flooded with sea water, and the fish and water are pumped into the plant for processing. After steam cooking, the fish are pressed to yield a solid cake and liquids. The solids are dried and ground to form fish meal, and the liquids are centrifuged yielding oils. The remaining water contains soluble proteins and is called stickwater. The stickwater is then concentrated forming solubles that look like molasses, are rich in protein and are also used in animal feeds.

The Gulf menhaden is a smaller fish than the Atlantic species and has a shorter life span. The average Gulf menhaden usually weighs less than half a pound, and is fewer than three years old. The Atlantic menhaden may live seven or eight years and weigh nearly two pounds.

NOAA research on menhaden is done primarily at the NMFS Atlantic Estuarine Fisheries Center, Beaufort, North Carolina, where the species has been studied for many years in cooperation with the menhaden industry and others, including universities, having an interest in the resource. Information on the life history, migrations, growth, and mortality has been gathered, as well as studies conducted as to the causes of fluctuations in abundance. Techniques also have been developed for predicting the density of populations of menhaden.

Schooling is an outstanding behavior characteristic of menhaden that seems innate from the very young to old age. Menhaden school according to their size and the number of fish in a school varies greatly. Purse seine fishing depends almost entirely on sighting of surface schools from airplanes. The average catch per set differs from area to area, as does the average size of the fish in the school. If the mean fish weight for each area is used to calculate the numbers of fish in an average sized school, the numbers range from 50,000 in the North Atlantic area to nearly 200,000 in the North Carolina fall fishery.

Since the fisheries service began a formal menhaden research program at Beaufort in 1955, reports of mass mortalities have been received each year. The apparent causes of death include: capture in a net that failed to hold the catch, near freezing temperatures in estuaries and the lower reaches of tributaries, low dissolved oxygen, and pollution by industrial wastes or chemicals.

In some ways the menhaden fisherman could be described as a "farmer of the sea." His vessel is his tractor, the purse seine is his combine, and the endless oceans are his fields. His catch brings millions of people healthier, happier, and more productive lives.

Sea Fare

In The Oven

Baking is one of the easiest and most elegant ways to cook fish, but it is overlooked by many homemakers.

A whole baked fish can be highly decorative, presenting the fish in all its glory. Steaks, fillets, portions, and sticks may be baked in equally interesting dishes wth a myriad of sauces, seasonings, and stuffings. Canned crab, tuna, salmon, sardines, or shrimp lend themselves to fix-ahead casseroles, salads, and sandwiches.

Follow a few simple rules for tasty baked fish—keep the fish moist and flavorful with a sauce or topping; bake in a moderate oven; and do not overcook.

The flesh of fish is tender and does not require a long cooking period. Fish is cooked properly when these signs appear—the flesh loses its translucent appearance and becomes opaque; the juices are milky colored; and the flesh is easily pierced with a fork and will separate into flakes. Always place the fork in the thickest part of the flesh, where it takes the longest to cook. Overcooking fish will toughen the flesh, dry it out, and impair the flavor.

The National Marine Fisheries Service's National Consumer Educational Service suggests that garnishes and vegetables for seafood menus be selected with an eye to adding nutrition and variety through contrasts in color, flavor, and texture. Some lively companions for seafood entrees include:

Canned pineapple slices, drained, topped with little haystacks of coleslaw.

Celery sticks stuffed with cheese.

Cucumber slices, fluted and sprinkled with tarragon vinegar.

Grapefruit sections dusted with paprika.

Lemon, lime, or orange slices sprinkled with minced pimiento, parsley, or green pepper.

Thick tomato slices topped with pickle relish or with thin lemon slices topped with slice of stuffed olives.

Vegetable	Combine with One or More
Beans, snap	Mushrooms, onions, tomatoes, celery, bacon, almonds.
Carrots	Peas, onions, celery, lima beans, apples.
Corn	Tomatoes, eggplant, green peppers, lima beans, bacon.
Peas	Carrots, onions, celery, potatoes, mushrooms.
Tomatoes	Beans, onions, corn, eggplant, green peppers, okra.

SALMON STEAKS WITH APPLE SLICES

2 pounds salmon steaks (½ to ¾-inch thick) fresh or frozen
1 teaspoon salt
⅓ cup chopped onion
¼ cup melted margarine or cooking oil
2 tablespoons flour
1 can (12 ounces) apple juice (1½ cups)
1 tablespoon lemon juice
¾ teaspoon ginger
¼ teaspoon leaf thyme
1 large red apple
1 teaspoon sugar

Thaw frozen steaks. Sprinkle with salt. Arrange in shallow 2-quart baking dish.

Cook onion in 2 tablespoons margarine or cooking oil until tender, not brown, in small saucepan. Stir in flour. Add apple juice, 2 teaspoons lemon juice, ½ teaspoon ginger, and thyme. Cook, stirring constantly, until sauce is thickened. Pour over steaks. Bake in moderate oven, 350° F., 30 minutes or until fish flakes easily when tested with a fork. Slice apple into 12 even wedges. Heat apple slices in remaining 2 tablespoons margarine or cooking oil, turning once. Sprinkle with sugar and remaining 1 teaspoon lemon juice and ¼ teaspoon ginger. Heat and turn just until apples are tender. Serve on salmon steaks. Makes 6 servings.

BAKED SALMON WITH PICKLE STUFFING

3 to 3½ pound chunk salmon or other firm fish, fresh or frozen
Salt
Pepper
2 tablespoons melted margarine or cooking oil

Thaw frozen fish. Clean, wash, and dry fish. Sprinkle inside of fish with salt and pepper. Place fish on a well-greased bake-and-serve platter, 18 by 13 inches. Brush fish with melted margarine or cooking oil. Bake in a moderate overn, 350° F., for 45 to 60 minutes or until fish flakes easily when tested with a fork. Makes 6 servings.

Note: A whole, dressed salmon or other firm fish, fresh or frozen (approximately 3 to 3½ pounds) may be substituted, if desired..

PICKLE STUFFING

1 quart dry bread cubes
⅓ cup butter or margarine, melted
¼ cup sweet pickle relish
¼ cup chopped onion
2 tablespoons lemon juice
2 tablespoons chopped parsley
1 teaspoon salt
Dash pepper

Combine all ingredients. Makes approximately 1 quart stuffing.

FISH FILLETS WITH CRANBERRY-ORANGE SAUCE

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

Thaw frozen fish. Cut fillets into 6 portions. Cook celery and onions in a 10-inch fry par in 4 tablespoons margarine or cooking oi until tender but not brown. Stir in bread cubes, pecans, ¼ teaspoon salt, orange rind, and orange juice. Turn stuffing into well-greased baking dish, 12 by 8 by 2 inches. Arrange fish in a single layer on stuffing. Drizzle remaining two tablespoons melted margarine or cooking oil over fish. Sprinkle with 1 teaspoon salt. Bake in a moderate oven, 350° F., 25 to 30 minutes or until fish flakes easily when tested with a fork. Serve with Cranberry-Orange Sauce. Makes 6 servings.

Cranberry-Orange Sauce

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

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

FLOUNDER ROLLS WITH CARROT STUFFING

2 pounds Flounder or Dover or English sole fillets (6 to 8 fillets), fresh or frozen
1 teaspoon salt
⅛ teaspoon white pepper
2 cups finely shredded carrot
¼ cup finely chopped onion
¼ cup butter or margarine
2 tablespoons chopped parsley (optional)
1 can (10½ ounces) condensed cream of celery soup
1 can (4 ounces) sliced mushrooms, drained
2 tablespoons lemon juice

Thaw frozen fish. Sprinkle fillets with salt and pepper. Saute shredded carrot and onion in butter or margarine until onion is tender, but not brown. Stir in parsley (if desired). Spread an equal amount of carrot mixture over each fillet. Roll up and secure with metal skewers or wooden picks. Combine soup, mushrooms, and lemon juice; mix. Pour into a shallow 1½ quart baking dish. Arrange rolls in soup mixture. Bake in a moderate oven, 350° F., about 30 minutes or until fish flakes easily when tested with a fork. Spoon sauce over rolls several times during cooking. Makes 6 to 8 servings.

BAKED SALMON-RICE SALAD

1 can (1 pound) salmon
2 cups cooked rice
1 cup thinly sliced celery
½ cup chopped parsley
¼ cup sliced pitted ripe olives
½ cup mayonnaise or salad dressing
2 tablespoons French dressing
2 tablespoons lemon juice
1 teaspoon curry powder
2 tablespoons mayonnaise or salad dressing
Paprika

Drain and break salmon into large pieces. Combine rice, celery, parsley, olives, and salmon. Combine mayonnaise, French dressing, lemon juice, and curry powder. Add mayonnaise mixture to salmon mixture; toss lightly. Place in 6 well-greased 6-ounce casseroles or custard cups. Top each with a teaspoon of mayonnaise. Sprinkle with paprika. Bake in a hot oven, 400° F., for 15 to 20 minutes or until heated. Serves 6.

FISH PORTION WITH SHRIMP SAUCE

12 frozen fried fish portions (3 ounces each)
6 ripe tomato slices, cut in half
Salt
6 process American cheese slices, cut in half
1 can (10½ ounce) condensed cream of celery soup
1 can (4½ ounce) tiny shrimp, drained
¼ cup milk
1 tablespoon lemon juice
1 tablespoon chopped parsley

Place frozen fried fish portions in single layer on well-greased baking sheet, 15 by 12 inches. Bake in hot oven, 400° F., for 15 to 20 minutes or until heated through and crisp. Place tomato slices on a second baking sheet; sprinkle lightly with salt. Add tomatoes to oven 5 minutes before fish is done. Place a half slice of cheese crosswise on each fish portion; return to oven just until cheese melts. Top each portion with a half tomato slice. While fish is heating combine and mix soup, shrimp, milk, and lemon juice. Heat and stir in parsley. Serve over fish portions. Makes 6 servings.

Note: If desired, a can of condensed cream of shrimp soup may be substituted for the cream of celery soup and the can of tiny shrimp.

SCALLOPED OYSTERS WITH CORN

2 cans (10 ounces each) frozen oysters
1 can (1 pound) cream-style corn
1 egg, beaten
¼ cup chopped pimiento
1 teaspoon Worcestershire sauce
½ teaspoon salt
⅛ teaspoon pepper
¼ cup sliced green onion
⅓ cup margarine or cooking oil
2 cups coarsely crushed soda crackers
2 tablespoons chopped parsley

Defrost and drain oysters. Combine and mix drained oysters, corn, egg, pimiento, Worcestershire sauce, salt, and pepper. Saute onion in margarine or cooking oil until tender. Stir in cracker crumbs and parsley. Arrange 3 layers of cracker mixture and 2 of oyster mixture in buttered 1½ quart casserole, starting and ending with a layer of creackers. Bake in moderate oven, 350° F., 30 minutes or until heated thoroughly and oysters are cooked. Makes 6 servings.

WEATHER SERVICE REVAMPS HEADQUARTERS OPERATION

The National Weather Service has reorganized its headquarters operation.

An Office of Technical Services has been established by grouping divisions which have provided services to all NWS areas. Included are the Engineering Division and the Test and Evaluation Laboratory from the Systems Development Office; the Communications and Data Acquisition Divisions from the Office of Meteorological Operations; and the Data Systems Division from the Office of Hydrology.

The OTS will oversee policies and procedures for the acquisition and communication of oceanic, meteorological and hydrological information; and the procurement, test and evaluation, installation and maintenance of meteorological, hydrological and oceanic equipment. Merritt N. Techter has been named Acting Associate Director.

The Office of Meteorological Operations has been renamed the Office of Meteorology and Oceanography, and combines the Office of Oceanography with the responsibility for marine weather forecasting. Karl R. Johannessen heads the office.

The Systems Development Office, with Dr. William H. Klein as Acting Director, has four divisions: the Techniques Development Laboratory, Systems Design and Experiment Division, Systems Integration Division, and Equipment Development Laboratory. The SDO has primary responsibility for development of the Automation of Field Operations and Services Program, among other tasks.

The following Acting Chiefs of Divisions or Laboratories have been appointed by Dr. George P. Cressman, NWS Director: Office of Meteorology and Oceanography—*Meteorological Services Division*, Dr. Harry P. Foltz; Ocean Services Division, Max W. Mull; Space Operations and Support Division, Kenneth M. Nagler: and Overseas Operations Division, John C. Straiton.

Office of Technical Services—Engineering Division, J. Michael St. Clair; Communications Division, James R. Neilon; Data Systems Division, Tillman F. Gladney; and Test and Evaluation Division, William E. Eggert.

Systems Development Office—Techniques Development Laboratory, Dr. William H. Klein; Systems Design and Experiment Division, Russell G. McGrew; Systems Integration Division, Robert E. Johnson; and Equipment Development Laboratory, James A. Cunningham.

Tomorrow's Weatherman will use all-electronic system for forecasts. Computerized data-handling with TV-type displays will greatly speed the job. Dean Costantinou tries out forecaster's console in automated facility at Weather Service Headquarters.

Fish Plants Given New NOAA Inspection

NOAA is offering fish processing plants a new kind of inspection service in which the processing plant itself is the target of inspection, rather than the food items produced.

The service, rendered by the National Marine Fisheries Service, is expected to benefit both manufacturers and consumers of seafoods. It was established partly in response to many requests from owners and operators of processing facilities. Heretofore, plant inspection was available only as a part of the more comprehensive (and more expensive) *product inspection service* offered by NMFS.

NMFS will help fish processing plants establish and maintain satisfactory levels of plant sanitation and hygienic practices that will facilitate the production of clean, safe, and wholesome seafoods. The inexpensive service is being made available on a voluntary, fee-for-service basis and entails inspection of plants only, unless the processor desires inspection and certification of fishery products as well.

When a request for the "Sanitarily Inspected Fish Establishment Service" is received from a seafood company, a member of the NMFS Fishery Products Inspection and Safety Program, working with plant personnel, will conduct sanitation surveys designed to pinpoint the strengths and weaknesses of the facility and processing system under scrutiny, and present a proposal for any necessary improvements in hygienic conditions and practices.

Once the weaknesses have been eliminated, a brief visit will be made to the plant by an NMFS inspector once or twice a week.

When all minimum sanitary requirements have been met, the NMFS awards a plaque to the company, attesting to the fact that its plant facilities and operating practices are capable of producing clean and safe fishery products. The name of the processor is then included on a list of commercial seafood producers that are sanitarily inspected and approved by the Federal Government. The list is published once every three months, with updating and amendments each month, in the NMFS "Guide to Federally Inspected and Approved Fish Establishments and Products." Such listings are widely distributed and recipients include many potential buyers such as schools, cafeterias, restaurants, and food chains.

If a fish processing plant becomes unable to meet the sanitary inspection requirements and is unwilling to correct deficiencies, it must return the NMFS certificate of approval.

Environmental Data Obtained By Pacific Buoy

An advanced environmental data buoy for automatically gathering meteorological and oceanographic data from the marine environment has been deployed in the Pacific Ocean approximately 300 nautical miles west of Astoria, Oreg. The 35-ton buoy was anchored in almost two miles of water.

The buoy, designated EB-02, is the first to be deployed in the deep ocean off the Northwest and will provide meteorological data to the National Weather Service for dissemination over U.S. national and the worldwide environmental data networks. EB-02 joins another large environmental data buoy (EB-03), located in the Gulf of Alaska, that has aided weather forecasting for Alaska and the west coast of North America by transmitting meteorological information from its ocean station 175 miles (280 kilometers) southeast of Kodiak Island since September 1972.

The buoy program is being conducted under the direction of the National Ocean Survey at its NOAA Data Buoy Office at NASA's National Space Technology Laboratories near Bay Saint Louis, Miss. The Office is headed by James W. Winchester.

The buoy is a 29-foot (8.8 meter), deep keel, boat-shaped hull designed to withstand winds up to 155 knots (178 miles or 204.8 kilometers per hour), currents of six knots (seven miles or 11 kilometers an hour), and wave heights of 60 feet (18.3 meters).

Environmental data obtained by its sensors will be transmitted in near real-time to the Coast Guard Radio Station at San Francisco for relay to the NOAA Shore Communication Station at the Coast Guard Radio Station in Miami. From there it will be sent to the National Weather Service and finally to worldwide recipients over the environmental data network.

noaa/update

Pam Marie Rochford of Rupert, Idaho, Girls' Nation's choice for Administrator of NOAA, enjoys the view from the desk of Dr. Robert M. White. Pretty 17-year-old is a cheerleader, student body secretary—and, yes, radio weathercaster.

OREGON BAY FIRST OCZM SANCTUARY

The Nation's first NOAA-funded estuarine sanctuary will be at the South Slough of Oregon's Coos Bay.

With the aid of matching state funds, an $823,965 grant by the Office of Coastal Zone Management will make possible the acquisition of land for the sanctuary.

The purpose of the Oregon program is to reserve an area as a natural field laboratory for long-term study of natural and human processes in estuarine ecosystems. Information gained from this natural site will be applied to coastal zone management decision-making.

The sanctuary area—approximately 4,120 acres, 700 of which are wetlands—is dominated by two key features: a 23-acre forest- and brush-covered island, and a narrow, heavily forested finger of land dividing the slough into two arms. The South Slough watershed includes about 26 square miles with three major creeks and several smaller ones feeding into the main slough.

Near Coos Bay, a broad wetland area exposes itself fully to the sun, effectively trapping the light and receiving nutrients from both the land and sea. The shallow estuarine waters are literally an organic soup of microscopic and macroscopic plant and animals drifting with the tides and currents. Many species of animals spawn in these warm estuarine waters. South Slough is an irreplaceable nursery and food bank for fish and is used heavily by migratory birds as well as resident waterfowl and wading birds.

When the sanctuary is established, researchers will seek to develop baseline ecological measurements, monitor changes which have significant effect on the estuarine ecosystems, assess man's influence on the environment, and determine the area's carrying capacity.

NOS Bans Refuse Junk By NOAA Ships

An anti-pollution order restricting the discarding of floating refuse in coastal waters and the deep sea by ships of the NOAA Fleet has been issued by the National Ocean Survey. The order is part of a continuing campaign by NOAA to improve procedures aimed at preventing contaminants from being discarded into the ocean, lakes and tributaries.

It is designed to help protect the ocean environment from a common source of pollutions, and covers material which will not decompose when thrown into the water, such as styrofoam cups, bottles, trash can liners and plastic-covered bags of trash.

NOAA's fleet already is equipped with anti-pollution devices for meeting standards of the Environmental Protection Agency on the disposal of sewage. The new order supplements these by extending precautionary methods to materials widely used in ships' commissaries which are practically indestructible.

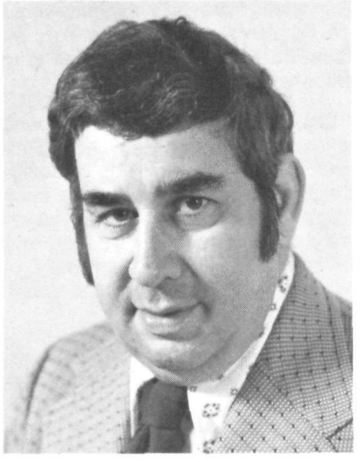
The order bans entirely the throwing overboard of non-sinkable materials within 50 miles of land or in water less than 200 meters (656 feet) deep. Material discarded outside these limits must be holed and weighted to insure their immediate sinking. The order applies to all of NOAA's oceanographic, hydrographic, fisheries and Great Lakes survey ships.

Lieb Named To NWS Preparedness Post

Herbert S. Lieb, Deputy Director of NOAA Public Affairs, has been appointed to the newly created post of Chief of the Community Preparedness Staff at National Weather Service central headquarters.

Mr. Lieb will oversee a staff whose job will be to develop preventive and protective planning at the community level to decrease the loss of life and property due to natural disasters. The staff will coordinate regional and field preparedness programs; promote public education programs on severe weather; and provide liaison with other Federal agencies promoting community preparedness.

Mr. Lieb entered the Weather Bureau in 1950 at the Analysis Center in Washington, D.C. In 1955 he joined the Public Information Coordinator's staff at Weather Bureau Headquarters. He was Deputy Director of the Office of Public Information of the Environmental Science Services Administration, NOAA's predecessor.



He served as a Weather Observer with the U.S. Air Force in India during World War II, and earned a bachelor's degree in journalism from the University of Missouri in 1949.

Survey Projects Are Announced

The National Geodetic Survey has announced the following projects:

A six-month, 800-mile survey in Minnesota, Wisconsin and Michigan, by a 20-man party headed by James L. Cook.

A five-month, 320 mile survey in Olympic Peninsula, Wash., measuring more than 300 elevations. The 20-man party is directed by Robert R. Gerrish.

A four-month, 500-mile survey in Utah and Wyoming, by a 14-man group headed by John R. Shea.

A three-year statewide survey in Connecticut of geographic positions and elevations by a 20-man party headed by Harry Romine.

Astronomic observations of longitude and latitude at approximately 37 sites in eight states extending from Maine to Maryland by three-man party headed by Richard Maxey.

Undersea Range Is Named For The Researcher

An undersea mountain range has been named Researcher Ridge, in honor of the NOAA ship *Researcher*. The United States Board on Geographic Names formally adopted the name for a North Atlantic range 248 miles (400 kilometers) long, and 43 miles (70 kilometers) wide located 558 miles (900 kilometers) northeast of Barbados, in the Central North Atlantic.

The ridge was discovered in 1971 by NOAA scientists aboard the *Researcher*, then commanded by Captain Steven L. Hollis, as part of the Caribbean-Atlantic Geotraverse investigations.

The Caribbean-Atlantic Geotraverse, supported by the International Decade of Ocean Exploration, was a marine geophysical project carried out by scientists with the Marine Geology and Geophysics Laboratory (one of the Environmental Research Laboratories' Atlantic Oceanographic and Meteorological Laboratories) and several other U.S. and foreign scientific organizations.

noaa/people

Commander Ralph J. Land is the new Chief of Operations at the Atlantic Marine Center, Norfolk, Va.

Robert L. Nolan has been selected for the position of Assistant Chief of the Meteorological Services Division at the National Weather Service Eastern Region Headquarters in Garden City, N.Y.

Dr. Richard J. Berry has been named to the post of Chief, Research Management Division, in the Office of Resource Research of the National Marine Fisheries Service in Washington, D.C.

Dr. Joseph Smagorinsky, Director of the Environmental Research Laboratories Princeton, N.J.-based Geophysical Fluid Dynamics Laboratory, has been selected by the United Nations' World Meteorological Organization to receive the International Meteorological Organization (IMO) Prize. Twelve hundred dollars, a gold medal and a certificate is presented each year to a scientist for eminence in the field of international meteorological organizations.

Sylvia Harris, of the Environmental Data Service's National Climatic Center in Asheville, N.C., has been appointed to serve as the Center's Federal Women's Program Coordinator.

Dr. Thomas E. Murray has been appointed Assistant Program Director of the Institutional Support Program in the Office of Sea Grant.

Commander Robert A. Ganse has received a Doctor of Philosophy degree from St. Louis University.

Douglas Doles, a computer technician at NOAA's Pacific Marine Center, has received a Community Brotherhood Award from the National Conference of Christians and Jews for his work among young boys and the elderly in Ballard, a Seattle community.

Marian D. Renfrew has been appointed Meteorologist in Charge at the Trenton, N.J. Weather Service Office.

Dr. Bruce B. Collette, Assistant Director of the National Marine Fisheries Service Systematics Laboratory in Washington, D.C., has been appointed Scientific Editor of the NMFS publication series Fishery Bulletin, Special Scientific Report-Fisheries, Circular, and Data Reports.

John W. Padan has been assigned to the Environmental Research Laboratories' Pacific Marine Environmental Laboratory in Seattle, Wash., where he will direct ERL's Deep Ocean Mining Environmental Studies.

John H. Houston, Chief of NOAA's Kansas City Field Finance Office, was proclaimed "Boss of the Year," at the annual "Boss Night" dinner of the Kansas City New Horizons Chapters of the American Business Women's Association.

Lt. John D. Busman has received the annual Association of Commissioned Officers "Junior Officer of the Year" award for calendar year 1973. He was recognized for his outstanding service while assigned to the Environmental Research Laboratories' Space Environment Laboratory.

Cdr. Leland L. Reinke is the new Executive Officer of the NOAA Ship *Rainier*.

Thomas N. Cunningham is the new Official in Charge at the Astoria, Oreg., Weather Service Office. He previously served as a Weather Service Specialist at the Reno, Nev., Weather Service Office.

Bob E. Finley, Chief of the National Marine Fisheries Service Consumer Educational Services Office in Chicago, Ill., has received the first "Man of the Year Award" ever granted by the 66-year old Shellfish Institute of North America.

Dr. Kirk Bryan, a research oceanographer with the Environmental Research Laboratories' Geophysical Fluid Dynamics Laboratory in Princeton, N.J., was recently voted president-elect of the Section on Oceanography of the American Geophysical Union.

Captain Robert E. Williams, who is assigned to the Sea Grant Program at the University of Washington, has authorized a 36-page book "So You Bought A Boat!", which may be obtained from the Division of Marine Resources, University of Washington (HG-30), Seattle, Wash. 98195.

Lieutenant Wayne F. Turnacliff has been named Mid-Continent Recruiting Officer for the NOAA Commissioned Corps. He will be based in Boulder, Colo.

Herbert P. Benner has been named Executive Officer to the Director, National Weather Service Western Region.

James F. Lander, Deputy Director of the Environmental Data Service's National Geophysical and Solar-Terrestrial Data Center, in Boulder, Colo., has been appointed NOAA Liaison Representative to the National Academy of Sciences Committee on Seismology.

Hasker B. Samuel, Jr., has joined the NOAA Personnel Division as Chief of the National Weather Service Section, Personnel Operations Branch.

Lieutenant Commander Melvin N. Maki is the new Executive Officer of the NOAA Ship *Davidson*.

Donald A. Downey, Advisory Agricultural Meteorologist with the National Weather Service at Fayetteville, Ark., recently served as Co-Program Chairman for the Rice Technical Working Group, an international group of researchers in rice production and marketing.

Maurice Kleve, a predoctoral student from the University of Houston who is doing his research at the National Marine Fisheries Service Gulf Coastal Fisheries Center in Galveston, Tex., won an award for the "Outstanding Contribution" in the graduate student competition at the annual meeting of the Texas Society for Electron Microscopy.

Dr. Donald J. P. Swift of the Environmental Research Laboratories has been appointed to the National Science Foundation's Oceanography Advisory Panel representing the area of Marine Geology and Geophysics.

Lieutenant Commander Kenneth F. Burke is the new Officer-in-Charge of the NOAA Officer Training Center at the U.S. Merchant Marine Academy in Kings Point, N.Y. He succeeds Commander Joseph Dropp, who has been Officer-in-Charge since the training center was transferred from Norfolk, Va., in 1970, and who now is Commanding Officer of the NOAA Ship *Peirce*.

Lieutenant (junior grade) Michael C. Meyer is the Assistant Training Officer at Kings Point.

Earl W. Estelle has taken over as Chief of the Emergency Warnings Branch of the National Weather Service's Weather Analysis and Prediction Division in Silver Spring, Mr.

Dr. Harris B. Stewart, and Dr. Peter A. Rona, have been re-elected and elected respectively to two-year terms as trustees of the Miami Museum of Science.

Albert S. Kachic is the new Regional Hydrologist at the Headquarters of the National Weather Service Eastern Region in Garden City, N.Y.

Frank D. Taylor has been selected as the Official in Charge of the Weather Service Office in Olympia, Wash.

Commander Richard E. Newell is the new Operations Officer of the ocean survey ship *Oceanographer*, flagship of the NOAA Fleet.

Richard L. Urbanak Meteorologist in the National Weather Service Space Flight Meteorology Group at Cape Kennedy, Fla., has been named Meteorologist in Charge of the Weather Service Office at Key West, Fla.

Captain Gerard E. Haraden is the new Deputy Director of the Atlantic Marine Center in Norfolk, Va.

Dr. Charles Reed Schwarz of Bethesda, Md., has been appointed scientific advisor to the Project Manager for the North American Datum program, which is designed to modernize the geodetic network that provides the basis for all accurate horizontal surveying on the North American continent.

Albert L. Comiskey has been named Chief of the Environmental Services Branch at the National Weather Service's Alaska Regional Headquarters.

Lieutenant (junior grade) Donald D. Winter has been chosen to represent the Lake Survey Center in an international technical exchange program between the National Ocean Survey's Lake Survey Center and the Canadian Hydrographic Service.

Edward J. Maree, Supervisory Meteorologist at the Regional Weather Coordinating Center at New York, has been appointed RWCC Meteorologist-in-Charge, a newly established position.

Dr. George H. Keller, Director of the Marine Geology and Geophysics Laboratory of AOML, participated in dives to the Mid-Atlantic Ridge on the submersible ALVIN, as part of Project FAMOUS (French-American Mid-Ocean Undersea Study).

Gerald Hill has reported for duty as Public Affairs Officer, National Marine Fisheries Service.

Helen H. Tepdelen, Wilford W. Buggs, and Andrew J. Shepard are staff members of the Environmental Research Laboratories who have been selected to begin new careers under the scientific upward mobility training programs with NOAA.

A. Jay Hull, former Weather Service Specialist at Wichita, Kansas, has been appointed Meteorologist-in-Charge of the National Weather Service Office at Cape Hatteras, N.C.

Dr. William H. Klein, Director of the Techniques Development Laboratory of NWS since 1964, has been named Acting Director of the Systems Development Office in the newly reorganized National Weather Service headquarters.

John R. McClain is the new Meteorologist-in-Charge of the Raleigh, N.C., Weather Service Forecast Office. A veteran of 22 years' service with the National Weather Service, Mr. McClain was formerly MIC of the Charleston, W. Va., WSFO.

Lt. Frank B. Arbusto, a Lake Survey Center NOAA Corps Officer, has been appointed Commanding Officer of the Research Vessel *Shenehon*. Lt. Arbusto previously served as Officer-in-Charge of the Lake Survey ship *Johnson*.

Aviation Safety Aided

RADAR IDENTIFIES FLYING BIRDS

The birds are singing a new type of song for three researchers with the Environmental Research Laboratories—not with their throats, but with a form of body language translated into sound by doppler radar.

John L. Green and Dr. Ben B. Balsley of the Aeronomy Laboratory have found that the distinctive movements of bird species in flight produce unique echoes on doppler radar. These echoes can be plotted graphically for a visual "signature" or broadcast through a loudspeaker, to produce some very strange sounds.

With the help of Lieutenant Lloyd Thomas of the NOAA Commissioned Corps, the scientists are putting the discovery to work, developing a doppler radar technique for identifying birds in flight. The results of their research may be used to solve the mysteries of migration and help air traffic controllers prevent dangerous collisions between birds and aircraft.

Using a portable doppler radar system, the three have been filming birds in flight at a lake near Boulder, and synchronizing the visual images with the sound produced in doppler.

Each species of bird has a distinctive flight motion. Ornithologists have found that there is an inverse correlation between a bird's wing length—and thus its size—and the frequency of its wingbeats. In addition, large birds tend to flap their wings from the shoulder, while some smaller birds flex their "wrists" in flight. Some birds wiggle their tails; others rhythmically move their necks. These differences in flight motions between bird species are often subtle. At present, the NOAA researchers can distinguish between ducks and geese, for example, but not between different kinds of ducks.

When the returning doppler signal is plotted on a graph, all these motions appear as a distinctive visual pattern. The bird's body produces a strong continuous signal, which plots graphically as a horizontal dark line. The wing beats add thinner vertical lines and each sway of the neck or tail wiggle adds a line or two to the total doppler fingerprint.

By hooking the radar receiver to a loudspeaker, the scientists obtain an audio readout, in which the bird's body produces a steady whine and the wingbeats make a distinctive warbling sound.

The researchers are now concentrating on producing a training film that air traffic controllers and others can use to learn to recognize the sound made by, for example, a flock of geese. A recently completed pilot film confirmed that the method is workable.

Bluefin Tuna Stock Under Investigation

Have populations of bluefin tuna diminished to such a low point in the Atlantic as to threaten the continued use of the species as an important fisheries resource? Answers to that and other questions about the giant fish are being sought in an expanded scientific investigation of bluefin tuna stocks in the Atlantic under the direction of the National Marine Fisheries Service Southeast Fisheries Center in Miami, Fla.

NMFS seeks to bring into close cooperation all States, organizations, and persons interested in the conservation of the bluefin tuna while assessing its status after years of heavy fishing by sport and commercial fishermen on both sides of the Atlantic. NMFS scientists are shaping their effort to culminate in the rapid establishment of a national bluefin management and conservation policy formulated to offset any declines in bluefin populations and revitalize the stocks. Various states are expected to play a significant part in the management program.

Contributory research is carried out at the NMFS Southwest Fisheries Center, La Jolla, Calif., and at the Northeast Fisheries Center in Woods Hole, Mass., and recreational and commercial tuna fishermen, State organizations, conservation agencies, and international advisory groups are advising and assisting to varying degrees in the stepped-up tuna investigation.

Some fishing tournaments have been cancelled for the first time this year, and many sport groups are proposing tag and release tournaments both for expansion of data collecting and to try to save the fish.

In 1973, the U.S. commercial catch of bluefin in the Atlantic dropped by one-third; on the other hand, sport fishermen caught a record 659 heavyweight bluefins from 72 vessels (also a record) at a popular fishing tournament held in the fall of 1973 in northwest Atlantic waters. Some marine biologists have expressed concern over a possible shortage of medium-sized fish—the future breeders—noted in recent catches. They say that for some time most of the bluefin tuna caught have fallen into either the immature class (under 50 pounds) or the giant class (over 300 pounds).

Ayers To NMFS As Gamefish Coordinator

Robert J. Ayers has been named assistant to the Director of the National Marine Fisheries Service, to coordinate game fish programs.

Mr. Ayers, who has spent all of his 16-year professional career as a fisheries, wildlife, and environmental specialist in the Midwest and on the Pacific coast, for the past two years has been chief of the Environmental Resources Branch, Corps of Engineers, Cincinnati, Ohio.

His new position will involve integration of the many recreational fisheries programs and endeavors conducted at NMFS field stations throughout the country into one national program.

Mr. Ayers earned his B.S. degree in fisheries at Oregon State University.

Recent visitors to office of Robert W. Schoning, NMFS Director, were Soviet members of U.S.-U.S.S.R. Fisheries Claims Board, A.G. Afanasyev (left), and I. A. Znamenskiy (right). The board considers claims of loss or damage to fishing vessels and gear.

U.S. Fishermen Win Atlantic Quota Increase

United States fishermen have been granted a quota increase of 16,600 metric tons for 1975 by the International Commission for the Northwest Atlantic Fisheries. ICNAF regulates certain fisheries in international waters off the northeast coast of the U.S. and Canada.

The Commission has elected David H. Wallace, NOAA's Associate Administrator for Marine Resources and Commissioner for the United States to ICNAF, as Vice Chairman.

The 1975 U.S. share of the total quota increased from 20 to 25 percent. With the exception of a modest increase for Canada, quotas of all other nations were reduced in order to provide the total required reduction of approximately 75,000 metric tons as agreed at an earlier meeting.

For 1975: More Of The Same

GREAT LAKES LEVELS HIGH FOR THIRD YEAR

The Great Lakes are well into a third season of high water levels, a condition which has occurred only twice before in this century, and the outlook for next year is for continued high levels.

The National Ocean Survey's Lake Survey Center in Detroit said high water levels such as these usually persist for only about two years, but LSC forecasters offer little promise that the rate of precipitation will slacken in the near future.

Similar conditions occurred in 1917-1918 and 1952-1953.

Lakes Erie and St. Clair have already broken the record high level of water they set last year in May. While both are expected to be below their monthly record highs for the remainder of the summer, they may again approach record highs in the fall. The rest of the Great Lakes are expected to continue well above their long-time averages, although they are not expected to break established records.

NOAA scientists say that when the weather settles into its usual pattern and the amount of precipitation returns to normal, the water levels will go down in the Great Lakes. The current six-month lake level forecast, however, calls for continued high levels through December, with the lake levels at the end of the year being within a few inches of those of last December.

The present high lake levels are primarily due to precipitation (both rain and snow) which has been 16½ inches above normal since 1965. This condition has been aggravated by below normal evaporation and the cumulative effect has been to raise lake levels in some cases to all-time highs.

Timely warning during severe weather outbreak on Spring, 1973, won NOAA Unit Citation for staff of WSO IN Shreveport, La. Presenting plaque: NWS Southern Region Director Lawrence R. Mahar. Receiving: Ernest S. Ethridge, OIC.

New Geodetic Control Standards Are Set

NOAA has announced the publication of new standards for geodetic control.

The modernized standards were prepared by the Federal Geodetic Control Committee, composed of representatives of the Departments of Agriculture, Commerce, Defense, Housing and Urban Development, Interior and Transportation, and the National Aeronautics and Space Administration and Tennessee Valley Authority. Collaborating with the committee were the American Congress on Surveying and Mapping, the American Society of Civil Engineers and the American Geophysical Union, among others.

WORLD WEATHER PROGRAM IS DETAILED FOR A YEAR

The World Weather Program plan for fiscal 1975 details Federal programs to extend the time range and scope of weather predictions, to assess the impact of atmospheric pollution, to study the feasibility and consequences of weather modification, and to encourage international cooperation in meeting the meteorological needs of all nations.

The World Weather Program is an international effort, coordinated by the World Meteorological Organization. United States' participation in the program is coordinated by NOAA. Other agencies contributing are the Departments of Defense, State, and Transportation, the Atomic Energy Commission, Environmental Protection Agency, National Aeronautics and Space Administration, and National Science Foundation.

The World Weather Program has two major components—the World Weather Watch and the Global Atmospheric Research Program (GARP)—supported by a System Design and Technological Development effort.

Field investigations for the GARP Atlantic Tropical Experiment (GATE) took place this summer in a 20-million-square-mile area of tropical land and sea extending from the eastern Pacific Ocean—across Latin America, the Atlantic Ocean, and Africa—to the western Indian Ocean. Instruments on 38 ships, more than 60 buoys, 13 aircraft, six types of satellites, and at nearly a thousand land stations are being used to observe and record weather and ocean phenomena from the top of the atmosphere to about 5,000 feet below the sea surface.

Understanding the tropical atmosphere is a key to understanding the processes which ultimately affect atmospheric circulation and weather all over the earth. GATE field work is scheduled to continue through September 23.

Work is also under way in planning other regional Global Atmospheric Research Program experiments such as the Air Mass Transformation Experiment slated in the westernmost Pacific Ocean, the Monsoon Experiment which will study the properties of air masses over the Arabian Sea during the southwest monsoon season, and the Polar Experiment which is concerned with energy transfer processes in the polar regions. The target date for a global observation experiment is 1978.

U.S. activities in the World Weather Program in the coming year include the initiation of an operational geostationary satellite system for more effective environmental warnings. A portion of the system was realized on May 17 with the launching of NASA's new Synchronous Meterorological Satellite-1. A second, similar satellite is scheduled to be launched later this year. Work will also continue on the expansion of a baseline monitoring network and the U.S. will offer continued assistance to developing nations for their participation in the World Weather Watch, a program in which member nations of the World Meteorological Organization make available the basic meteorological and related environmental information needed by each to support its weather services and research.

Eight Of NOAA Honored For EEO Efforts

Eight NOAA employees are among 16 Commerce Department members who have received certificates of recognition from Secretary of Commerce Frederick B. Dent for their outstanding work in developing equal employment opportunities for minorities and women.

They are: Dr. Dayton L. Alverson, Director of the National Marine Fisheries Service Northwest Fisheries Center in Seattle, Wash.; Charles O. Baker, Supervisory Meteorological Technician at the National Weather Service Office in Nome, Alaska; Janice R. Cavaliere, Writer/Editor in Publication Services at the Environmental Research Laboratories in Boulder, Colo.; Fred Hodo, Jr., a Cartographer in the Visual Chart Branch of the Aeronautical Chart Division in the National Ocean Survey's Office of Aeronautical Charting and Cartography in Silver Spring, Md.; Josephine Moss, an Oceanographer in the Environmental Data Service's National Oceanographic Data Center In Washington, D.C.; Doris J. Robinson, a Seafood Consumer Specialist in the Market Research and Services Division of the National Marine Fisheries Service Southwest Regional Office in Terminal Island, Calif.; Victor E. Serena, Chief of the Photogrammetric Branch of the Coastal Mapping Division at the National Ocean Survey's Atlantic Marine Center in Norfolk, Va.; and Maurice A. Ward, a Weather Radar Specialist at the National Weather Service Office in Palmdale, Calif.

Warm Water Sparks Growth In Lobsters

What are East Coast lobsters doing at a West Coast power plant? Growing almost four times faster in heated cooling water from a power company than they do in their native marine waters, say Sea Grant scientists from San Diego State University.

For the past three years, project leaders Dr. Richard F. Ford and Jon C. Van Olst and their associates have been delving into the mysteries of culturing the aggressive, cannibalistic and finiky northern lobster, *Homarus americanus*. If their careful and painstaking studies prove successful, the notion of domesticating active marine creatures may move closer to reality. Many problems remain to be solved and each solution points the way for culturing less glamorous and expensive species of seafood.

Experiments initiated at the Massachusetts Lobster Hatchery on Martha's Vineyard first indicated that lobsters whose natural environment is cold reach marketable size more quickly when their surroundings are warmed up.

The SDSU research team began their lobster-rearing experiments in a laboratory beneath the pier at the Scripps Institution of Oceanography (UC-San Diego, La Jolla) using sea water that was electrically heated.

During the summer and fall of 1973 a laboratory facility was built on land at the Encina Environmental Research Facility and scientists began to test the effects on lobster growth of a mixture of intake and discharge (effluent) cooling waters. Tests so far indicate lobsters cultured in this manner should reach marketable size (one pound) in about 18 months instead of the five to seven years required in nature, although they may require more food for this growth.

Power plant effluent is an inexpensive source of large amounts of filtered heated water which can be mixed with cooler ocean water to achieve the most favorable temperature, between 70 and 75 degrees Fahrenheit.

The animals are kept in fiber glass trays and tanks fed by the seawater-effluent mixture. Sea water is drawn from the power plant's lagoon and utilized within the plant to condense steam which drives turbine-generators in the production of electricity. After the coolant water is heated, it is discharged into a cooling pond from which it flows across the beach facing the plant into the surf.

The research facility must be aerated to maintain dissolved oxygen levels near saturation for the experimental animals. Researchers are also seeking to determine if there are any traces of chlorine remaining in the effluent after periodic treatment of the plant cooling system with the chemical. The potential effect on the lobsters would then be studied.

One of the biggest puzzles for researchers is how best to feed animals that often eat one another. Brine shrimp is a tempting and nutritious possibility but it is expensive and does lack certain elements essential to lobster growth and health.

Artificial foods designed and modified by mariculturists throughout the country are being tested and evaluated.

Diseases that do not commonly affect lobsters in cold-water environments seem to plague the animals kept at higher temperatures. There are difficulties in keeping animals under controlled conditions, although some obstacles are counterbalanced by the decreased larval mortality. A minuscule fraction of lobsters in nature survive the larval stage. Survival rate of young lobsters at the laboratory so far is about 30 percent past the larval stage.

Plans are underway to design production facilities which could be used in aquaculture on a large scale.

One prototype in use at both Scripps and Encina is a revolving carousel, dubbed "care-o-cell" by designer Van Olst, where lobsters are kept in compartments. Expanded several times, the "care-o-cell' would have walkways for researchers and a future model might be covered by a geodesic dome.

Invisible Veil Spawns Storms

An invisible curtain separating dry desert wind from moist air in the lee of the Rocky Mountains appears to mark a favored location for thunderstorm development over the southern Great Plains, according to an Environmental Research Laboratories scientist.

Dr. Joseph T. Schaefer of the National Severe Storms Laboratory in Norman, Okla., says the invisible "dryline" occurs most frequently in west Texas and Oklahoma during the spring and early summer. Approximately paralleling the terrain contours, the dryline is sometimes observed as far north as Nebraska and the Dakotas.

By studying the development and progression of actual dryline events, the NOAA meteorologist developed a numerical model to determine the life cycle of the dryline and the cause of its motion.

Computerized results indicate that the daytime movement of the invisible dryline is determined by surface heating of the earth, (which causes vertical mixing of dry and moist air) rather than by naturally occurring westerly winds. This revelation is significant to meteorologists. But the question of why the dryline is a preferred location of thunderstorm generation remains unanswered.

The importance of the dryline as a severe weather predictor has been recognized for almost a quarter of a century. A recent four-year study of radar echo formation showed that when cells existed within 200 nautical miles on either side of the dryline, 78 percent of the first radar echoes developed within 10 nautical miles of the dryline position.

Commerce Blocks Marine Mammal Kill

The Commerce Department, for the second successive year, has denied all requests for permits to kill marine mammals for commercial purposes.

In a report submitted to the Congress, Secretary Frederick B. Dent described circumstances surrounding the handling of some of the scores of applications received by the National Marine Fisheries Service to acquire some 10,000 marine mammals, all for scientific or public display purpoes.

Most of the 20 applications approved involved the capture and release of nearly 9,000 animals for scientific research. The next largest number of permits was granted to persons and organizations wishing to retain animals for science or for public display.

Kelp Beds Seeded By Sea Grant

Sea Grant scientists at the California Institute of Technology have developed advanced techniques for establishing and re-establishing valuable Pacific kelp beds.

According to Dr. Wheeler J. North, who heads the Kelp project at Cal Tech, work on the program—which first received Sea Grant funding in 1968—has progressed to the point where relatively large numbers of plants can be seeded at a fairly low cost through the dispersion of kelp embryos in the sea. The embryos, carefully raised and stored through laboratory techniques developed by Institute scientists, settle, reattach, and develop normally. Dispersals at two sites (Corona Del Mar and Dana Point) off the California coast have resulted in a tremendous number of juvenile plants where before there were only a few adult kelp plants.

The gaint kelp, *Macrocystis,* has been used in most of the Institute's studies because the genus is an important marine resource in California waters. The canopies are harvested and processed for extracts used as food additives and for colloidal constituents. The kelp beds also provide important habitat for fishes and invertebrates.

Commerce Secretary Frederick B. Dent and Dr. Robert M. White, NOAA Administrator (right), are briefed by National Hurricane Center Director Dr. Neil Frank (left) during Secretarial inspection of Miami Center as Hurricane Carmen approached Gulf shores.

Despite Ice, Polar Bears:

Drifting Buoy Tests In Arctic Are Found To Be Success

A two-year buoy test program in the Arctic ice pack, during which three buoys operated for almost one-and-a-half to two years ine one of the earth's harshest environments, has been completed by NOAA.

Seven 340-pound drifting buoys placed in the ice pack in 1972 were designed to operate for up to one year, but some substantially exceeded this despite storms, drifting ice, temperatures of 50 below zero Fahrenheit, and attacks by marauding polar bears.

A more sophisticated prototype Arctic data buoy is now being developed, and operational buoys of this type will be placed in the ice early next year.

The seven buoys, which were deployed off Alaska's North Slope, were part of an engineering experiment to demonstrate the feasibility and reliability of operating unmanned satellite-communicating, data-reporting buoys in the polar seas. One goal is to reach, through coordinated field experiments and theoretical analysis, a fundamental understanding of the dynamic and thermodynamic interaction between Arctic sea ice and its environment. An understanding of sea ice dynamics will lead to safer navigation of the hazardous waters which flank the frozen northland.

In addition, buoys which operate successfully in the polar regions could play an important role in weather forecasting of the future, since much of the world's weather develops in the Arctic and Antarctic. The buoys provide environmental data on air pressure, temperature and ice movements. Information from the buoys was transmitted to Fairbanks, Alaska, via NASA's polar-orbiting Nimbus-4 satellite.

Discharged batteries are assumed to have terminated the operation of one buoy after 667 days (approximately 22 months). Another operated 19½ months, and a third, which had operated successfully for 504 days (approximately 17 months) was still furnishing data when recovered. A single failure, the loss of the lower air temperature sensor, marred an otherwise perfect performance. Evidence indicated the failure was probably due to damage by an inquisitive polar bear, the second buoy to be so damaged. In each case, exposed wires were severed. Two buoys operated for approximately 15 months and the remaining two for about 2½ months.

The buoys were funded by the NOAA Data Buoy Office in Bay St. Louis, Miss., which is responsible for the development of unmanned environmental data buoys. Buoy design and development were performed by the University of Washington's Applied Physics Laboratory in Seattle, Wash.

Dean Haugen, Project Leader of the Data Buoy Program at the laboratory, estimated an array of about 30 buoys deployed from central ice camps and shore-based facilities could rather uniformly cover the entire Arctic Ocean. The buoys were installed in nine-inch-diameter holes cut into sea ice 9 to 12 feet thick. Some buoys drifted more than 900 miles.

Somewhere Else, Maybe

Could Squid Fishery Boom?

American fishermen could make a tidy profit fishing for squid—but not for American dinner tables, according to an MIT researcher.

A just-published study funded by the MIT Sea Grant Program shows that squid would make an excellent export product to Europe, but that Americans are too negatively disposed toward the idea of eating squid for it to be a profitable seafood item in this country, at least for the immediate future.

Paul Kalikstein, a graduate student in MIT's Alfred P. Sloan School of Management, analyzed the availability and potential market for squid, reported results of taste tests of squid products and surveyed consumers' and industrialists' attitude toward squid.

According to Kalikstein, the potential for squid fishing is enormous. Only about twenty million pounds per year are landed off the US—about eighteen million pounds off the coast of California and two million pounds off the east coast. The potential catch off the east coast alone is enormous, says Kalikstein, the estimates ranging to one billion pounds per year.

The catch is that US consumers at present have little interest in trying squid products. A telephone survey revealed what Kalikstein perceived as a "poor attitude" toward squid as a food source, and only about 11 percent of the respondents in a mail survey said they would try a squid product.

The report noted, however, that MIT researchers obtained "very favorable" results on taste tests. A panel of 70 tasters rated three squid products—fried squid rings, squid chowder and squid cocktail—uniformly excellent, Kalikstein said. All received between four and five on a five-point taste scale, with the chowder receiving almost all fives. The squid rings resemble scallops in flavor, the chowder mimics clam chowder, and the cocktail resembles oyster cocktail. This means, that while initial purchase would be low, repeat purchase of squid would be high, he said.

Fishing industrialists—processers, brokers, fishermen, etc.—interviewed by Mr. Kalikstein were uniformly negative toward squid products.

"I would venture to say that people within the seafood industry were more negative towards the domestic introduction of squid than the general consumer population. Many longtime seafood businessmen were quick to state that a successful introduction of a processed squid product would be impossible," Kalikstein said.

According to Kalikstein, squid would make an excellent export to Europe, however.

"It may come as a surprise to many Americans, but squid is a highly sought after food form in many areas of the world. Squid is particularly popular among the peoples of the Orient and the Mediterranean."

The rising price of squid on the European market, the increasing foreign squid fishing off the US east coast, and the recent international money realignments all combine to make US squid fishing a very attractive possibility, said Kalikstein.

Already, Kalikstein said, US exporters are eager for squid products, one saying that he could "export all I could get."

Land-Based Geodetic Net Is Extended

NOAA has offered its assistance in extending the land-based national network of measurements to offshore oil platforms and other offshore structures for which precise positioning is needed.

There are almost 3000 oil platforms off the coasts of Louisiana, Texas, and California, and in Cook Inlet, Alaska. In the Gulf, some extend as far as 150 miles from shore.

The National Geodetic Survey, which maintains the national networks of distances and elevations on which all basic surveys depend, is prepared to process data obtained by the new method of doppler geodesy satellite surveying.

The NGS will process the data with post-orbital data from the Navy Navigation Satellite Systems and determine geodetic positions for the platforms. The measurements would then be placed in the national geodetic data bank maintained by the Survey, where it would be available to all users upon request. The processing would be done for a nominal charge.

Caponio Named To Head ESIC

Dr. Joseph F. Caponio, former acting director of the National Agricultural Library, has become director of the Environmental Data Service's Environmental Science Information Center, Washington.

From 1953 to 1957 he was associated with the Library of Congress; then for two years he was chief of the reference and bibliography branch of the Armed Services Technical Information Agency. In 1959 he assumed direction of a similar branch in the Commerce Department's Office of Technical Services.

Dr. Caponio joined the Defense Department as Director of Technical Information, Defense Documentation Center, in 1961, transferring to the National Institutes of Health in 1964. He joined the Department of Agriculture in 1970.

Fishermens' Lives Seen Paradoxical

Since the earliest days of the American colonies fishing has been an important occupation, first for food only, and later for food, industrial products, and for recreation. It is a way of life for Americans along our coasts.

The life of the commercial fisherman has always been depicted as harsh. There is no doubt that it is often hazardous, and sometimes there is no pay at all, but thousands of young Americans continue to seek work as fishermen. Why?

Two long-time commercial fishermen, A. K. Larssen and Sig Jaeger, have provided some of the answers in a paper entitled "Some ABC's of Fo'c'sle Living." Larssen, now retired in Seattle, Wash., had extensive commercial fishing experience in his native Norway, and it extended to Alaska and the Indian Ocean. Jaeger also has extensive commercial fishing experience and served as director of the Fisheries Technology Program, Kodiak Community College, Alaska. He is currently a consultant to the Marine Advisory Programs at the University of Alaska and the University of Washington (Seattle). The article made up an entire issue of *Marine Fisheries Review*, published monthly by the National Oceanic and Atmospheric Administration. The Review is produced by NOAA's National Marine Fisheries Service, and the Larssen-Jaeger paper was commissioned by NOAA's Sea Grant Program.

Most fishermen get neither salary nor wages, the paper points out. Their only income is their share of the catch, and there are many different "share systems" or methods of figuring the crewman's income, according to the authors. It is even possible, although rare, for crewman to get what is called a "hole bill' if the expenses of a fishing trip exceed the value of the catch.

"The fisherman's income is pretty much like the sea from which it is drawn; it ebbs and floods like the tide, but without tidal regularity," say Larssen and Jaeger. Some fishermen do earn good incomes, while others, less lucky perhaps, earn barely enough for a skimpy living, and must seek to supplement their income elsewhere.

The authors point out that there seems to be a personal regard for fellow crew-members that is not generally accorded a colleague on a shore job. They also note the close teamwork required on board most fishing vessels and that most tasks are done almost automatically without the need for issuing orders.

The paper states that perhaps the most unique aspect of a job in commercial fishing is the long work day. A 12-hour day is virtually a minimum; from 16 to 18 hours is common.

PROGRESS MADE IN WHALE CONSERVATION

Major progress has been attained in the continuing effort to save the world's whales, NOAA Administrator Robert M. White has announced.

Dr. White, U.S. Commissioner of the International Whaling Commission, summarized conservation advances achieved by the IWC's 26th session in London, thus:

- A selective moratorium will apply to any stock falling below optimum population levels,
- Worldwide quotas for species of most concern have been greatly reduced,
- Stocks will be managed by ocean areas rather than by oceans as a whole,
- In setting optimum stock levels, factors other than numbers of animals will be considered—factors encompassing the health of the entire marine ecosystem, leading to more conservative quota levels.

Adoption of the principle of a selective moratorium, Dr. White said, represents a major switch in the outlook for preservation of the world's whales. It makes possible a moratorium for certain species, such as the fin whale, for longer than a decade.

The world-wide quotas established by the Commission provide significant reductions in the allowed catch of several species. In the case of the fin whale, last year's quota has been reduced by 35 percent, from 2,000 to 1,300, with an anticipated reduction to zero for the 1975-76 whaling season. The quota for the sei whale has been reduced 20 percent, from 7,500 to 6,000. The sperm whale quota was at last year's level of 23,000.

Only in the case of minke whales has the quota increased, from 5,000 to 7,000, on the assurance of scientists that this level will not seriously affect stocks of this small whale.

Kolf Is Named To Marine Liaison Post

Dr. Richard C. Kolf has been named Coastal Zone Coordinator in NOAA's Office of Sea Grant.

Dr. Kolf will act as liaison between the Office of Sea Grant and Office of Coastal Zone management.

He is also Sea Grant Associate Program Director for Project Support Programs.

Before joining NOAA he was with the Division of Environmental Systems and Resources of the National Science Foundation, where he was responsible for coastal zone matters involving the agency's Environmental Systems Program.

Brand The Crab? Quick! The Laser

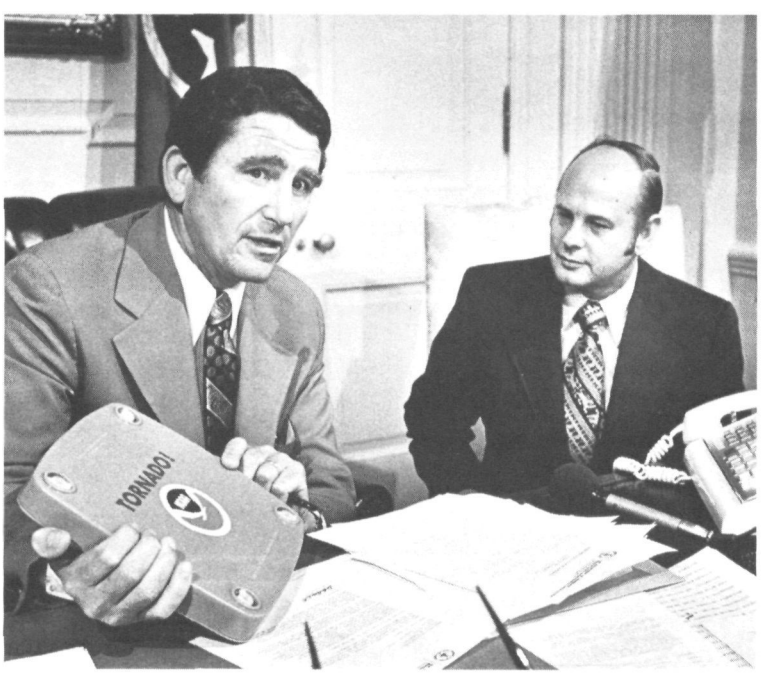
A way has been found at last to brand the slippery crab, whose habit of shell-shedding has frustrated researchers seeking to track its populations and migrations.

A laser beam may be the answer, according to Richard Stroud, Research Associate in Veterinary Medicine at OSU, whose work is aided by the OSU Sea Grant College Program.

Says Stroud: "Laser branding alters some of the pigmentation cells under the crab's outer shell. When a new outer shell is formed, it too will carry the brand."

Preliminary trials on Dungeness crab indicate that both freeze-branding and laster-branding will alter the crab's pigmentation cells producing a mark that will last through a molting cycle.

Mr. Stroud's research is being conducted in cooperation with the Fish Commission of Oregon and the United States Department of Agriculture.



Among governors of more than 20 states receiving prints of NOAA film "Tornado!" for use in school systems is Tennessee's Winfield Dunn (left), from Nashville MIC Cecil Palmer. Hundreds of prints of the public safety film have been made available for education of children.

Chart Automation Planned For Gulf

NOAA hopes to place its automated nautical chart data bank in operation for the Gulf of Mexico in 1975.

The Gulf will be the first area in the nation to have nautical chart data computerized. Automation of data for all of NOAA's 971 nautical charts, which cover U.S. coastal waters and various inland waterways and lakes, including the Great Lakes, is scheduled for 1980.

The creation of a data bank which involves converting necessary information to magnetic memory storage in computer language—is the first step in the establishment of a largely automated system for producing nautical charts. Under a 10-year, $25 million program, the data for all areas covered by the National Ocean Survey, which produces the charts, will be established in the data bank at the NOS' Rockville, Md., headquarters.

When completed, the bank will include nautical data for 90 charts of the Gulf area, and when fully operational will make possible a wide range of responses to special purpose uses, such as requests for a list of navigational aids in a specific area.

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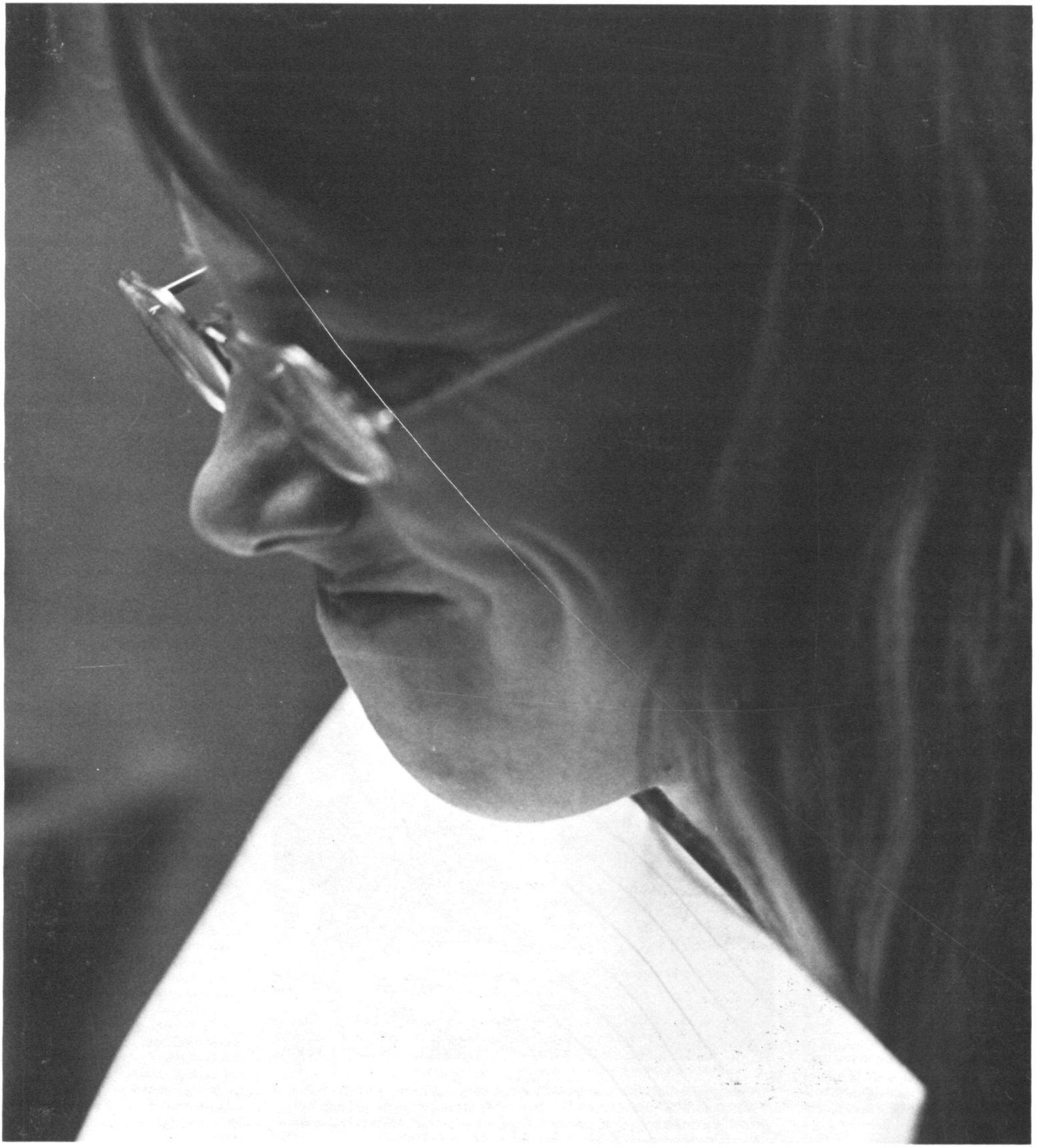

Diane Kidwell makes a face over computer program. *See "NOAA'S Amazing Thinking Machines," Page 44 .*