VOLUME 3 NUMBER 3 JULY 1973

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National Oceanic and Atmospheric Administration

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COVER: The National Weather Service's Albuquerque, N.M. Forecast Office provided special services to World Hot Air Balloon Festival, in which 123 colorful "motiveless craft" participated.

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Art Director

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U.S. DEPARTMENT OF COMMERCE
Frederick B. Dent, Secretary

National Oceanic and Atmospheric Administration

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

A Message From the Administrator

NOAA, the Congress willing, will have a new, consolidated home in the Nation's Capital early in 1976, the Bicentennial Year.

This would be good news under any circumstances. Our headquarters have been scattered about the metropolitan area in a wide and inconvenient variety of locations for entirely too long. This makes for inefficiency and waste — particularly the waste of time, one of our most important resources.

Not only will the move be salutary for approximately 5000 Washington-area members of the NOAA family; its effects will be nationally felt. The steady stream of NOAAites and others visiting headquarters will find the ready availability of people and places a refreshing change. Physical unification in itself leads to a heightened sense of our commonality of mission.

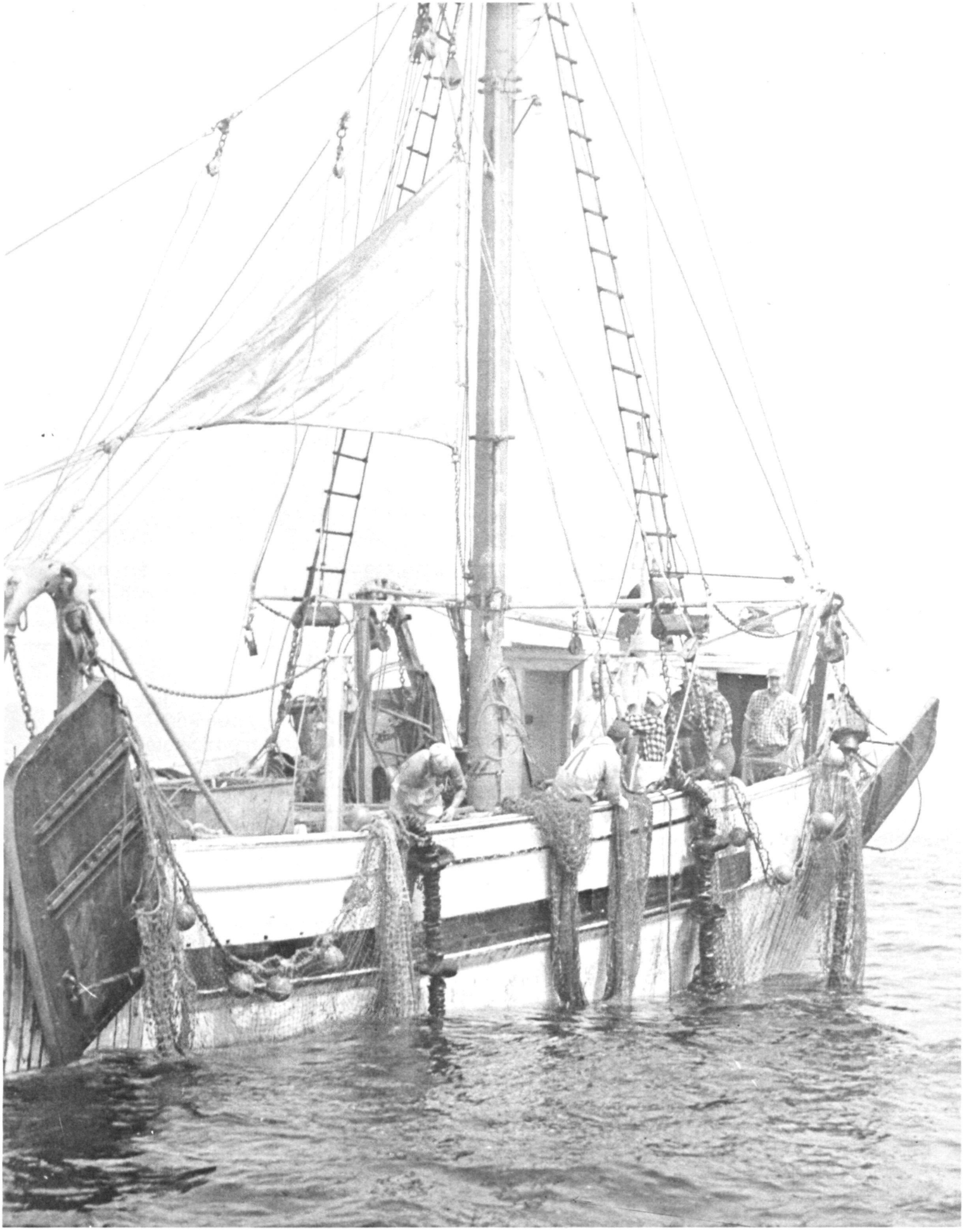
All of this represents progress, but what makes the move even more exciting is the fact that we shall be going to work in a brand-new, $77 million complex of approximately one million square feet in the heart of New Town in Fort Lincoln, at the Maryland-District line in Northeast Washington.

New Town will be easy to reach, from the Capital or from the suburbs. It will have all the vigor of every new and interesting venture. It will be a new community of approximately 16,000 persons who will live in a place where one-third of the land is set aside for recreation, where theatres, shops, cultural and educational facilities, and such amenities as a large green and a lake beckon. It will be socially, economically, and functionally balanced. It should be a vital and dynamic place for NOAA.

When we are relocated, let us not have an eight-thirty-to-five sort of relationship with those about us. We will represent a substantial percentage of the people spending their days in New Town. Let us become a genuine part of the new community.

We shall all be richer for it.

Robert M White



Georges Bank under scrutiny

BY HEDY MATTSON *

How would an oil find on a world-famous fishing grounds affect the economy and the environment? M.I.T. Sea Grant tackled the problem.

Stretching far to the east and north of Nantucket Island is an area of the rolling restless north Atlantic known to codfishermen for 225 years. With depths of less than 50 fathoms, shoaling in places to less than 10 fathoms, it supports a wide variety and great number of fish. Its shallows pose a danger to deep draft vessels. It is now also considered to be a potentially productive region for oil reserves.

Georges Bank, as the area is known, was a major fishing area for European fishermen as far back as the time of Columbus. The first recorded catch of cod by New England vessels from the bank came in 1748. Though catches varied through the years as the supply of cod fluctuated, by the close of the 19th century 174 dory schooners were fishing on Georges Bank and nearby Browns Bank southeast of Nova Scotia.

Haddock, too, was at one time plentiful in the Bank, yielding about 50,000 metric tons annually during the three decades ending in 1964. Bank fishermen also bring in flounder and sea scallops, among other species.

The schools of fish in these gray waters now attract Soviet, Polish, German, Spanish, Rumanian, French, Japanese, Cuban, and other fishing fleets, in addition to the American and Canadian vessels that have long fished the area.

Under these waters is a predominantly sandy bottom, strewn in places with shell and pebbles. Under the sand, geologists believe, lie significant deposits of petroleum. During the past few years, the Bank has been the subject of considerable seismic activity, and has been included in plans for a U.S. Geological Survey coring program.

Meanwhile, New England's economy—now in the process of changing from primarily manufacturing to service-based—has sagged. Unemployment rates are up from four percent to eight percent. New England's fuel costs are the highest in the nation, in a region noted for its long and cold winters. So the questions naturally arose—would an oil find on Georges Bank bring down the prices of petroleum products? Could oil production bolster New England's economy? There were some who thought this probable; others were not so sure.

And in any case, concern was voiced that even if oil production on the Bank could substantially increase regional income, the region's environmental quality might suffer. If oil were produced, it was feared, this could harm the prolific biological life on the Bank, which is the spawning and feeding ground of many commercially valuable fishes. How, environmentalists wanted to know, could changes in the ecosystem resulting from oil development be measured against possible changes in the local economic conditions?

Moreover, fishermen are already beset by high operating costs (53% of every dollar brought in goes right back out, to pay crew's wages). They fear further depletion of stock because of pollution, as well as impediments by oil industry facilities to their fishing methods.

Because the region has had no experience with offshore petroleum production and processing, the New England Regional Commission and New England Rivers Basins Commission solicited the help of the Massachusetts Institute of Technology to study the implications of Georges Bank oil on regional income and environmental quality. NOAA's Office of Sea Grant, recognizing the implications of such a study for other national areas, immediately supplied matching funds, as did the National Science Foundation.

The purpose of the study, says Professor Alfred H. Keil, Director of the M.I.T. Sea Grant Program, was not to advise New England on its oil policy, but rather to develop "a reliable information base for rational discussion among persons and groups having normally divergent opinions and adversary positions" and to provide the "information and analytic tools by which regional authorities . . . can approach relevant policy decisions." It is particularly significant, he says, because it attacks a major regional problem "from both the economic and environmental viewpoints simultaneously, using consistent hypotheses and assumptions."

Headed by Professor John W. Devanney III, of MIT's Department of Ocean Engineering, the interdisciplinary Sea Grant team spent a full year on research and analysis. One member of the team signed on as crew member on the trawler TREMONT for a trip to the Bank. Oil companies cooperated, as did nature conservancy and biological research groups, government agencies, and academic institutions. Richard Hennemuth of the National Marine Fisheries Service broke out data from his Georges Bank fishery tapes. The three-volume report, entitled "The Georges Bank Petroleum Study", was issued in February of this year.

How did they go about their study? To begin with, the team hypothesized a num-

* Hedy Mattson is Sea Grant Program Editor at Massachusetts Institute of Technology.

ber of locations on the Bank for petroleum discoveries, and assumed that each was capable of a wide range of production rates. A computer model capable of simulating physical variables such as refinery locations, and policy variables such as import restrictions, was generated. The researchers then explored possible oil finds in combination with hypothetical refienery locations, foreign crude prices, import quotas and natural gas pricing policies to determine implications of various combinations. Meanwhile, they began their studies of the possible biological impact of oil exploration and development on the Bank.

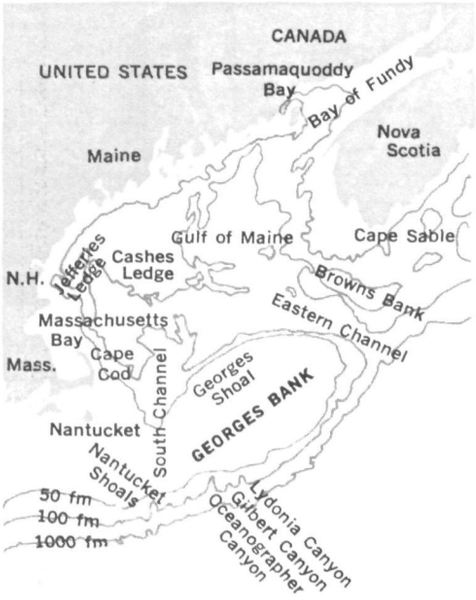
And the results that flowed from all this effort? One of the most startling discoveries —an economic factor from which came a great many other findings of the study— was this: the single most important factor that affects New England's regional income —that is, its ability to purchase goods and services—is the cost of foreign oil.

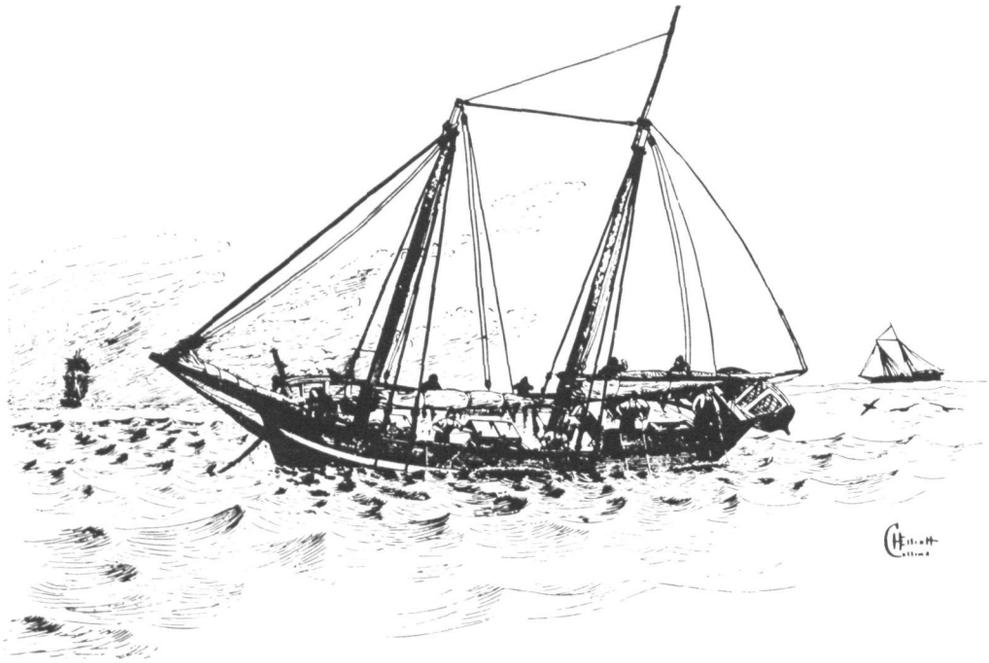
This means, for one thing, that any oil find from Georges Bank would have no appreciable effect on the cost of fuel to the consumer in the area.

Owing to the large rate of fuel consumption in New England, virtually all of the oil produced on Georges Bank could foreseeably be consumed by the region and imported oil would still be required to meet the demand. Thus, since the prices of products are determined by the most expensive alternative source necessary to meet market demands—in this case, foreign oil—a Georges Bank discovery would not of itself result in a decrease in regional products prices. (It is assumed that the bulk of oil imported into the region will continue to come from the Middle East and the Gulf Coast.)

Of prime importance to the New England economy, however, is whether lease and royalty payments from oil discoveries are alloted to the region or are turned over to the Federal government. Louisiana experience tells us that a large fraction of the income generated by an offshore find is turned over to the public body controlling the find through competitive bidding.

The value of a gas find is also dependent upon future decisions of the federal government to maintain or abolish regulation of





From America's earliest days, fishermen have harvested the rich waters of Georges Bank off Cape Cod (upper left). Handlines were used for about 200 years aboard the European vessels that fished the banks. At first, the lines were fished from the deck of the ships, (upper right), but later on they were fished by one- and two-man crews in dories carried to the fishing ground by fishing schooners or other larger vessels.

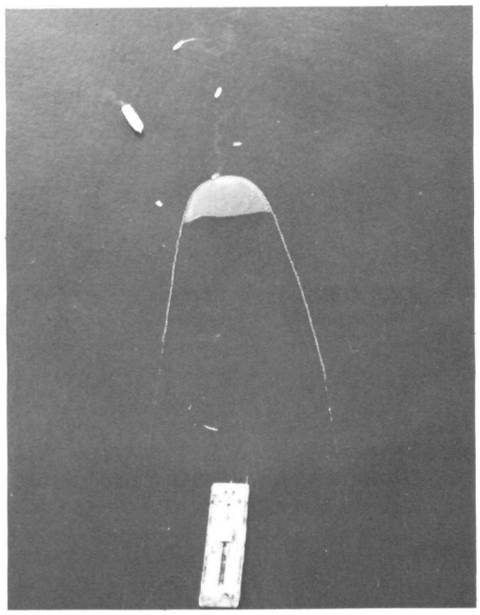
natural gas prices. The price of natural gas will be determined by the price of low sulphur heating fuels in the absence of federal price regulation. Some of the gas will go to higher valued uses. The marginal cost in most cases of landing gas is less than the current federally regulated wellhead prices. However, if the federal government completely deregulated natural gas prices, the gas would be conservatively priced at the value of the residual it replaces on an energy equivalent basis which ranges from 60¢ to $1.00 per thousand cubic feet depending on whether foreign residual fuel costs are escalated.

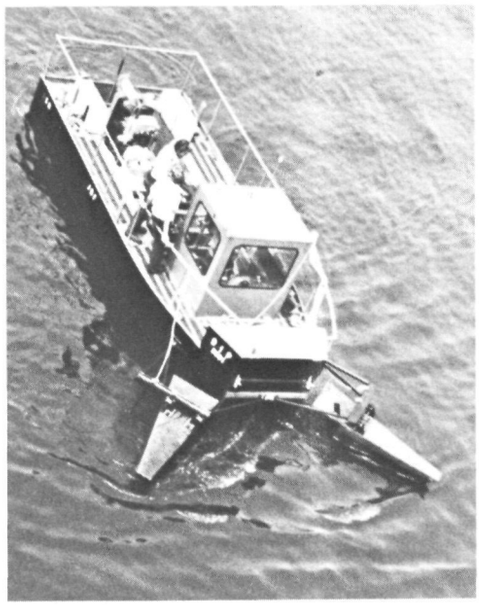
The study considered five refinery locations to determine which would be least costly to New England: 1. middle Atlantic employing current terminals; 2. middle Atlantic with terminals capable of handling 65′ draft tankers; 3. Canadian Maritime Provinces; 4. deepwater Maine; 5. southeastern New England.

The team noted that even if Georges Bank is developed, a substantial portion of the nation's oil consumption will still have to be imported. New England is the most distant market for domestic oil and therefore will pay the highest prices. Further, it is unlikely that all New England oil consumption would be refined at only one of the five probable locations. The oil industry would want to avoid producing an overcapacity of refineries at any one point and various companies supplying the refining capacity would not use the same location.

However, from a regional point of view, a deepwater refinery complex in a New England location, serviced by supertankers, distributing its products by coastal barges and utilizing a full extra-regional labor force, would be only slightly superior to that same complex placed elsewhere on the East Coast. A refinery complex in southeastern New England that uses pipelines to distribute its products to Boston, Providence, Portland and other cities, was the lowest cost refining option investigated by the team.

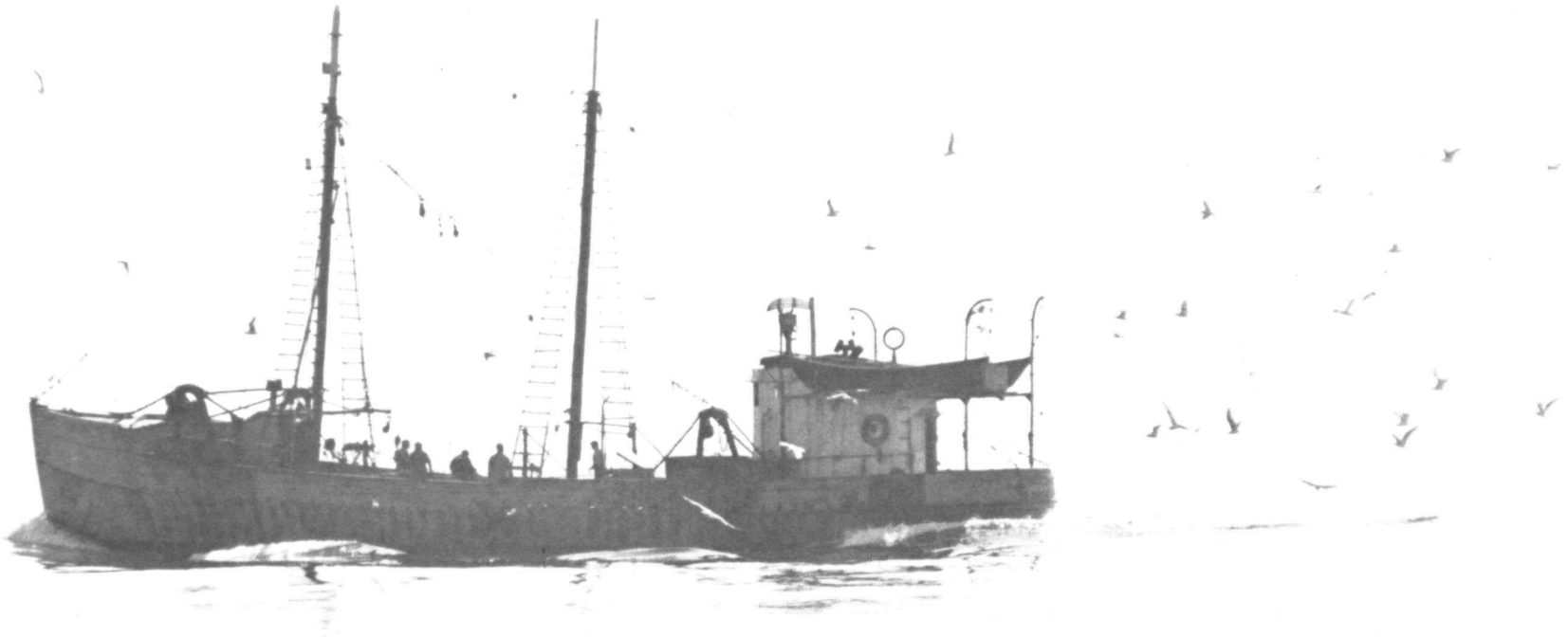
The researchers found that a Georges Bank oil discovery in itself would have little effect on employment in the region. If regional refining is brought into the picture, refinery-related employment could





In the Gulf of Mexico, oil rigs and platforms (left) co-exist with both commercial and sports fishing boats, while oil company work boats shuttle the roughnecks (drilling crew) back and forth and provide supply and equipment support. Oil spills are always a threat; among efforts to reduce the threat are Coast Guard oil containment operations (upper right) and such alternative as this "Skimmer" in operation (lower right).

Present-day fishing operations on Georges Bank. After the cod or other fish are brought aboard, checkers cull the catch and gut the fish, preparing them for the return to port and transshipment to market.



Ubiquitous companions of fisherman, gulls hover around this Boston trawler—typical Georges Bank fishing vessel—on a calm day.

be quite significant in situations of moderate underemployment or sharp unemployment. On the other hand, if refineries increase the incidence of nearshore spillage, the loss in regional income associated with the spillage could be greater than the increase in regional income due to regional refining.

The loss in regional income due to interference with the Georges Bank fishery appears to be small compared to the increase in regional income associated with an oil find. However, the M.I.T. report cautions, the loss in fisheries income will be concentrated in a segment of the population which under current roles of the game would not otherwise be compensated.

The potential biological impact of oil activities on Georges Bank received special attention. The M.I.T. group found that the most important factor was whether a spill occurred offshore or nearshore. A very large offshore discovery, they concluded, would roughly double the potential amount of oil spilled in the region. Of this spillage, 1–5% would reach shore in the summer and almost none in the winter, because of the prevailing winds in the area. The summer spills would require 30 days to come ashore and by then would be "well-weathered" by action of waves, winds and tides. The oil would not come to shore as one coherent mass but rather in the form of dispersed tar balls.

Nearshore spillage is a substantially more severe biological problem, the Sea Grant team concluded. If the region refines its distillate products, nearshore spillage could be increased by 30% to 100%. The probability of spillage is also greatly increased, they found, when barge transport of products is employed rather than pipeline.

The immediate toxic responses to oil occur in the first 24 to 48 hours following a spill. If the toxic components were to penetrate nearshore sediments, they would be less subject to biodegradation and more capable of affecting the environment for longer periods. When crude oil and oil products are spilled, they are altered by evaporation, dissolution, bacterial, and chemical action. Weathering due to environmental exposure affects both the contamination level and the relative composition of the pollutant.

The particular type of oil spilled is another important factor which determines the biological impact, they found. The key variable appears to be the concentration of the aromatic compounds dissolved in the water column. Despite their overall similarities, different oils and oil products exhibit a great variety of composition.

The researchers have emphasized that the results of their investigations made no suggestions for the future of oil development in New England. Their method of study was to employ hypotheses by which a model could be constructed as a means to pursue objectively based research.

In summation, the results of the research indicate:

1 New England's employment would not be appreciably affected by petroleum development, except at times of high unemployment and underemployment;

2 Fuel prices would not appreciably decrease because New England would still depend on imported fuel and the foreign nations will still require high prices;

3 If oil were marketed in New England, prices would be comparable to those of imported oil.

The economic pressure to develop Georges Bank, the team concluded, is independent of an import quota. If foreign crude prices do not continue to escalate, the only noticeable result of abolition of the quota would be a reduction in lease bids. The important factor, however, is whether the region would receive the lease and royalty payments or whether these payments would go to the federal government. Should New England control these payments, the increase in regional income could be quite large.

Oil exploration and discovery would not materially upset the Geoges Bank ecosystem, the researchers say. Any oil spill originating from the Bank could possibly reach shore (a 1–5 percent probability in the summer and practically nil in winter). Such a spill would not come ashore as one unit but in the form of dispersed tar balls. However, nearshore spillage resulting from coastal tanker traffic could cause biological and recreational disruption which could exceed the economic benefits of regional oil refining.

Should New England explore the Georges Bank and exploit any possible oil reserves? The M.I.T. researchers opened the doors to rational discussion and made critically apparent the necessity for continued study to understand the ramifications of any future developments. □

Donald F. Moore, retiring Assistant Administrator for Environmental Modification, gives a wide-ranging interview on

CHANGING THE WEATHER

Donald F. Moore retired on June 30, 1973 with 33 years of Government service.

He was appointed Assistant Administrator for Environmental Modification when that post was created in a NOAA reorganization in June 1972. In that capacity he served as NOAA's policy officer for activities related to environmental modification—both intentional and inadvertent. He also administered Department of Commerce responsibilities under the 1971 legislation requiring that all non-Federal weather modification activities in the United States and its territories be reported to the Secretary of Commerce.

Previously Mr. Moore served as NOAA Assistant Administrator for Policy and Plans since the agency's establishment in October 1970, and as Assistant Administrator for Plans and Programs in the Environmental Science Services Administration from 1968 to 1970.

He was born in Clinton, Wisconsin, and attended Delavan High School, Delavan, Wisconsin. He enlisted in the Air Force in 1940 and was trained as a weather observer and forecaster. He was commissioned a second lieutenant in 1942, after attending Officer Candidate School.

His Air Force assignments included duty as inspector of weather facilities throughout the United States, as operations officer for weather squadrons in Brazil, Japan and Germany, and as assistant weather officer of the Eighth Air Force, Strategic Air Command.

From 1950 to 1952, he worked in the Plans Office at Air Weather Service headquarters. He was then transferred to the Joint Chiefs of Staff in the Pentagon, where he was assigned as Secretary of the Joint Meteorological Committee. He also was designated Secretary for the Standing Group Meteorological Committee of the North Atlantic Treaty Organization, the Canada-U.S. Regional Planning Group Meteorological Committee, and the Subcommittee on Aviation Meteorology of the Air Coordinating Committee. From 1959 until 1961 he served with the Air Force Systems Command as deputy director of a research and development project to improve the weather service.

He joined the Weather Bureau—now NOAA's National Weather Service—in 1963 as military advisor to the Chief of Bureau and also held the post of acting chief of the Office of Planning.

Retiring from the Air Force in 1964 with the rank of Colonel, he served as Deputy Federal Coordinator for Meteorological Services and Supporting Research, until his 1968 appointment as ESSA Assistant Administrator for Plans and Programs.

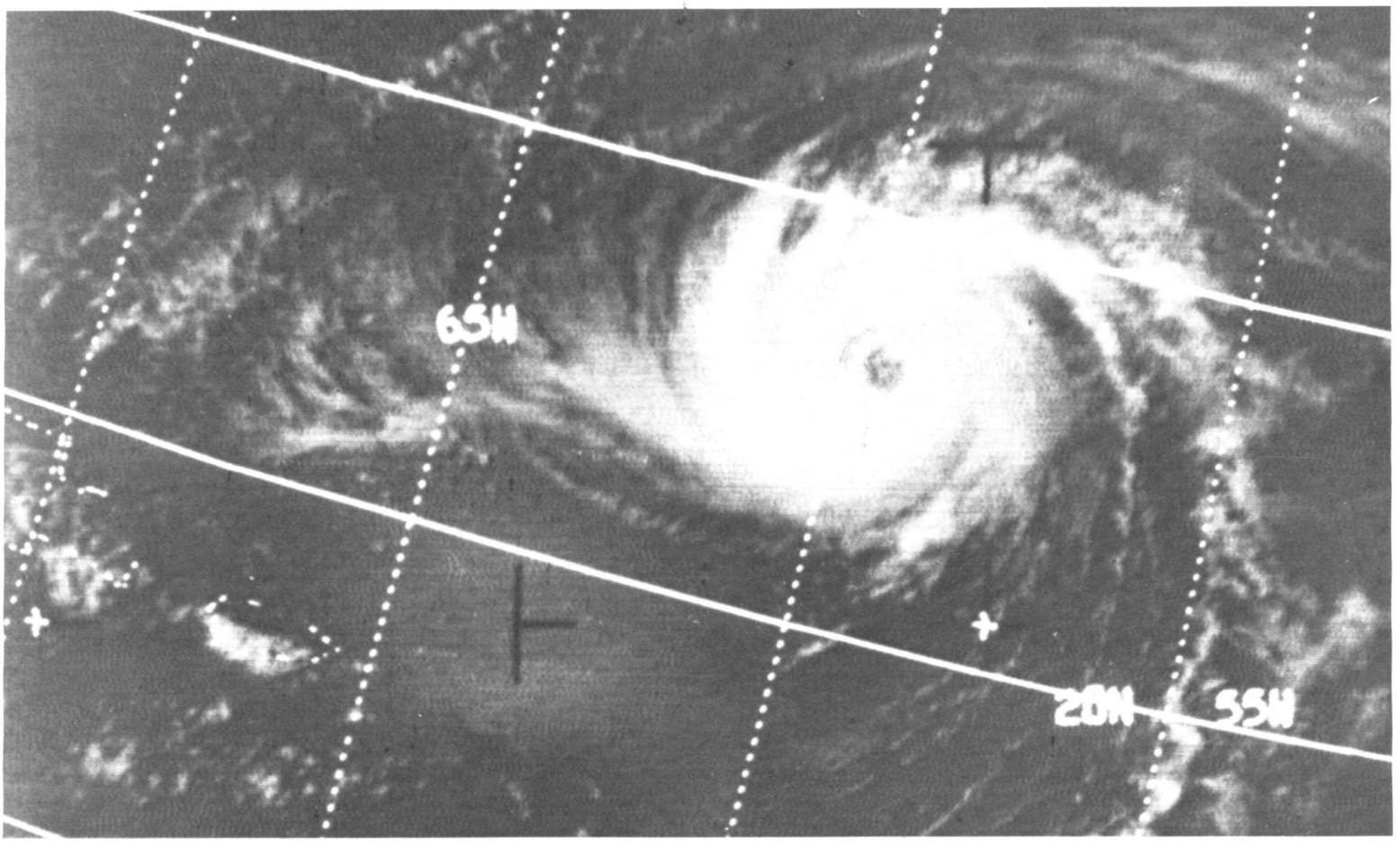
He won the Commerce Department's Gold Medal in 1971 for his outstanding leadership as NOAA Assistant Administrator for Policy and Plans.

Mr. Moore has studied at the University of Maryland, George Washington University, American International College, Montgomery College, the Institute of Tropical Meteorology at San Juan, and various military institutes including the Air Command and Staff College and the Air War College at Maxwell Air Force Base. He is a professional member of the American Meteorological Society.

Herbert S. Lieb interviewed Mr. Moore for NOAA Magazine

Donald F. Moore

Hurricane Debbie, large eye clearly visible, is seen from ESSA 9 satellite at 2 p.m. on August 19, 1969. Hurricane Debbie gave NOAA's Project Stormfury the most positive results in history of this long-term hurricane modification effort.



Q. A great many of the NOAA family know little or nothing about weather modification; we'd like you to give them an introduction to the subject.

A. Fine.

Q. Weather modification is often confused with weather control. Could you explain the difference?

A. Weather modification is intended to produce a transient effect on the weather for immediate local benefit; climate control would have a long-term lasting effect. Weather control is a confusing term, since it can mean either weather modification or climate control.

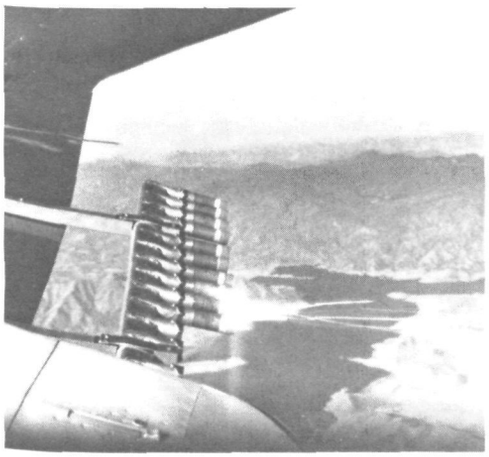
Q. We usually think of weather modification in terms of cloud seeding. What other kinds of weather modification are envisioned and how far along are they?

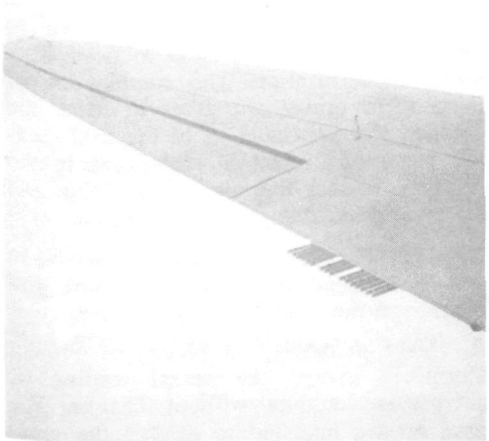
A. There are experiments which seek to alter the electrical properties of clouds to enhance precipitation. Dr. Heinz Kasemir of our Atmospheric Physics and Chemistry Laboratory has produced some interesting results through the use of metal chaff to reduce the electrical potential of severe thunderstorms and hence the lightning. Thin films have been laid down on water surfaces to inhibit the transfer of vapor from the water surface to the atmosphere. Possible applications include reducing the water loss from reservoirs resulting from evaporation, cutting off the source of moisture which leads to fog formation and depriving the hurricane of the energy it draws from the ocean's surface. Other approaches to fog involve the use of the downwash of a helicopter to blow a hole in the fog and the use of heat sources along runways to dissipate the fog. One of the oldest forms of weather modification is the smudge pots burned in orchards to protect fruit crops from freezes. There have been many other approaches to weather modification beyond the conventional seeding techniques.

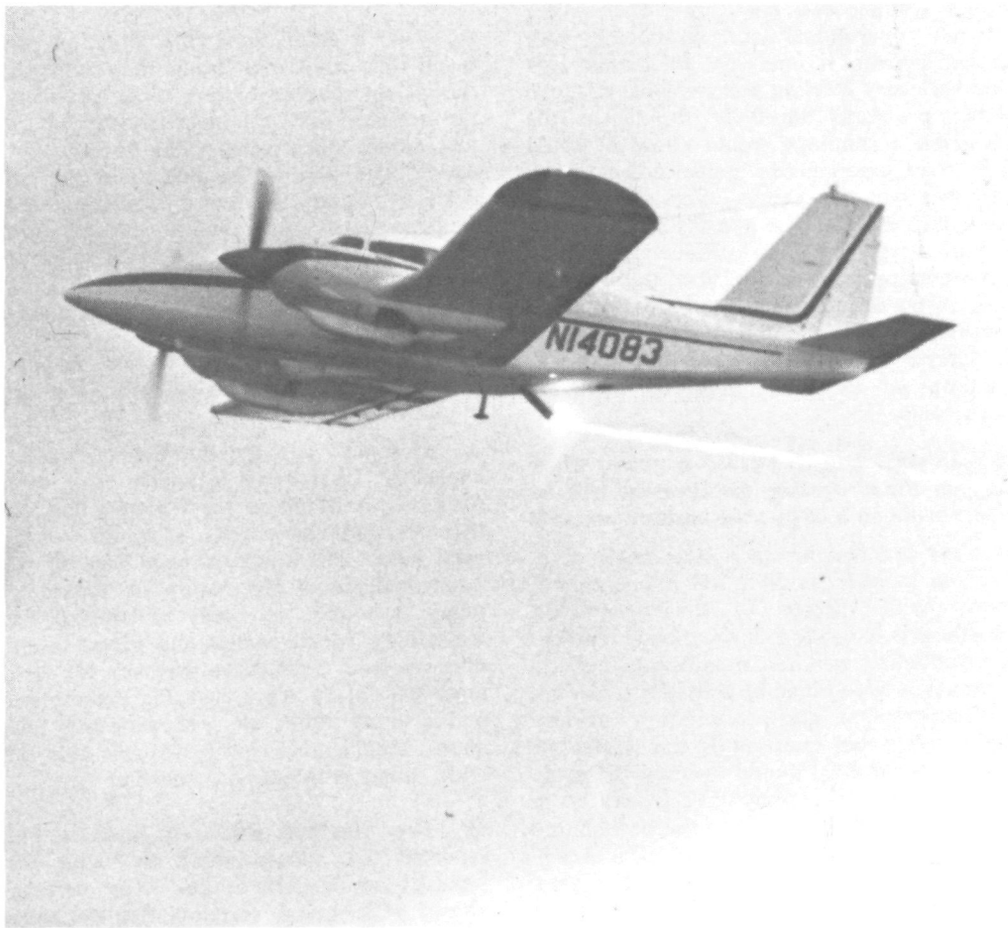
Q. What are some of the new technologies—seeding techniques, sensors, aircraft, hardware—being applied to weather modifications?

A. The basic technology in weather modification really hasn't changed appreciably in the past ten years. Silver iodide, dry ice and salt combine to be the primary seeding agents and delivery is by ground and airborne dispensors. Work continues on developing more efficient seeding agents with emphasis on those which will have no adverse ecological impact. The National Hail Research Experiment of the National Science Foundation plans to employ aircraft launched rockets this summer to achieve better targeting of the seeding agent within the storm. Work continues on improving cloud physics instrumentation which are vital to increased knowledge of the micro-physical change that actually result from cloud seeding. Computer modeling has made substantial progress and its role in successful weather modification is assuming ever-increasing importance. There are some developments taking place in other fields that have tremendous potential for weather modification. I think probably the best examples would be NOAA's upcoming synchronous satellite, which has the potential of contributing to our knowledge of the effects of weather modification outside of the target area, and the remote sensing work of Dr. Gordon Little's Wave Propagation Laboratory which should enable us to sense many of the physical changes taking place in clouds as a result of weather modification without having to actually penetrate the storm itself. At the present time armored aircraft is used to penetrate severe thunderstorms.

Bird's-eye view of weather modification: thin streams of silver iodide trailing from wings of aircraft, in a wide variety of locations.







Q. What kinds of weather modification programs is NOAA conducting or planning?

A. NOAA's weather modification program for the approximate future will be focused in three specific areas—the continuation of Project Stormfury, under the direction of Dr. Cecil Gentry, and hopefullly a move of that project to the Pacific in the summer of 1976; Dr. Joanne Simpson's tropical cumulus work in Florida, which is progressing very well, and involves a major experiment this summer; and a reorientation of Dr. Helmut Weickmann's Atmospheric Physics and Chemistry Laboratory in Boulder, where we're going to turn our attention to moderation of severe storms other than hurricanes. We're going to start looking into the possibility of doing something with larger scale weather systems which have the potential for major disasters, such as East Coast winter storms, blizzards in the Great Plains, flooding and the like.

Q. How many other government agencies are involved in weather modification? And what are they doing?

A. There are nine federal agencies engaging in some form of weather modification, including the three DOD departments. I have mentioned to you the three programs of the Department of Commerce. The Department of Agriculture's interest is primarily in lightning suppression. The Department of Interior's concern is in augmenting the water resources of the country. DOD is engaged in fog suppression—both cold and warm fog, and in some precipitation enhancement activities and has been a joint sponsor with NOAA in Project Stormfury for the past ten years. The National Science Foundation in addition to conducting the National Hail Research Experiment, contributes to the fundamental knowledge in all areas of weather modification and carries on economic, social, legal and ecological studies associated with weather modification. NASA has a small program in fog and cloud modification. Lastly, the Department of Transportation is primarily concerned with the dissipation of fog over airports.

Q. What kind of inter-agency groups or federal offices are now coordinating the program and problems in weather modifications?

A. The Federal weather modification programs are coordinated within the Interdepartmental Committee for Atmospheric Sciences of the Federal Council for Science and Technology through its panel on Weather Modification. ICAS has issued a report, ICAS 15A, which sets up national weather modification projects and recommends accelerated progress in these areas.

Q. What kind of weather modification has been most successful so far?

A. There are two areas in which most people active in this field will generally agree that weather modification shows some success. One is what is called orographic winter cloud seeding, and this is done primarily in the western part of the United States. It involves seeding of clouds on the upslope side of mountains for the purpose of increasing snowpack to increase run off of water into the reservoirs. Some of these programs have been going on successfully for as much as 20 years. The other area is the elimination of cold fog. This program is carried out commercially by some of the airlines and by the U.S. Air Force, and very successfully so. Now there are some programs nearing an operational stage. Dr. Simpson's program has promise in this direction and some of the work of the Bureau of Reclamation in the western part of the United States is in a similar category.

Q. If you were to rate the various proposals for weather modification, which types would you say show the earliest promise for economic benefit?

A. Well as I mentioned earlier, orographic cloud seeding and cold fog dispersal are already operational and producing economic benefit. If one were to assume that the necessary funding was available to move other programs ahead as rapidly as the available technology would allow, I would say that precipitation enhancement from summer cumulus clouds offers the earliest economic benefit. The benefits include additional water for crop production, power consumption, and so on. Also, the moderation of hurricanes may yield early economic benefit, because the funding for this effort is proposed to be a level necessary to achieve an early capability to moderate hurricanes.

Q. If you were to hazard a guess, when do you think weather modification will be operational on a large-scale basis all around?

A. It's not possible to give a single date, because weather modification is operational today with respect to the orographic clouds and cold fog I mentioned earlier. Conventional weather modification efforts embrace a wide range of activities including hail suppression, and precipitation augmentation. The real question is the degree of success achieved. I would defer to the goals of the National Academy of Sciences Report on Weather Modification as the best source for any conjecture in this area. The Academy is looking toward 1980 as the year in which it should be possible to identify the conditions under which precipitation can be modified on a predictable basis. I would hasten to add that the projection is based on a rather large budget that was foreseen as needed by the National Academy—a budget which far exceeds the present expenditures in the Federal government.

Q. Do you feel that NOAA and other scientists concerned with weather modification have developed experiments to the point where a broader fundamental understanding is a condition to further development?

A. Yes. I feel that a lack of fundamental understanding of the physics, the dynamics, and electrical properties of both modified and unmodified clouds is definitely limiting progress in this field. What is needed, and this has been brought out by a number of groups, the National Academy of Sciences in their forthcoming report on weather modification, by the National Advisory Committee on Oceans and Atmosphere, by NOAA, and by the Bureau of Reclamation, is a first-class, well-controlled and well-instrumented field experiment carried out somewhere in the High Plains area of the United States. Knowledge gained from such an experiment would have direct application to weather modification for precipitation augmentation, lightning and hail suppression and the moderation of storms.

Q. Because of the complex, and often very controversial questions and problems involved, do you see weather modification moved indoors, that is, in the laboratory, using high-speed electronic computers and mathematical modeling?

A. No, I don't think the situation will reach that point, nor would I wish to see this occur because I don't think you'll get the answers that you need in the laboratory alone. Some states today do not allow operational weather modification but are perfectly happy to see a well-conceived, well-conducted experiment carried out. Success in weather modification depends on a combination of mathematical modeling, laboratory studies and field experiments.

Q. Over the horizon, do you see any hope at all for taming tornadoes with weather modification?

A. If I gave you the impression that we expect to be taming tornadoes any time soon, I didn't intend to. I would not say that it's impossible, but I would put it very far in the future, simply because we don't understand the nature of tornadoes today, and until we really understand the mechanism which creates and drives tornadoes we don't really have the basis for their modification. So it's a two-step proposition and I don't think we can seriously talk about modification until we are able to make some progress with the first step.

Q. The Stanford Research Institute has reported that man's ability to lessen the intensity of hurricanes has been demonstrated with enough certainty that the technique should be used operationally now to save lives and reduce damage in coastal areas? What is NOAA's position in this?

A. NOAA disagrees with the findings of SRI in this regard. We have had, since the beginning of Project Stormfury, two good storms for our experiments. These were on the same storm, Hurricane Debbie, in 1969. While the results of these two experiments were extremely encouraging and tended to support the hypothesis underlying the experiment, many more experiments will be necessary before one can say with any certainty that we do know that a given treatment of a storm will produce a specific result. In addition, a storm does many things. What Debbie has shown is that we've apparently been able to diminish the peak wind in a hurricane by 15 to 30 percent in these two cases. There are, however, a lot of unanswered questions. Will we get the same results in future hurricanes? What happens to the storm surge as a result of reducing the winds and spreading the storm? Could we in fact increase the amount of damage along the shore as a result of increased storm surge? We don't think so, but we don't know for certain. What happens to the precipitation pattern? Precipitation is an extremely important aspect of hurricanes and typhoons and one would not want to appreciably decrease the precipitation along the east coast of the United States, if this were, in fact a byproduct of hurricane moderation. There are a great deal of things we don't know about the moderation of hurricanes and additional experiments are clearly in order before NOAA could assume responsibility for recommending an operational program.

Q. Since hurricane modification experiments have demonstrated promising results and potentially significant benefits, why was Project Stormfury discontinued?

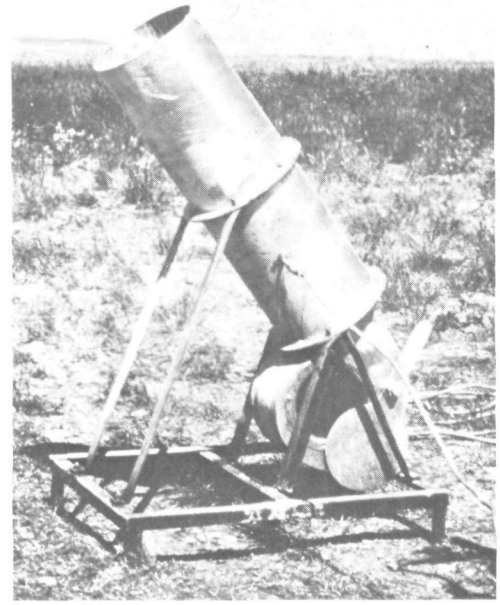
A. Well that does sound a little inconsistent, but there's an exceptionally good reason for it. As I pointed out earlier we've really only had two good storms in a ten-year period, consequently progress has been painfully slow in Project Stormfury. In addition, DOD elected no longer to fund its own participation in Stormfury and NOAA was faced with paying the full bill with the DOD participation being on a reimbursable basis. Finally the NOAA Research Flight Facility aircraft and instrumentation were getting very old and expensive to maintain and the RFF was in need of a major modernization. The combination of those three things caused us to reach the decision that continuation of the field seeding phase of Project Stormfury as in the past was neither feasible nor desirable and a new approach was clearly required.

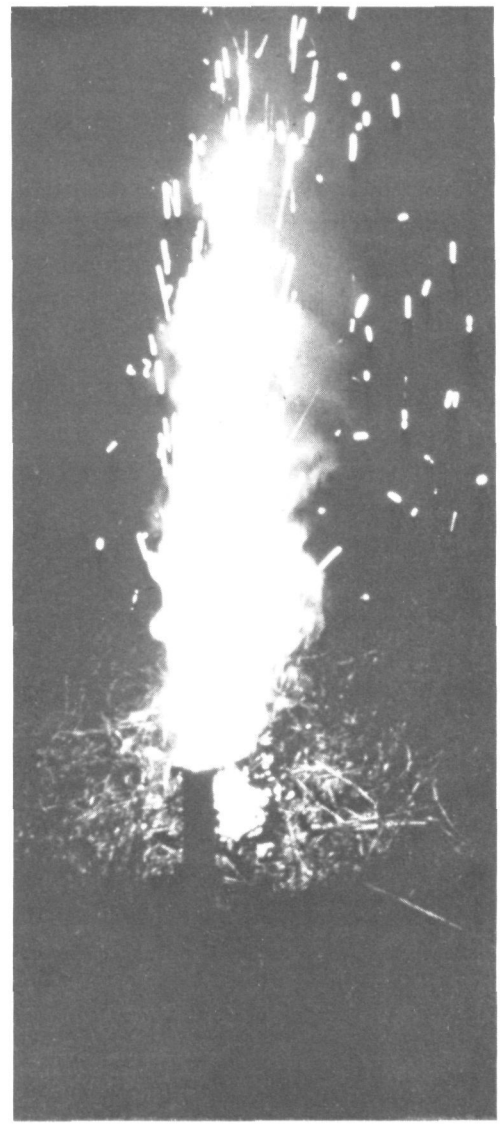
Q. Will Project Stormfury be reinstated, and if so when? and where? I believe you mentioned the Pacific as a possibility.

A. Very definitely, all phases of Project Stormfury except the actual seeding of hurricanes continue without change. We have always intended to resume the seeding experiment. It is my personal view that Project Stormfury is the most important weather modification project in the nation. In fact, the course we are taking should result in our obtaining additional experiments at a far more rapid rate than we have been achieving in the Atlantic. Our plan calls for a modernization of the Research Flight Facility while at the same time reducing it from four to two aircraft, i.e., two four-engine turbo-prop aircraft. Using these two aircraft in conjunction with three similar Air Force four-engine turbo-prop aircraft based on Guam (which NOAA will instrument and fund for) we should have the capability to carry out the project in the summer of 1976 in the Pacific. We fully expect that in the first summer of operation in the Pacific, NHRL will be able to seed at least three good typhoons and if our expectations are realized we will have had more successful experiments in a single year than we have had in the past ten.

Q. The Research Flight Facility has been heavily involved in weather modification other than with hurricanes. Will the reduction in the RFF have a serious impact on NOAA's weather modification program?

A. No, we do not believe so. The B-57, one of the aircraft that we have declared surplus, had ceased to be used. It was a highly specialized aircraft and the require-





A silver iodide generator, a prime tool of the weather modifier's trade, is raised vertically by EG&G Company employee at Fort Lewis College.

Ground-based silver iodide in acetone solution burner, top. Below, a pyrotechnic hygroscopic generator burns brightly from ground at night.

ments for it were very limited. The two DC-6's are to be replaced with a single new four engine turbo-prop aircraft and this aircraft will have considerably more capability than the two 6's in terms of payload, range, etc.—so I would say that no, the RFF's ability to support our weather modification program is not significantly affected.

Q. Is there a weather modification scheme that could be applied to mitigating such disasters as the recent Mississippi Valley floods?

A. Certainly not at the present time. As I mentioned earlier, Dr. Weickmann's lab is being reoriented toward looking at what might be done with the larger storms, but I would think that it would be many years before we could hope to be able to have any effect on storms as widespread as the ones that led to the serious flooding of the Mississippi River.

Q. Whenever there is a major disaster such as Hurricane Camille, or the widespread flooding from Agnes, or the Rapid City flood, there is always speculation that cloud seeding was a contributing factor, or even caused these catastrophes.

A. Oh yes, the speculation is always there. We answer a great deal of correspondence along these lines. The fact of the matter is that weather modification played absolutely no part in Agnes, which was of course the major natural disaster in recent years. A number of people have suggested that Agnes was seeded. This was not the fact at all. In the Rapid City situation, seeding, not by NOAA, was actually going on just prior to the disaster itself. However, the facts surrounding that particular case have been gone into extensively by people knowledgeable in weather modification and there's general agreement that the seeding activities could not have contributed to the disaster, which was certainly natural in its origin.

Q. People tend to seek help from weather modification agencies whenever a prolonged drought is upon us. Doesn't drought by its definition preclude beneficial results?

A. It certainly doesn't enhance the possibilities of success in a weather modification activity, because by definition you're short on clouds to begin with. It is my view that weather modification can do little to ease a major drought once it is well underway. If the weather modification funds which seem to become available after disaster has struck could be made available when the situation begins to arise, the possibility of getting some positive results would be greatly enhanced. From past experience, attempts at mitigating drought with weather modification on an emergency basis have produced questionable results in terms of increased water and produced practically nothing in the way of scientific information.

Q. Would you say that there is a difference in conducting, say, a cloud seeding experiment to relieve drought in Florida from say, conducting a similar experiment in Oklahoma?

A. Most certainly. The characteristics of cumulus clouds differ widely between geographical areas and the dynamic seeding techniques which work in Florida, may or may not be the correct treatment for Oklahoma or nearby states where perhaps passive silver iodine or salt seeding may be more effective.

Q. How much would you estimate the Federal Government is now spending on weather modification?

A. The combined federal funding on weather modification has been about $20 million a year for the past two years—that is FY 1972 and 1973. The President's FY '74 budget request has reduced this to something on the order of $16 million in line with his efforts to hold down federal spending.

Q. How much do you think we will be spending ten years hence?

A. Well, in view of the numbers I just gave you, if I were to extrapolate the present situation we could be out of business in ten years. I really don't believe this. The National Academy report suggests that a spending level of $50 million a year is justified on the basis of the potential benefits of weather modification. I don't expect Federal spending to reach $50 million in the next several years, but I do expect we will see a moderate upturn shortly.

Q. Does NOAA's new role in reporting of nonfederal weather modification activities carry with it any regulatory responsibilities?

A. No regulation of weather modification activities is involved.

Q. What recommendations would you make for the study in effective handling of the socio-economic, legal and associated ecological problems?

A. Well that's a rather broad question, but an important one. At the present time most of the studies that are carried out in this area are funded through the Research Applied to National Needs program of the National Science Foundation, and I think that is a proper place for them. It is essential that these types of studies be carried out in each area of weather modification, e.g., fog modification, hurricane modification, hail suppression, and so on. Unless careful attention is given to possible socio-economic, legal and ecological problems as the technology moves forward, it is possible that some of these factors will inhibit effective operational application once the technical capability has been achieved.

Q. How many states now have some kind of regulation for weather modification activities?

A. Nineteen states are known to have statutes on their books dealing with weather modification. The legislation ranges all the way from prohibition of weather modification to very sophisticated laws providing for issuing of permits and licenses.

Q. Are there a lot of non-government weather modifiers?

A. Yes. I can't give you the precise number at the moment because we only began our reporting requirements in October and people are only required to report if they're currently active. Since most of the weather modification activity is carried on during the summertime, we don't have a complete report at the moment. However, of those currently active there are 15 different non-Federal operators.

Q. Do you think you have a pretty good knowledge of the numbers and types of non-Federal weather modification efforts?

A. I think we have knowledge of all that are currently in progress. The industry has been very good about reporting. We have a program with the National Weather Service for reporting to us any weather modification activities that their weather stations become aware of. We also maintain a clipping service which covers all weather modification activities reported in major newspapers.

Q. What good is reporting without regulation?

A. It is extremely valuable from the standpoint of being able to provide information to the general public and to other Federal agencies of the activities of non-Federal weather modification organizations. In the past there have been cases where Federal experiments have produced confusing results because the experimenting agency was unaware that a private operator was operating upwind and was contaminating the experiment—so it's important to know who's operating where. In addition we receive many letters from people who feel certain that weather modification is responsible for the unusual weather that they are having and we are able to satisfy them that weather modification is not the cause. The reports are also a prime ingredient in an annual report that we issue on the state of weather modification in the country as a whole.

Q. What is NOAA's position on whether weather modification should be done by private enterprise or by government? or by both?

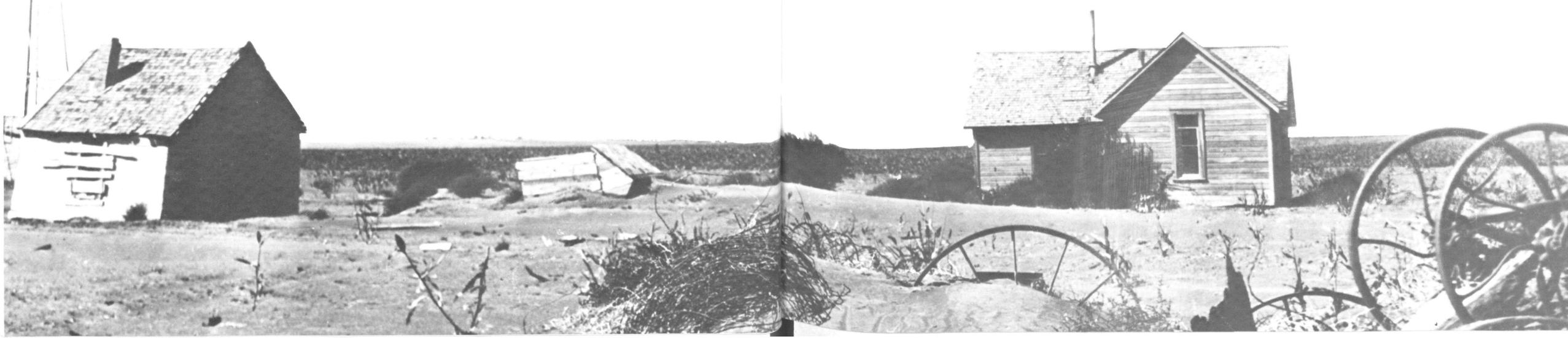
A. We feel strongly that all operational weather modification, with only one exception that I can think of at the moment, is the proper domain of the private sector. The one exception would be modification of hurricanes where the size and number of planes involved suggest that it would have to be a Federal activity. NOAA has taken the position that it does not intend to engage in operational weather modification activities—we stand ready to assist state and local municipalities in programs that they would like to institute with private operators but we do not intend to be the operator.

Q. The President's 1973 environmental message gives the DOC new responsibilities with regard to non-Federal weather modification activities. What are these responsibilities and how are they to be implemented?

A. The President directed the Secretary of Commerce to expand NOAA's present reporting procedures to provide for Federal notification to operators and state officials in cases where a report discloses that a proposed project may endanger persons, property or the environment or the success of Federal research projects. This is a very difficult charge because it puts the onus on NOAA to define what constitutes endangering persons, property or the environment and what constitutes endangering the success of a Federal project. We have been consulting closely with Federal agencies, the private weather modification community and the university community to come up with sensible safeguards in this area. We're moving slowly because it is an extremely important task and any over-zealousness on our part could effectively harm the private sector of weather modification. Our intention is to draw up the proposed rules after further consultation and then ask a committee of the National Academy of Sciences to look them over and give us its advice. We will then publish the proposed rules in the Federal Register and invite comments. Once having received the comments, we will revise the regulations appropriately and place them in effect.

Q. There's been a great deal of concern about whether in modifying the weather we may have opened Pandora's box; for example, many have said that man has already modified the global weather inadvertently to a significant degree. Do you feel this is true?

A. Well, perhaps we're mixing up long-term climatic changes with weather modification. As I mentioned in response to your opening question, weather modification as we now understand it is not likely to have any long-term climatic effect. On the other hand, the insults that the earth's atmosphere is receiving from both man-made and natural causes are very likely to have long-term effects. We don't know what these are at the present time as we're just beginning to appreciate the potential seriousness of the problem. We must first set up a world-wide monitoring network to find out just what changes are taking place in the atmospheric constituents. That will be followed by an analysis of these trends and then ultimately a determination of the implications these hold for the climate and for man.



Silver iodide generator, from which winter storm clouds are seeded on random time schedule, sits 7000 feet up west slope of Bridgier Ridge, Montana. It is operated by Montana State University under a contract with the Bureau of Reclamation.

—Bureau of Reclamation Photo

Q. Please elaborate a bit on what NOAA and others are doing in monitoring global changes.

A. The Stockholm Conference provided strong support for global monitoring of the atmosphere. The U.S. has been a leader in this field. The NOAA Observatory at Mauna Loa represents the longest continuous record of changes in the atmosphere. We have also cooperated with the National Science Foundation in a similar location in Antarctica, and this year we are opening our third station at Barrow, Alaska. Our plans call for another station in Samoa and stations on the East and West Coasts of the United States. This will represent the U.S. contribution to a world-wide monitoring network and it is a substantial one.

Q, Is there a relationship between a single cloud seeding experiment and possible changes in rainfall over thousands of square miles?

A. There is certainly no present evidence to suggest this.

Q. Has a downwind effect of cloud seeding been demonstrated?

A. Yes, in a number of specific experiments there have been indications of a downwind effect. At this time we do not know enough to accurately describe the nature of the downwind effect, but there certainly is enough evidence to indicate the possibility of not only downwind but upwind and lateral effects as well. This subject is in need of additional study.

Q. Could cloud seeding over Florida affect some of the Caribbean Islands, for instance?

A. Certainly not the experimental program being carried out in Florida at the present time. The answer is less clear if one were to go operational in Florida on a large scale. I think it would be necessary to conduct studies to answer the question you have posed before large-scale operational seeding is conducted.

Q. If you do seed clouds in order to augment rain in one area, doesn't this decrease the water supply elsewhere? Or do we know?

A. In fact it may increase it, but I wish we knew. This is an extremely important question from two standpoints. First, from the standpoint of conducting a successful experiment, simply because if you don't know whether you're having an effect outside your target area you may, in fact, be compromising your control area and therefore compromising your experiment. More importantly, if there are extra area effects, and incidentally these effects may be felt upwind and laterally as well as downwind, then the operational implementation of weather modification will become an increasingly complex problem. You're going to have to consult people outside of a target area as well as people inside, since those outside may or may not wish to have their weather modified.

Q. There has been speculation that the wide-spread use of silver iodide in weather modification experiments has a potentially damaging ecological or biological effect. What is your opinion and what is being done to examine this contention?

A. On the basis of available evidence, none of the activity at the present time poses any ecological harm. In terms of potential, one would have to project where the operational program might lead. For example, how much silver iodide is going to be discharged into a given area of the atmosphere and over what period of time? It's a topic for study that's been going on for some time. In addition, other seeding agents are being studied in an attempt to improve the efficiency of the precipitation process and to minimize or eliminate any possible ecological impact.

Q. There have been charges that scientists have arrogated weather modification to themselves and have excluded the public. Is this true?

A. No. This is not generally the case. There may have been isolated cases of this in the past but the weather modification community, both Federal and non-Federal, has come to realize that you cannot successfully carry on weather modification experiments unless you have the support and the assistance of the people in communities being affected. If you try to operate without grassroots support, you're going to fail.

Q. It's obvious that no matter how you modify the weather some people will like what is done and others won't. How do you think one should deal with this?

A. Perhaps the best way to get over this problem is to improve our state of knowledge in weather modification so there aren't so many uncertainties. The problem arises at the present time, primarily because there are so many conflicting views as to just what is accomplished by a given weather modification activity. So I would say the answer rests in (1) learning more about what the effects are of a given treatment, and (2) educating the public once this knowledge is obtained.

Q. If I, as a private citizen, thought I had a really great original idea on how to prevent tornadoes or make rain, who would listen to me?

A. NOAA for one, and just about any Federal agency with an interest in the type of weather modification you have in mind. We receive a large number of letters on this subject. We carefully review each proposal received and supply the correspondent with our views as to his approach. We encourage all suggestions on any aspect of weather modification.

Inadvertently man has interfered with nature throughout history.

Through rain dances and other ceremonies, he has sought weather modification for an equally long time.

But the modern scientific era of weather modification began in 1946 when two scientists, Vincent J. Schaefer and Dr. Irving Langmuir, experimented with cloud seeding by dropping dry ice into supercooled clouds over Massachusetts' Berkshire Mountains. The seeding experiment was repeated in Oregon shortly afterward by the Weather Bureau and the Portland *Oregonian.* Later, Bernard Vonnegut discovered that the smoke of silver-iodide crystals worked as well as dry ice.

These early experiments produced scientific interest and captured the public imagination. Here might be a cost-effective way to produce precipitation.

Scientific tests in the 1950's, however, suggested that before precipitation could be increased significantly, much more had to be learned about natural precipitation processes.

Weather modification research received new recognition in the early 1960's as a result of cumulative advances in science and technology during the previous decade.

With the aid of high speed computers, specialized radar, weather satellites and much improved aircraft instrumentation, scientists felt they were now in a position to make a rational and formidable attack on the weather modification problem.

Scientists from NOAA took a significant role in these new and exciting ventures.

Patient men with hemp rope and piano wire have given way to electronic echo sounders

Plumbing The Trackless Depths

BY RAYMOND WILCOVE

Lt. R. R. Lukens, USC&GS, was not believed by ships that passed in the night.

"Ahoy the BLAKE," hailed a passing sea captain, to a Coast and Geodetic Survey ship lying motionless in mid-Atlantic. "Can I help you?"

"No, thanks," replied her skipper. "We're anchored and require no help."

Anchored? In the middle of the Atlantic ocean? Expletives crackled through the still air, as the good sea captain—thinking he was the butt of sarcasm—exploded in anger, and sailed off to report that he had passed a crazy ship with a crazy skipper.

It was late in the 1890's, and the BLAKE's captain was Cdr. Charles D. Sigsbee, who later went down with the MAINE when it sank in Havana Harbor in 1898.

But Sigsbee wasn't disoriented, merely engaged in deep sea sounding. By an elaborate use of shock absorbers and wire rope, he had managed to anchor in a depth of 2000 fathoms, about 12,000 feet.

Sigsbee wasn't the first to make soundings in the deep sea, but the practice was still relatively unknown to merchant marine skippers, who hadn't heard of Sir James Clark Ross and his famous oceanographic research vessel, HMS EREBUS. Ross is generally credited with proving that the sea is not bottomless, as had been generally believed until then.

The British captain recorded a depth in the South Atlantic of 2425 fathoms, about 2¾ miles, on January 3, 1840. Ross's sounding took one hour. Almost exactly 128 years later, it took the NOAA Ship DISCOVERER, with its sophisticated electronic sounding equipment, only a few seconds when it re-enacted the historic event on January 22, 1968. The DISCOVERER found that the depth was 678 feet less than recorded by Ross.

But considering the equipment Ross was forced to use, the discrepancy was not considered out of bounds.

Ross was on a four-year voyage when he made his sounding. In his book, "A Voyage of Discovery and Research in the Southern and Antarctic Regions During the Years 1839–43," Ross described how he had plumbed the depth of the "bottomlesss" ocean.

"We had made several fruitless attempts to obtain soundings as we passed through the tropics. These repeated failures were principally occasioned by the want of a proper kind of line, but they served to point out to us that which was most suitable.

"I accordingly directed one to be made on board, 3600 fathoms, or rather more than four miles in length, fitted with swivels to prevent it unlaying in its descent, and strong enough to support a weight of seventy-six pounds.

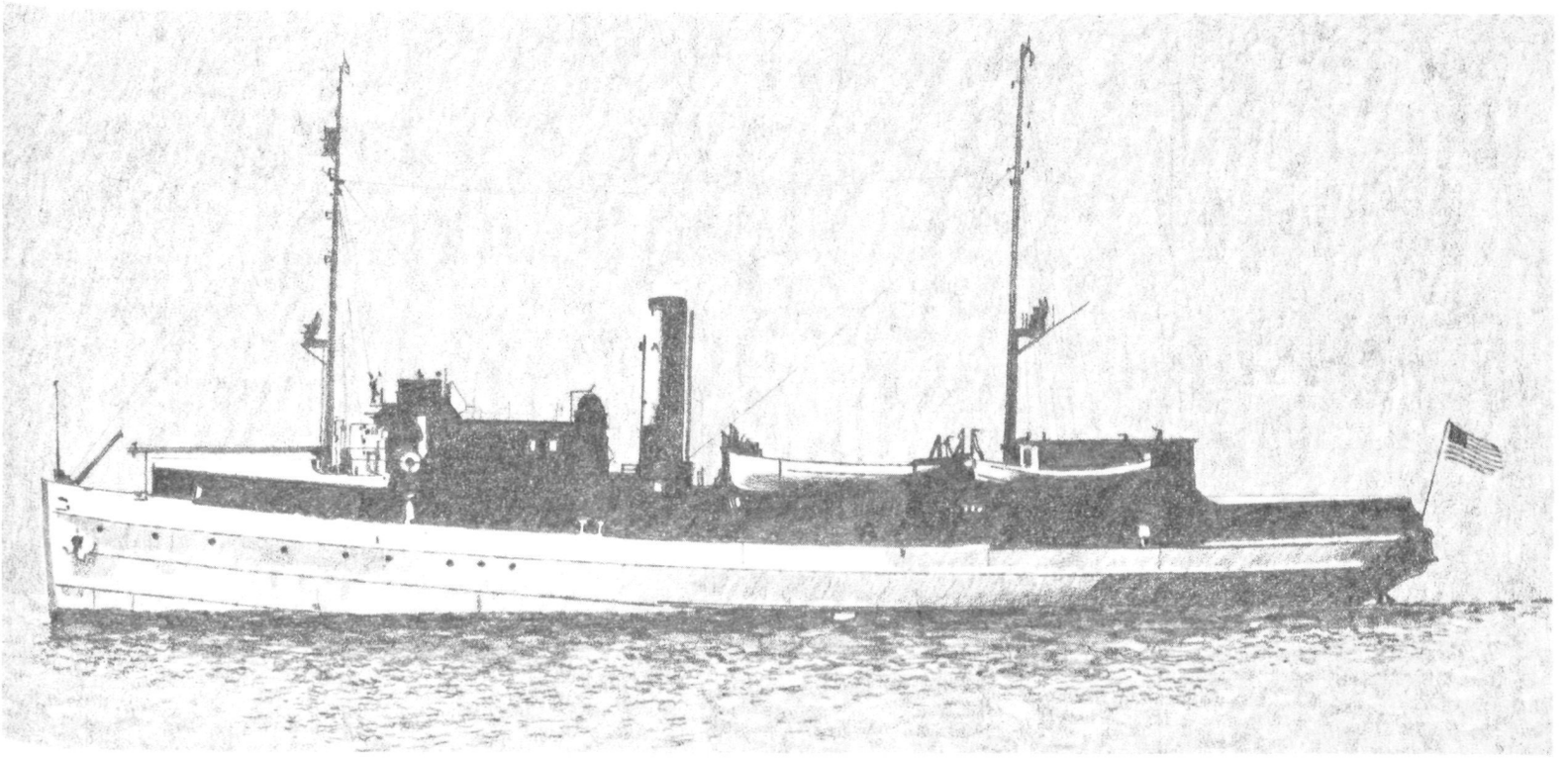
"On the 3rd of January, in latitute 27° 26′ S., longitude 17° 29′ W., the weather and all other circumstances being propitious, we succeeded in obtaining soundings with 2425 fathoms of line, a depression of the bed of the ocean beneath its surface very little short of the elevation of Mount Blanc above it."

So Ross proved that the sea had a bottom and it was not too many years later that Sigsbee anchored in the mid-Atlantic to do his "thing." While we do not have a detailed explanation of the methods Sigsbee used, a 49-year-old account has come to light of soundings taken in Alaskan waters during the first quarter of the 20th century. Except for improved equipment, the methods utilized in the frigid waters of Alaska were probably not much different from those employed by Sigsbee.

The detailed explanation of the methods used for sounding in the deep sea were set out by Lt. R. R. Lukens, the Commanding Officer of the C&GS Steamer PIONEER. Written in 1924, the account makes interesting reading when compared with the much more sophisticated methods used today. NOAA ships are now equipped with data acquisition systems capable of automatically recording and plotting simultaneously hydrographic and ship positioning information. The vessels use an electronic echo sounder to measure and record water depths and locate submerged features, and satellite or long-range electronic positioning systems to position properly the feature on published charts. The instrument records depths by measuring the velocity of sound waves. Returning echoes are converted to depth and form a continuous graphic profile of the sea floor. As this is done, fast automated equipment codes and plots the information.

But the development of the echo sounder as a vehicle for determining deep sea depths did not come until well after World War I and the methods used in the 1920s were a far cry from those used now. Lukens, who died in 1964, revealed, in describing the work of the PIONEER, that he ran into the same problems Sigsbee did in the previous century.

"Occasionally, while sounding at night," he wrote, "a passing steamer is attracted by our strange behavior and comes close to inquire the trouble and to ask if help is needed. When the well-meaning captain is told that we are only sounding, he lets loose a few nautical oaths and slams his telegraph full speed ahead, wondering why anyone would be so crazy as to sound in the middle of the ocean.



USC&GS Ship Pioneer sounded the ocean bottom in the 20's with five nautical miles of piano wire—a far cry from today's electronic echo sounders.

"The deep sea sounding apparatus is simple," wrote Lukens, "but its successful operation requires skill and experience. It is based on an actual wire measure while the ship remains stationary."

A fine grade of piano wire with a tensile strength of about 200 pounds was used, wound on a reel containing five nautical miles of wire, undoubtedly a considerable improvement over the hemp rope used by Sir James Clark Ross of HMS EREBUS. The reel was geared to an electric motor for winding in and was governed by a hand brake when paying out.

The wire passed off the reel over a pulley which registered the length of wire payed out and then out to another pulley at the end of a 20-foot beam extending from the side of the ship, and from there into the water.

To prevent the wire from kinking upon reaching bottom, a three-fathom (18-foot) line of hemp rope was used for attaching the sounding weight to the wire. The weight was a 65-pound cast iron shot which was fastened to a detaching rod in such a fashion that upon striking bottom the weight was detached. The weight had to be detached; otherwise the wire was difficult to haul back.

While the sounding was being made, the ship had to be kept headed into the sea, with the wind a little on the port bow, and very careful maneuvering was required to keep the sounding wire in a vertical position. This was especially difficult when the subsurface currents were different from those on the surface.

Deep sea sounding today is markedly different from the methods and equipment used by Ross, Sigsbee and Lukens. The wire sounding machine has given way to echo sounding, an outgrowth of the experimental work begun in 1912 for detecting icebergs and of the submarine detecting devices used during World War I. The Coast and Geodetic Survey, predecessor of NOAA's National Ocean Survey, was instrumental in the development of the echo sounder for deep sea sounding and hydrographic surveying.

Echo sounding is essentially a method for determining the depth of water under a survey vessel by measuring the time required for a sound wave emitted from the vessel's hull to reach the bottom and return as an echo. We are all familiar with echoes in air and realize that they are caused by reflections of sound from some distant object. If the time is measured between the production of a sound and the reception of its echo, the distance may be determined by multiplying one-half the time interval by the velocity of sound in air. The velocity of sound in the air is 185,795 miles per second.

The same principles are applied in measuring water depths by echo sounding. A sound is produced at the survey vessel. It travels to the bottom, from which it is reflected back to the vessel as an echo. From the elapsed time and a knowledge of the velocity of sound in sea water, the depth can be computed. The velocity of sound in sea water is approximately 4800 feet per second. Corrections for variances in temperature and salinity are applied to the measured depth to obtain true depth.

Echo sounding equipment is designed to produce the sound, receive the echo, measure the intervening time interval, convert the time interval into depth and register these depths on continuously fed paper and into a computer, producing a continuous profile of the bottom under the ship and a paper or magnetic tape for automated processing by shore facilities.

Our knowledge of the ocean floor has been greatly augmented by the advent of echo sounding. The measurement of great depths, which formerly required an hour or more, can now be obtained in seconds, thus making it possible to take thousands of soundings in areas where formerly only a few scattered ones were economically feasible. (The echo sounder has also revolutionized hydrographic surveying along the coast. The continuous profile eliminates the possibility of missing a pinnacle rock between individual soundings. When survey parties used a leadline before the development of the echo sounder, a party could average some 600 individual soundings a day. With the echo sounder, a continuous profile over a vessel's route equal to the vessel's speed multiplied by the hours of survey is obtained. This could amount to hundreds of thousands of readings in a day.)

Thanks to the echo sounder, the mysteries of the sea bottom are becoming better known. Just as we know now that the sea is not bottomless, so do we also know that the bottom is not all flat, as had been previously believed. It has turned out to be a fascinating realm filled with giant mountains, ranges and plateaus, with great canyons which exceed in magnitude those on dry land, and with giant fractures in the floor.

Some day, as a result of the development of the echo sounder, the bottom of the sea will be entirely mapped, but the ocean is so vast that it will be a long time before the task is completed. In the doing, many new mysteries of the sea will come to light. □

When Mother Nature runs wild, and you're isolated in your home, be ready with a

DISASTER DIET KIT

BY JOAN VANDIVER FRISCH

Every year, natural disasters of one kind or another visit the United States in spectacular fashion. They come from many sources—from winter storms, hurricanes, earthquakes, floods.

When they are over, we count our losses in terms of the dead, the injured, of property demolished, and opportunity lost. Diverse as these disasters are, all share one bond: isolation. When Nature runs wild on the grand scale, the odds are heavy that thousands of persons will find themselves temporary prisoners in their homes—without heat, without refrigeration, without communication, without transportation, often for days on end.

After the storm has passed—and when the lights and heat have gone—how will you eat?

One way to be prepared is to have a disaster diet kit in your larder, using quick-to-prepare foods requiring neither refrigeration nor cooking. This isn't to say your Disaster Diet will rank as a memorable gastronomic experience. But the Disaster Diet Kit will see you through for several days, and you will be well nourished.

As the name implies, kits should be assembled from a variety of foods which are non-perishable—canned, dehydrated or freeze-dried. Most of the following lists of suggested food items are readily available in your supermarket; sporting goods stores carry an even more complete line of freeze-dried and dehydrated foods. In assembling the kit, bear in mind that all canned foods can be stored for up to one year without danger of contamination and freeze-dried and dehydrated items, if kept dry, indefinitely—and, above all, remember that since you won't have power, you must have a manually operated can-opener.

And before we delve further into the specifics, remember you'll be needing such things as paper plates, cups, napkins and towels, a one-quart container, large mixing spoon, sharp knife, plastic or wooden eating utensils, soap, dishcloths, flashlight, matches in watertight metal container, all stored in a plastic dishpan—and candles.

Most of the canned food items listed are available in the common one-pound-size can. Although many can labels consider one-half cup portion as one serving, homemakers can better judge the number of servings per can by their family's appetities. A few of the items are available in individual, serving-size, snap-top cans, such as canned pudding desserts, bean dip, and beverages, making them more convenient but less economical. A few companies package these dessert items in family-size cans as well.

To plan nutritionally balanced meals from non-perishable food items, keep in mind the Basic Four Food Groups—suggested by the Council on Foods and Nutrition of the American Medical Association—which include daily:

MILK GROUP—2 or more glasses—Adults
3 or more glasses—Children
4 or more glasses—Teenagers

MEAT GROUP—2 or more servings for all ages—should give at least as much protein as 4 ounces cooked lean meat. About equal amounts of protein come from:
1 ounce cooked lean meat, poultry, or fish or 2 tablespoons peanut butter (1 ounce) or ½ cup cooked dried beans or peas.

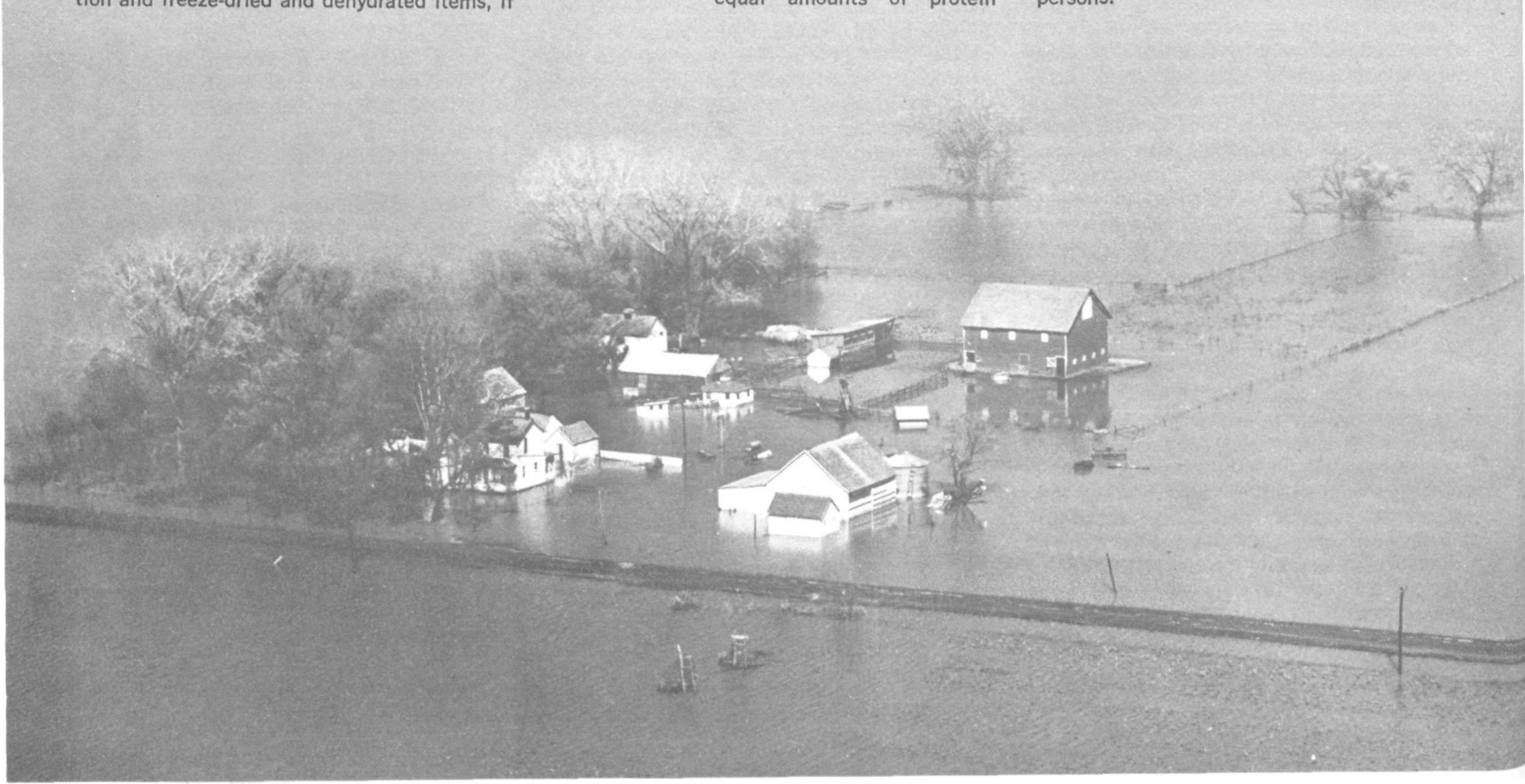
VEGETABLES AND FRUITS GROUP—4 or more servings for all ages—should include dark green or yellow vegetables; deep yellow fruits, citrus fruits or tomatoes to equal ½ cup per serving.

BREAD AND CEREALS GROUP—4 or more servings for all ages—should include enriched or whole grain breads, cereals, or pasta to equal 1 slice bread or ½ to ¾ cup cereal or pasta per serving.

While choices of food items to satisfy these nutritional requirements will be limited to those that require no cooking or heating, supermarkets carry an infinite variety of ready-to-serve foods and foods requiring only the addition of water or milk.

In addition, stock at least five gallons of drinking water for your family—enough for reconstituting at least 4 quarts of dry milk per day as well as for other purposes—for at least a week.

Economy is the other major consideration in choosing foods for Disaster Diet Kits. The following food lists will include most available non-perishable food items with suggested menus for under $5 a day for a family of four persons.



Sample Menus

Each Disaster Diet Menu should include the following to be nutritionally well balanced:

BREAKFAST
Citrus or vitamin C-enriched fruit or juice
Dry cereal with milk
Canned sliced meat (optional)
Milk

LUNCH AND DINNER
Main protein dish
Green or yellow vegetable or fruit
Enriched toast, crackers, or cookies
Fruit and/or fruit desserts
Milk

*** BREAKFAST**—$1.53
Vitamin C-enriched pineapple juice—29¢/46-ounce can
Toasted oat cereal—33¢/7-ounce box (1 cup each)
Sliced corned beef—73¢/12-ounce tin
Milk—18¢/quart

LUNCH—$1.33
Sardines in tomato sauce—40¢/1-pound can
Enriched saltine crackers—19¢/1 pound box
Zucchini—32¢/1-pound can
Lemon instant pudding made with 2 cups milk—24¢
Milk—18¢/quart

DINNER—$1.77
Beef stew—96¢/1 pound 13 ounce can
Green string beans—16¢/1 pound can
Sliced peaches—34¢/1 pound 13 ounce can
Enriched banana cream cookies—13¢/8 cookies
Milk—18¢/quart

DAY'S TOTAL COST—$4.63
Basic Four Food Requirement Totals
Milk—3½ servings
Meat—3 servings
Breads and Cereals—4 servings
Fruits and Vegetables—4 servings

BREAKFAST—$1.50
Tomato juice—35¢/46-ounce can
Shredded wheat with milk—32¢/12 biscuits
Sliced pork loaf—65¢/12-ounce tin
Milk—18¢/1-quart envelope (whole dry milk)

LUNCH—$1.54
Macaroni and cheese—42¢/two 1-pound cans with tuna—33¢/6½-ounce can
Mixed vegetables—24¢/1-pound can
Strawberry instant pudding—12¢/package plus 2 cups milk—12¢/6-ounce evaporated can diluted
Enriched vanilla cream cookies—13¢/9 cookies
Milk—18¢/quart

DINNER—$1.89
Chicken and dumplings—99¢/3-pound can
Poke salad greens—22¢/1-pound can
With vinegar—5¢
Raisin pie filling—45¢/1-pound can
Milk—18¢/quart

DAY'S TOTAL COST—$4.93
Basic Four Food Requirement Totals
Milk—3½ servings
Meat—3 servings
Breads and Cereals—4 servings
Fruits and Vegetables—4 servings

BREAKFAST—$1.27
Grapefruit sections—31¢/1-pound can
Corn flakes—20¢/8-ounce box
Sliced meat loaf—58¢/12-ounce tin
Milk—18¢/quart

LUNCH—$1.57
Refried beans—42¢/1-pound can
12 table-ready taco shells—49¢/4-ounce box
Turnip greens—16¢/1-pound can
Pineapple-cream pudding including 2 cups milk—24¢
8 graham crackers—8¢
Milk—18¢/quart

DINNER—$2.14
Shrimp chow mein—$1.07/one 12-ounce can
Chow mein noodles—35¢/5½-ounce can
Green peas—17¢/1-pound can
Mandarin oranges—37¢/1-pound can
Milk—18¢/quart

DAY'S TOTAL COST—$4.98
Basic Four Food Requirement Totals
Milk—3½ servings
Meat or dried beans—3 servings
Breads and Cereals—4 servings
Fruits and Vegetables—4 servings

Shopping List For 3 Days' Menus

- ☐ Package of 12-1 quart whole dry milk envelopes—$2.17 (or 2 packages of 10-1 quart non-fat dry milk envelopes—$1.64 per package)
- ☐ 2 pound package of assorted cream-filled cookies—49¢
- ☐ 1 pound package of enriched saltine crackers—43¢
- ☐ 1 pound package of graham (whole wheat) crackers—45¢

Natural disaster need not bring a culinary catastrophe along with it. Careful advance shopping, as above, can insure your family abundance of interesting meals.

The well-kept disaster diet larder uses foods not requiring cooking or refrigeration. Remember paper, plastic dishes and utensils, and such items as manual can opener.

Making the best of a bad situation is easier when there is variety on the dinner table where food cannot be cooked or chilled. This repast lacks style, but is good nutrition.

*** Prices as of early April 1973.**

ENRICHED CEREALS—any three of the following:
- ☐ 1 package of shredded wheat biscuits—32¢/12 biscuits
- ☐ 7 ounce box of toasted oat cereal—33¢
- ☐ 8 ounce box of corn flakes—20¢
- ☐ 6 ounce bag of puffed wheat—20¢
- ☐ 8 ounce box of crisp rice cereal—32¢

VEGETABLES—any six of the following:
- ☐ Green string beans—16¢/1 pound can
- ☐ Turnip greens—16¢/1 pound can
- ☐ Mixed vegetables—24¢/1 pound can
- ☐ Okra with tomatoes—33¢/1 pound can
- ☐ Zucchini—32¢/1 pound can
- ☐ Sliced carrots—32¢/1 pound can
- ☐ Black-eyed peas—17¢/1 pound can
- ☐ Tomatoes—23¢
- ☐ Green peas—17¢
- ☐ Poke salad greens—22¢

FRUITS—any three of the following:
- ☐ Grapefruit sections—31¢/1 pound can
- ☐ Mandarin oranges—37¢/1 pound can
- ☐ Peaches—34¢/1 pound 13 ounce can
- ☐ Apricots—34¢/1 pound can

FRUIT JUICES—any three of the following:
- ☐ Vitamin C enriched frut juices—29¢/46 ounce can
- ☐ Tomato juice—35¢/46 ounce can

MAIN DISH ITEMS—any nine of the following:
- ☐ Beef stew—96¢/2½ pound can
- ☐ Macaroni and cheese—42¢/1 pound can
- ☐ Chicken and dumplings—99¢/3 pound can
- ☐ Chili with beans—89¢/2½ pound can
- ☐ Spaghetti in tomato sauce with cheese—36¢/two 1 pound cans
- ☐ Sardines—40¢/1 pound can (in tomato sauce)
- ☐ Corned beef hash—73¢/1 pound 9 ounce can
- ☐ Shrimp, pork or chicken chow mein—$1.07/1 pound 12 ounce can with chow mein noodles—35¢/5½ ounce can
- ☐ Tuna—33¢/6½ ounce can
- ☐ Salmon—82¢/1 pound can
- ☐ Corn beef—73¢/12 ounce can
- ☐ Refried beans—42¢/1 pound can
- ☐ Pork luncheon meat—65¢/12 ounce can
- ☐ Canned meat loaf—58¢/12 ounce can
- ☐ Chunky clam chowder—57¢/19 ounce can
- ☐ Beef ravioli—81¢/2½ pound can
- ☐ Codfish cakes—33¢/10½ ounce can

PUDDINGS AND FRUIT DESSERTS—any six of the following:
- ☐ Instant pudding—12¢/package in these flavors: lemon, coconut, banana, chocolate, butterscotch, strawberry, or pineapple cream
- ☐ Pie filling—45¢/1 pound can in these flavors: apple, cherry, raisin, lemon

MISCELLANEOUS ITEMS—(optional)
- ☐ Catsup—34¢/14 ounce bottle
- ☐ Vinegar—17¢/pint bottle
- ☐ Salt—11¢/box
- ☐ Peanut butter—88¢/1 pound 12 ounce jar
- ☐ Instant breakfast—48¢/6 packages
- ☐ Instant chocolate drink powder—39¢/1 pound can

Non-Perishable Canned Foods

MAIN DISH ITEMS
- ☐ Beef Stroganoff
- ☐ Salisbury Steak in Mushroom Gravy
- ☐ Ham Loaf
- ☐ Stuffed Cabbage Rolls
- ☐ Beef Chili With Beans
- ☐ Corned Beef Hash
- ☐ Pork Luncheon Meat
- ☐ Beef Chow Mein
- ☐ Chicken Chow Mein
- ☐ Shrimp Chow Mein
- ☐ Chow Mein Noodles
- ☐ Beef Taco Filling
- ☐ Refried Beans
- ☐ Oyster Stew
- ☐ Clam Chowder
- ☐ Split Pea Soup
- ☐ Chopped Beef
- ☐ Sliced Fried Beef
- ☐ Beef Tamales in Sauce
- ☐ Lasagna
- ☐ Spaghetti and Meat Balls
- ☐ Beef Ravioli
- ☐ Beef Stew
- ☐ Chicken and Dumplings
- ☐ Danish Ham
- ☐ Clams
- ☐ Crab
- ☐ Codfish Cakes
- ☐ Tuna
- ☐ Shrimp
- ☐ Sardines
- ☐ Salmon
- ☐ Lobster
- ☐ Oysters
- ☐ Vienna Sausages
- ☐ Deviled Ham
- ☐ Corned Beef Spread
- ☐ Liverwurst Spread
- ☐ Boned Chicken
- ☐ Boned Turkey
- ☐ Chicken a la King
- ☐ Chicken Stew
- ☐ Chopped Ham
- ☐ Creamed Chipped Beef
- ☐ Macaroni and Cheese
- ☐ Corned Beef
- ☐ Pork and Beans
- ☐ Black-eyed Peas
- ☐ Lobster Bisque with Sherry
- ☐ Crab Soup
- ☐ Cream of Shrimp Soup
- ☐ Gazpacho Soup
- ☐ Bits of Bacon
- ☐ Soups, all varieties
- ☐ Imitation Sour Cream
- ☐ Evaporated Milk
- ☐ Low Fat Evaporated Milk
- ☐ Spanish Peanuts

VEGETABLES AND FRUITS
- ☐ Sweet Cucumber Chips
- ☐ Olives
- ☐ Pickled Vegetable Mixture
- ☐ Tossed Vegetable Mixture
- ☐ Tropical Fruit Salad
- ☐ German Potato Salad
- ☐ Bean Salad
- ☐ Macaroni Salad
- ☐ American Potato Salad
- ☐ Tomato Wedges
- ☐ Pear-shaped Tomatoes
- ☐ Artichoke Hearts
- ☐ Antipasto Mixture
- ☐ Beans, all types
- ☐ Corn
- ☐ Carrots
- ☐ Hominy
- ☐ Sweet Potatoes, Yams
- ☐ Turnip Greens
- ☐ Mixed Vegetables
- ☐ Okra With Tomatoes
- ☐ Zucchini
- ☐ Poke Salad Greens
- ☐ Fruit Juices
- ☐ Peaches
- ☐ Apricots
- ☐ Mandarin Oranges
- ☐ Pears
- ☐ Applesauce
- ☐ Gooseberries
- ☐ Figs
- ☐ Raspberries
- ☐ Blueberries
- ☐ Spiced Pears
- ☐ Plums
- ☐ Prunes
- ☐ Grapefruit Sections
- ☐ Applesauce With Blueberries
- ☐ Applesauce With Raspberries
- ☐ Applesauce With Pineapple
- ☐ Blackberries

DESSERTS
- ☐ Fruit Cocktail
- ☐ Cherry Pie Filling
- ☐ Lemon Pie Filling
- ☐ French Apple Pie Filling
- ☐ Strawberry Pie Filling
- ☐ Peach Pie Filling
- ☐ Blueberry Pie Filling
- ☐ Blackberry Pie Filling
- ☐ Mandarin Orange Dessert
- ☐ Vanilla Pudding
- ☐ Banana Pudding
- ☐ Chocolate Pudding
- ☐ Rice Pudding
- ☐ Tapioca Pudding
- ☐ Peach Pudding
- ☐ Pineapple Pudding
- ☐ Apricot Pudding
- ☐ Lemon Pudding
- ☐ Butterscotch Pudding
- ☐ Orange Nut Bread
- ☐ Chocolate Bread
- ☐ Spice Bread
- ☐ Fruit and Nut Bread
- ☐ Date and Nut Bread
- ☐ Boston Brown Bread

Dehydrated Foods Requiring Only the Addition of Water or Some Form of Reconstituted Milk But No Heating

- ☐ Whole Dry Milk Powder
- ☐ Nonfat Dry Milk Powder
- ☐ Instant Lemon Pudding
- ☐ Instant Coconut Pudding
- ☐ Instant Strawberry Pudding
- ☐ Instant Butterscotch Pudding
- ☐ Instant Vanilla Pudding
- ☐ Instant Pineapple Cream Pudding
- ☐ Instant Chocolate Drink Powder
- ☐ Strawberry Instant Breakfast
- ☐ Vanilla Instant Breakfast
- ☐ Chocolate Instant Breakfast
- ☐ Eggnog Instant Breakfast

Ready-To-Eat Foods

- ☐ Dry Cereals
- ☐ Enriched saltine crackers
- ☐ Graham (enriched whole wheat) Crackers
- ☐ Packaged Taco Shells
- ☐ Melba Toast
- ☐ Zwiebach toast
- ☐ Graham cracker pie crusts
- ☐ Corn chips
- ☐ Whole wheat or enriched snack crackers
- ☐ Cookies made from enriched flours
- ☐ Bottled hot sauce
- ☐ Worcestershire Sauce
- ☐ Catsup
- ☐ Mustard
- ☐ Sugar, honey
- ☐ Salt, pepper
- ☐ Preserves
- ☐ Bottled, sealed salad dressings
- ☐ Peanut Butter
- ☐ Oyster Crackers
- ☐ Bread Sticks
- ☐ Sealed tartar sauce
- ☐ Vinegar
- ☐ Raisins
- ☐ Dried prunes, apricots, peaches

Scientists and fishermen, working together,

Build A Better Fish Trap

BY HERBERT H. SHIPPEN *
AND JOHN A. GUINAN

Build a better mouse trap?

National Marine Fisheries Service scientists have gone the adage one better, and built a better fish trap—and fishermen have already started to beat a path to their door.

The trap in question is designed to catch sablefish, a delicious denizen of Pacific waters used primarily for smoked fish. The trap is part of a system that has evolved over a span of five years through cooperation between commercial fishermen and a team of scientists and gear specialists at NMFS's Northwest Fisheries Center under the direction of Dr. Dayton L. Alverson. Both groups have contributed ideas that have been tested under experimental and commercial fishing conditions. The system consists of up to a dozen baited traps set out like beads on a half mile long string across the ocean floor; several such strings are fished by each boat.

After one to several days, the traps are retrieved, the catch harvested, and the traps reset or moved to a new location.

Dr. Alverson points out that traps have several advantages over traditional methods of catching sablefish. "Trap-caught fish are alive and usually in excellent condition when brought aboard the fishing vessel," he says. "Moreover, traps go right on working while the fishing vessel is otherwise engaged or is waiting out stormy weather. The trap itself protects the captured sablefish from predators which often attack fish hooked on traditional gear, and the size of openings in trap meshes can be used as a conservation device to allow undersized fish to escape."

Unlike catches by other gear, where a variety of species may be captured, sable-

* Herbert H. Shippen is a fisheries biologist at the NMFS Northwest Fisheries Center, Seattle.

Collapsible steel mesh trap, developed by NMFS scientists and gear specialists working closely with commercial fishermen, is used by sablefishermen in the North Pacific.

fish dominate trap catches and their separation requires little effort. No one is sure why sablefish are less wary of traps than are other species, but sablefishermen are happy to know it. Halibut, turbot (arrowtooth flounder), rockfish, Pacific cod, and lingcod have been taken in traps, but never in sufficient quantity to make a commercial fishery by trap appear feasible.

Traps do have certain disadvantages—in particular, they are relatively expensive and vulnerable to loss and damage. Lost traps might continue to capture fish for months or even years before disintegrating, but conservation-minded NMFS scientists have reduced this hazard by placing panels of cotton mesh in the traps. Cotton deteriorates rapidly in salt water, and fish captured by a lost trap can soon escape.

The use of portable traps for catching fish is not new, but on the west coast of North America they have been used traditionally only for invertebrates such as crabs and shrimp—even though crab fishermen were well aware that fish are frequently captured. However, a Seattle setline fisherman and scallop dragger, Sig Jaeger, was a strong believer that traps might be an effective means of fishing, and he urged that the idea be tested.

The first try was in the summer of 1968, when the Seattle fisheries center chartered the University of Washington's research vessel COMMANDO for a trial capture of halibut using modified king crab traps. Disappointingly few halibut were taken and their quality was poor because of injuries suffered in the trap.

In the fall a new try was made by the Federal fisheries research vessel JOHN N. COBB, again using modified king crab pots. Fishing offshore along the Washington coast, the cruise had moderate success in capturing sablefish, proving the effectiveness of traps in catching this species. Most important, the condition of the fish was excellent. Additionally, the traps were selective against spiny dogfish, a nuisance species that makes life difficult for fishermen using traditional gear. Traditionally, sablefish are taken by use of a large number of baited hooks fished on the bottom. When dogfish take the bait, the fisherman loses money.

Having established that sablefish could be captured by trap, the next step was to improve the system to make it economically competitive. To help accomplish this, the BARON, a 96-foot commercial dragger, was chartered during the summer of 1969. The BARON fished 17 modified king crab pots using chopped frozen herring for bait. A number of innovations were tested during this cruise, including the regulation of fishing time to maximize the catch, an examination of the effectiveness of triggers (one-way opening devices) in entrance tunnels, and lights inside the trap.

To simulate a commercial fishing trip, Dr. Alverson's group chartered the MV SEATTLE under the command of Captain Jaeger for a 12-day period during the fall of 1969. The SEATTLE was fitted with gear for handling traps and equipped with 23 modified king crab pots with triggers in the tunnel entrances. The results of the charter period so impressed Captain Jaeger that he offered to continue the experimental fishery to give Federal personnel an opportunity to test new methods and ideas continuously.

During the year that Captain Jaeger conducted his fishery, many different trap sizes and tunnel configurations were tested. Although the economic success of the venture was dampened by unusually severe winter weather and a high rate of trap loss, two fundamental discoveries were made. Captain Jaeger was himself largely responsible for both ideas.

The first idea stemmed from the fact that each of the bulky modified king crab pots was fished from a single buoy line and each unit of gear cost more than $500. Captain Jaeger proved that such a system was unsuitable for a successful commercial venture. Needed was a system of fishing that would drastically reduce the cost per trap and reduce trap losses. The second major idea was the need for a collapsible trap to replace the rigid traps then in use, and enable a vessel to carry many more units of gear to the fishing grounds.

Development of lightweight, inexpensive traps to be fished in multiples began during the spring of 1970. The initial traps used in this phase were cylindrical, noncollapsible, with a tunnel entrance in either or both ends. They proved to be unusually susceptible to damage, however, and it became increasingly apparent that success of the system would depend not only on a collapsible trap but on its ruggedness as well.

The first collapsible sablefish traps, based on a model suggested by Captain Jaeger, were developed in a joint effort between the Northwest Fisheries Center and a local wire works. The model currently used by NMFS is eight feet long by 34 inches square. The steel mesh of the panels is two inches square, a size that permits small fish to escape. Each trap will collapse flat for storage aboard the vessel, but all parts remain connected so that two fishermen can put the trap into working shape in less than a minute. The tunnels are of light synthetic webbing stretched into shape by rubber bands.

In California, 14 vessels already are using the new technology; two vessels in Oregon, three in British Columbia, and four in Alaska have been adapted. At least 10 more boats in Oregon, Washington, and Alaska are preparing to enter this fishery. Fishery scientists, too, are taking advantage of this system which provides fish in excellent condition, uninjured by hook or net.

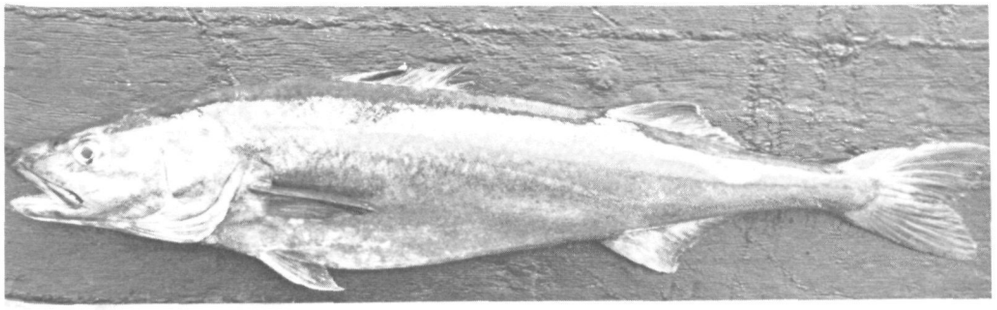
Sablefish are streamlined creatures ranging up to about 40 inches long and 40 pounds weight. Their dark color is responsible for some of their common names such as blackcod and coalfish. They spawn in late winter and early spring in deep waters (200–400 fathoms) off the Pacific coast of North America. A female may spawn up to a million eggs each year depending on her size.

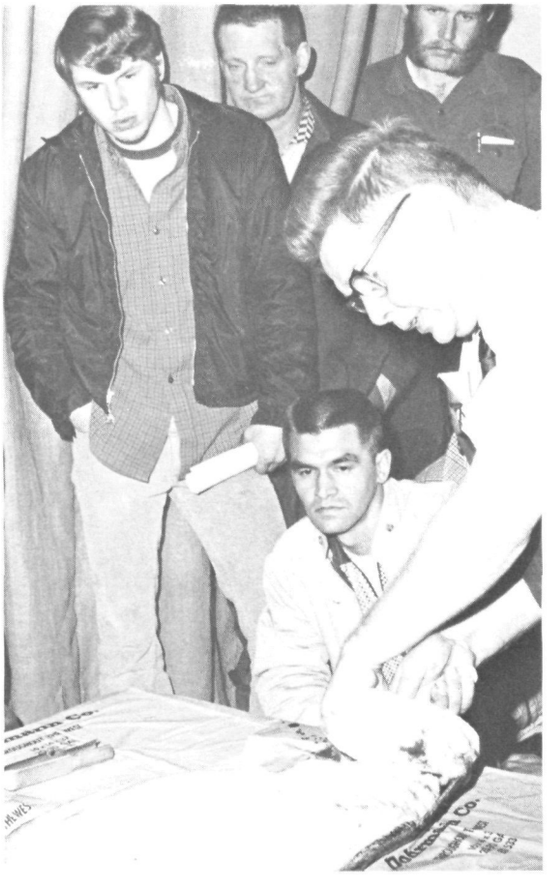
The species ranges from southern California to the Gulf of Alaska, Bering Sea, and westward to the shores of Siberia. Sablefish are taken in large numbers by Japan and the U.S.S.R. in the Bering Sea and Gulf of Alaska. Larvae have usually been captured on the surface several score miles from shore, but juvenile sablefish frequent shallow bays and inlets close to shore. As adults they move offshore into deeper water. Biologists have released several thousand tagged sablefish to investigate little known aspects of migratory behavior of the species.

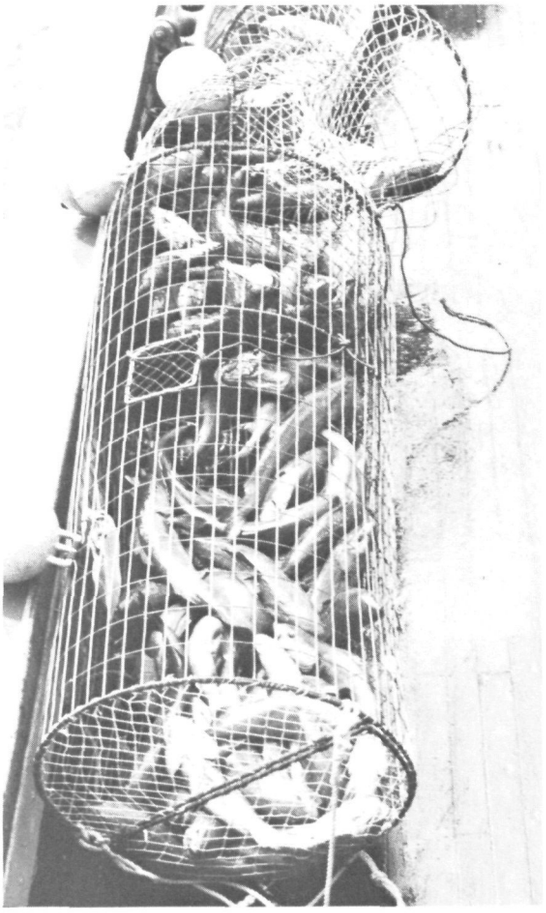
Sablefish have been only modestly important to the U.S. fishing industry except during certain periods such as World Wars I and II when demand was strong because of shortages of other species, and food was needed for export. Large quantities of sablefish were salted during these times. During World War II U.S. landings reached 8,000 metric tons annually but in recent years have declined to between 2,000 and 3,000 metric tons. Catches between 6.000 and 8,000 metric tons by Japan in the North Pacific and Bering Sea during 1968–70 demonstrate, however, that sablefish is a species upon which U.S. fishermen might well expand his efforts. At this time, marketing and public acceptance are problems to be overcome. U.S. imports of sablefish from Japan came primarily to the west coast in 1972 when about 550 metric tons were imported. Small quantities are also imported from British Columbia.

Rather oily, sablefish is especially attractive for smoking, and much of the present harvest is dressed, frozen, and held for that purpose. In the past large quantities of sablefish were salted and much of it exported as a substitute for salted salmon, but demand for the salted product has declined in recent years, however, Some years ago sablefish livers were frequently in demand because of their rich vitamin A content, but with synthetic production of Vitamin A, the demand no longer exists.

Complete details on the collapsible fish-trap system for sablefish are being prepared for publication. The system, developed cooperatively by scientists and fishermen, holds promise of rich rewards for both. For the scientist there is satisfaction of new discoveries that will aid in the conservation and rational utilization of the species, and for the fishermen, the prospective harvest of a resource that in the past has been relatively undeveloped by the U.S. fishing industry. □







National Marine Fisheries Service fishery biologist examines sablefish caught by one of the collapsible steel mesh traps used in the fishery; below, the object of this attention.

Sig Jaeger, Director of Fisheries Technology at Kodiak Community College (above right) and long-time commercial fisherman, worked with NMFS technicians to develop new trap.

Earlier model of sablefish trap, shown with a nice catch, was cylindrical, proved to be attractive to fish but too fragile for the prolonged usage of the Pacific fishery.

WHAT HEATS THE SOLAR WIND?

Shock zone in outer space

A common view of outer space is the one popularized by science fiction writers: a vast, black emptiness only occasionally punctuated with stars and planets, the stars at almost inconceivable distances from each other. In earthly terms, this conception is not altogether wrong; the emptiness of outer space seems its outstanding characteristic; the very best vacuums attainable on earth with the most sophisticated machines are still dense gases by contrast with the near material void of the space between the stars.

Still, outer space is far from empty, and scientists are beginning to learn how it is populated by tenuous but highly dynamic fluxes of particles—molecular, atomic, and subatomic. These particles are accompanied by electromagnetic fields that strongly influence both the behavior of the particles with which they are associated and other particles they may meet on their endless journeys among the stars and galaxies.

During the past two years, there have been reports of observations from a satellite called "Ogo 5" which indicate the presence of a thin atomic hydrogen gas in interplanetary space; the observations tend to support the view that the tenuous hydrogen comes from an interstellar gas streaming through the solar system.

BY RICHARD GILLULY

Another United States spacecraft, Pioneer 10, headed for Jupiter, has detected some indications of a higher temperature than scientists had expected in the "solar wind," the stream of electrically charged particles always pouring in all directions from the sun. This heating of supersonic solar wind protons (positively charged particles) occurs beyond about three Astronomical Units (One AU is the distance between sun and earth, about 92.9 million miles) from the sun.

Dr. Thomas Holzer, a physicist with the Aeronomy Laboratory of NOAA's Boulder, Colo.-based Environmental Research Laboratories, believes the heating may result from the interaction of the solar wind with hydrogen atoms in the interstellar gas.

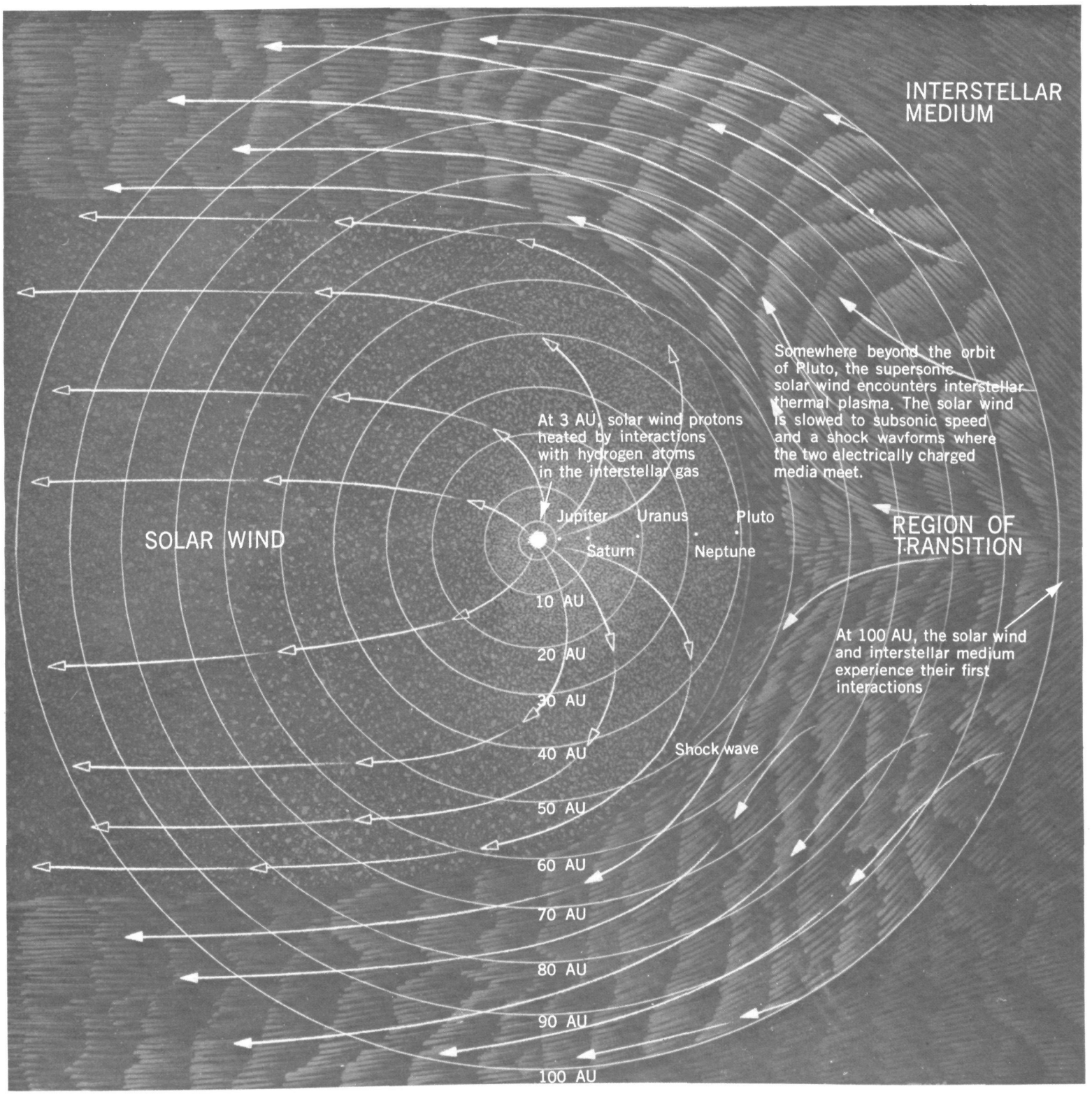
Holzer has constructed a mathematical model of the solar wind interaction with the neutral component of the interstellar medium which indicates that the solar wind heating at three AU is a process quite distinct from a far more violent interaction around the fringes of the solar system, which is associated with the ionized component of the interstellar medium.

Holzer's model indicates that a significant fraction of the interstellar hydrogen fails to penetrate to the orbit of the earth—primarily because of its interaction with the solar wind. On the other hand, the ionized component of the interstellar gas, a material called "thermal plasma" (which is electrically charged like the solar wind), probably does not even penetrate into the solar system, but is stopped somewhere beyond the orbit of Pluto (40AU), according to a model developed by E. N. Parker of the University of Chicago several years ago.

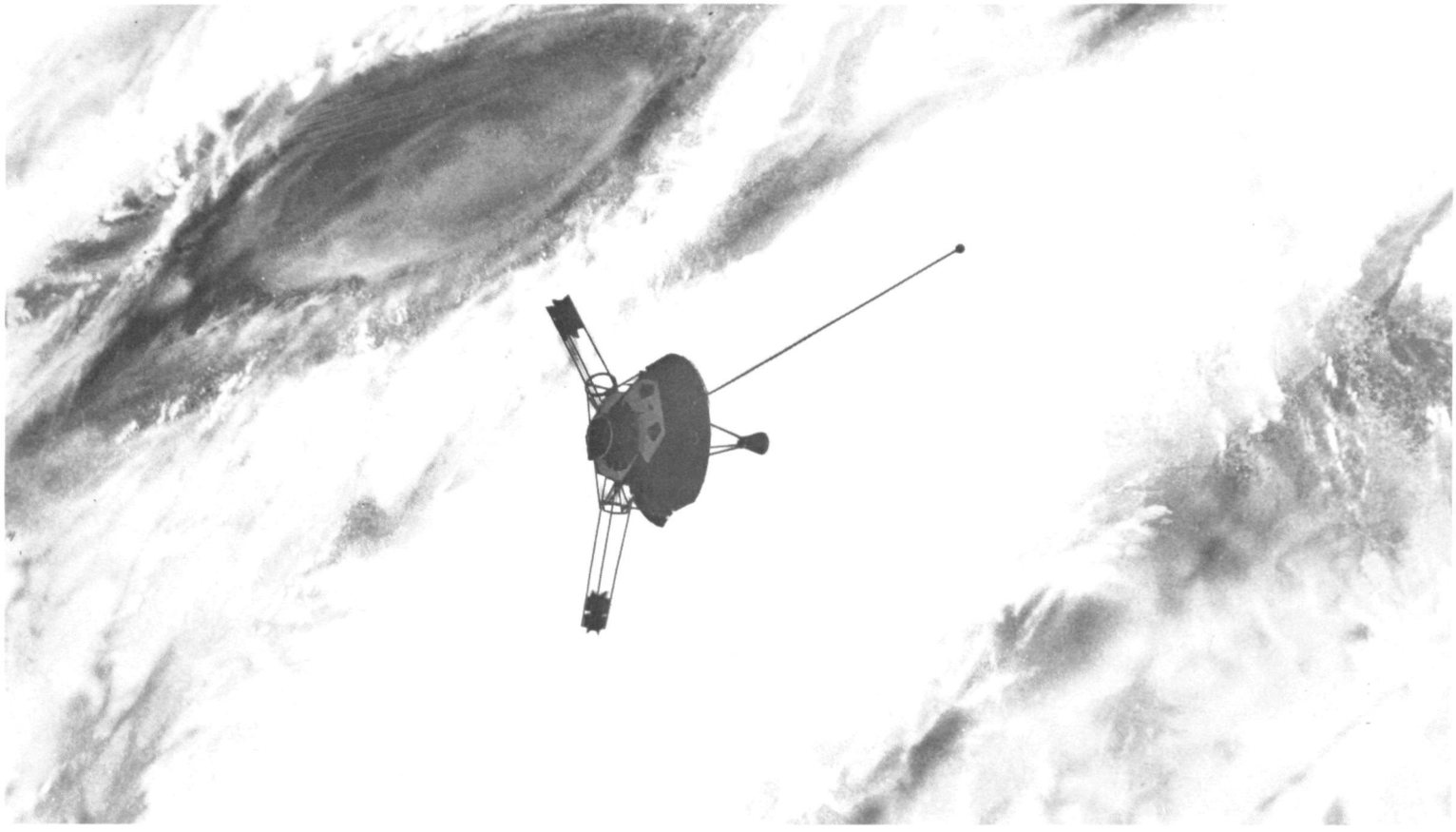
Thus, there are probably two zones in the solar system where interaction with the interstellar medium occurs. The supersonic solar wind is slowed and heated by the interstellar hydrogen, but it remains supersonic. Then it encounters the thermal plasma and undergoes an interaction that likely involves a shock. Through this shock, the speed of the solar wind is drastically slowed and its temperature is increased, but at the same time the thermal plasma is kept from penetrating deeply into the solar system.

Involved in the interactions, says Holzer, are several different processes, some of which depend on the nature of the emission from the sun of the solar wind. "Most of these processes," says Holzer, "are easily understood, and the complicated mathematics of my model is mainly a kind of bookkeeping used to keep track of them."

But some of the analogies involved in an explanation require a departure from



Artist's conception of recent models of interaction between the solar wind and interstellar medium shows first interaction occurring at perhaps 100 Astronomic Units (AU) from the sun. This zone is followed by a region of transition in which a slowed (subsonic) solar wind interacts and blends with the thermal plasma, the ionized (electrically charged) component of the interstellar medium. The inner boundary of the transition zone is marked by a shock wave created by the first sharp encounter of the supersonic solar wind and the thermal plasma. The uncharged component of the interstellar medium—atomic hydrogen—penetrates farther into the solar system, to about 3 AU, where deep-space probes like Pioneer 10 have reported heating of solar wind protons.



NASA's Pioneer 10, launched in early 1972, is on its way to Jupiter (artist's conception). When Pioneer 10 was about three astronomical units from the sun last year, higher-than-expected proton temperatures were detected.

NASA Photo

The Great Galaxy in Andromeda. The interstellar medium originates in deep outer space, though its source is not precisely defined. Dr. Thomas Holzer has constructed mathematical model of likely interaction of solar wind with the neutral component of the interstellar medium.

earthbound thinking. The solar "wind," for example, is not like the wind in the earth's atmosphere. The density of the solar wind at the earth's orbit (as measured by satellites) is about five particles per cubic centimeter (a centimeter is a little more than a third of an inch). This, as earlier suggested, is a density lower than the best vacuum attainable on earth.

More startling is the speed of the wind: 400 kilometers per second, or about 880,000 miles per hour. At this very high speed, the solar wind is moving supersonically, just as is a supersonic jet aircraft when moving at much lower speeds in the earth's atmosphere. The threshold of supersonic speed in the atmosphere is the speed beyond which there can be no audio communication to the rear of the object moving at that speed. Likewise with the solar plasma; it is moving so fast that there can be no "communication" from a particle to another particle behind it. This explains, in part, the "shock" process that occurs when the solar wind strikes the interstellar thermal plasma.

The solar wind is made up of several kinds of particles, but the most important ones are protons and electrons. These are produced from hydrogen atoms when the intense thermal energy of the sun's atmosphere sends particles (mainly free electrons) crashing into the atoms and knocking free their electrons.

Since each hydrogen atom is made up of a single electron and a single proton, the result of the collisions is a mixture of the electrically charged protons and electrons. Once again because of the intense heat of the sun's outer atmosphere, tremendous energy of flow is imparted to the particles—enough so that they are able to flow at supersonic speed away from the pull of the sun's gravity and into space. And because the particles are electrically charged, a magnetic field accompanies them, in effect an extension of the sun's magnetic field. Thus the particles flowing radially out from the sun are termed a "magnetized plasma."

The interstellar medium is probably made up of several components, all of which have a role in the interactions:

—The thin, electrically neutral hydrogen gas at an estimated density of one particle to ten cubic centimeters (plus lesser amounts of other neutral gases such as helium and oxygen);

—The thermal plasma, which is quite similar to the solar wind in that it is made up primarily of electrons and protons, and which, like the neutral hydrogen, has a density of about one particle to ten cubic centimeters;

—Cosmic rays, which are extremely high energy, but low density, protons, electrons and other particles, and which though far thinner than the other components, contribute about half the total energy content of the interstellar medium;

—And a magnetic field associated with the charged particles.

Holzer's model, plus earlier work, indicate that the following processes occur as the solar wind interacts with the interstellar medium;

—The sun's gravity attracts the streaming interstellar hydrogen atoms. But at the same time, the photons (light waves or light "particles") which constantly stream from the sun tend to repel the atoms—because light, too, is a kind of wind which can exert a force. The net outcome is not precisely known yet, but it appears that the two forces may nearly cancel each other out.

—Some of the neutral hydrogen becomes charged through two processes. First, photons striking the hydrogen atoms knock electrons away from the atoms in a process called "photoionization," and second, the solar wind protons become hydrogen atoms and the interstellar hydrogen atoms become protons through a simple exchange of an electron.

—As the neutral hydrogen becomes charged and becomes associated with the solar magnetic field, some of the energy of flow of the solar wind is converted to random motion, which is the same as heat. At the same time, and for the same reason, the velocity of the solar wind is diminished, although its speed remains supersonic. The charging of the neutral hydrogen and concomitant association with the sun's magnetic field causes it to act, in effect, as a relatively gentle and penetrable barrier to the solar wind.

—When the still supersonic solar wind strikes the less penetrable thermal plasma, the tendency for separate magnetic fields and associated particles not to intermingle is so strong that a shock event occurs. The supersonic wind is slowed by a factor of about four, to subsonic speed, and heat is once again generated.

"In both processes," says Holzer, "the conversion of flow energy to thermal energy is somewhat similar to the conversion of kinetic energy to heat through friction when you rub two rough objects against each other."

There are still a number of unanswered questions in connection with the interactions, says Holzer. "A prime one is just where in the solar system the processes occur, and this, in turn, depends on a precise estimate of the density of the interstellar materials, which we don't have yet."

However, there are some indications. Thermal plasma density can be averaged over a long distance by studying the photon emission (electromagnetic radiation) from pulsars, cosmic objects which emit photons (radiation) in discrete pulses over a broad energy spectrum. An alteration of the pulse is caused by an interaction of the photons with the free electrons of the plasma, and the density of the plasma can be inferred from the observed alterations.

Neutral hydrogen can be detected in somewhat similar fashion. Hydrogen atoms absorb photons at typical energy levels. So if a satellite near earth observes a star (or a pulsar) with a known energy spectrum, a characteristic gap occurs in the spectrum of the cosmic object being observed. The gap represents the photon energy range where hydrogen absorbs photons. Once again, the density of the interstellar hydrogen can be inferred from this change in spectrum.

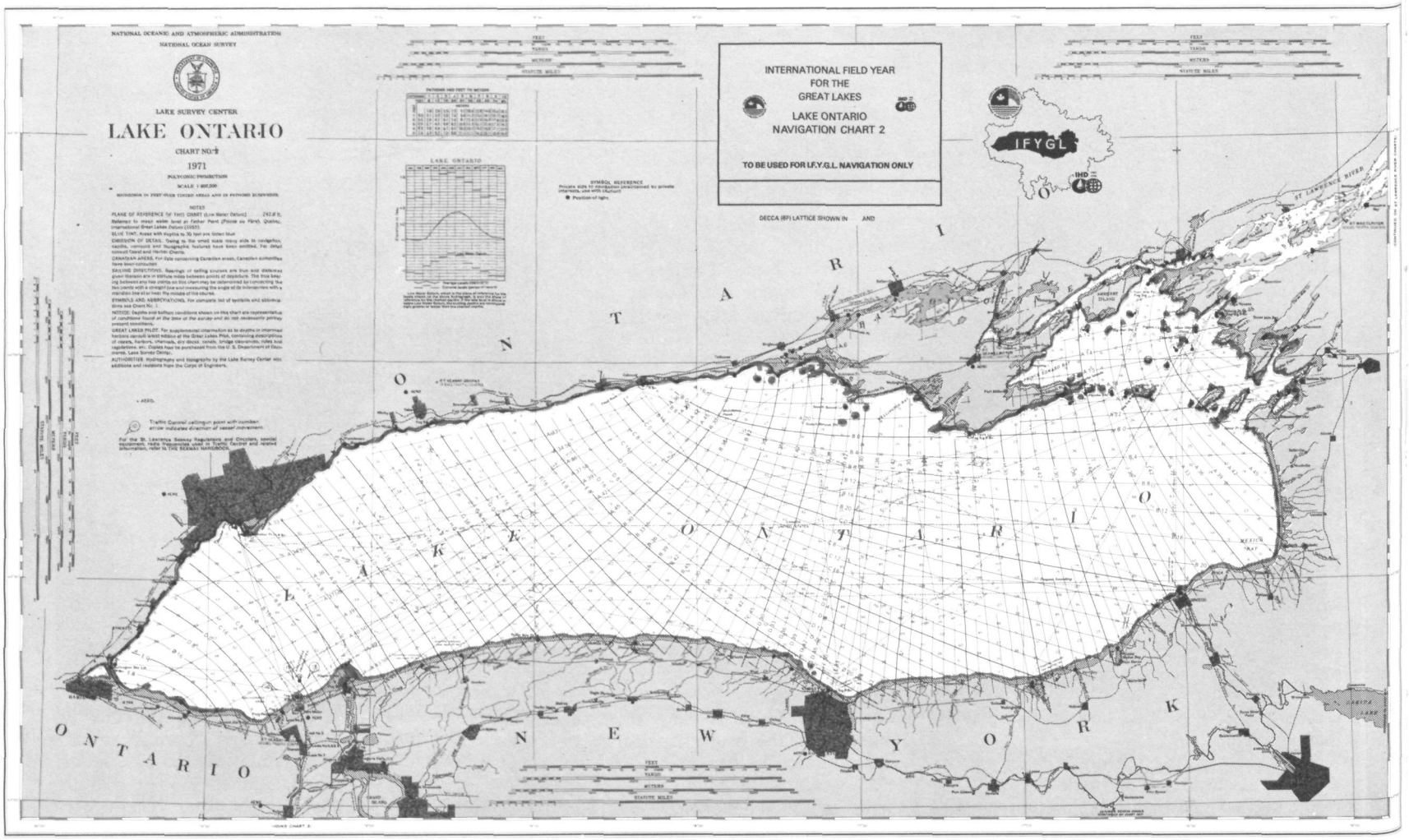
But the problem with both of these techniques is that only an average density along the line of sight between the cosmic object and the observation point can be obtained. There is some evidence that the plasma and the hydrogen atoms may, in some cases, be fairly uniformly distributed in the region of interstellar space observed along the line of sight. But it is possible, says Holzer, that dense clouds of the materials and concomitant areas of very low density exist. If this is the case, there is no sure way to know what the density near the solar system is.

However, the Ogo 5 observations appear to confirm that the interstellar hydrogen does exist in interplanetary space perhaps somewhere near the average density deduced from the earlier observations. Hydrogen atoms will absorb photons from the sun, then re-emit them—sometimes in the opposite direction. Ogo 5 instruments have detected these returning photons in the form of characteristic "Lyman alpha" radiation. Another component of the interstellar gas, helium, is theoretically able to penetrate further into the solar system than hydrogen. There is some evidence that helium, possibly from this source, has been detected near earth, another indication the interstellar medium may be behaving as predicted.

But because of the lack of precise information, Holzer has estimated the location of the region of the interaction of the solar wind with the neutral hydrogen for several possible interstellar gas densities. The greater the assumed density, the nearer the sun the interaction will begin. If the density of neutral hydrogen is one particle per ten cubic centimeters—the average from the pulsar and star observations and the amount indicated by the Ogo 5 observations—then the interaction becomes important about three AU from the sun. If the density were three times greater, the interaction would become important about two AU from the sun, just beyond the orbit of Mars.

And if the thermal plasma density is as hypothesized, then the shock zone between it and the solar wind should occur on the fringes of the solar system, near the orbit of Pluto about 40 AU from the sun.

A clearer definition of the interstellar medium may, Holzer says, provide some clearer answers for cosmologists, the scientists who study the origins and fate of the universe. The NOAA scientist is helping to provide that clearer definition. □



QUICK SERVICE FOR LAKE SCIENTISTS

"Scissor" cartography pays off on IFYGL project

BY JOSEPH SCHANTA *

One of the special navigation charts prepared for the International Field Year for the Great Lakes (at top) by the scissor-wielding staff cartographers of the Lake Survey Center.

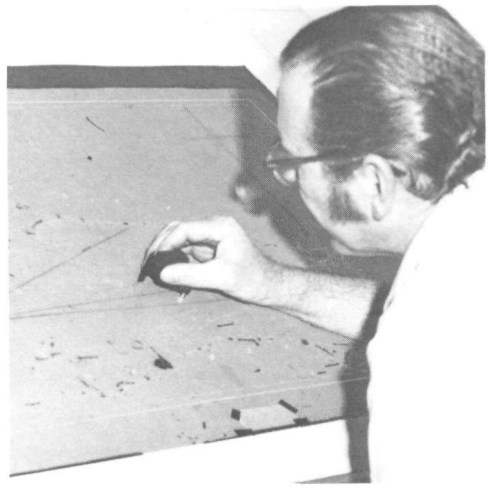
Wielding a pair of scissors in pursuit of his assigned work is not the standard operating procedure for a cartographer—the required accuracy generally calls for more orthodox methods. However, this was the spot that the Lake Survey Center Reproduction Branch found itself in not too long ago—so snip and cut we did. The task: to prepare a series of graphics, maps and charts of Lake Ontario and the Lake Ontario drainage basin, for use during the International Field Year for the Great Lakes (IFYGL). The chart series was ultimately to consist of Chartlets and of a series of Planning, Plotting and Navigation Charts.

The graphics were needed by scientists and technicians undertaking hundreds of research and monitoring projects. For many of the experiments, measurements at closely-controlled sites were needed over long periods of time. The vessels and aircraft used to support the scientists needed to be able to know accurately where they were, and to be able to return to the same stations for repeat observations. Stationary buoys and towers had to be in exact location to comply with scientific requirements. Positions had to be precise so that vessels could avoid anchored instrumentation while ensuring its recovery.

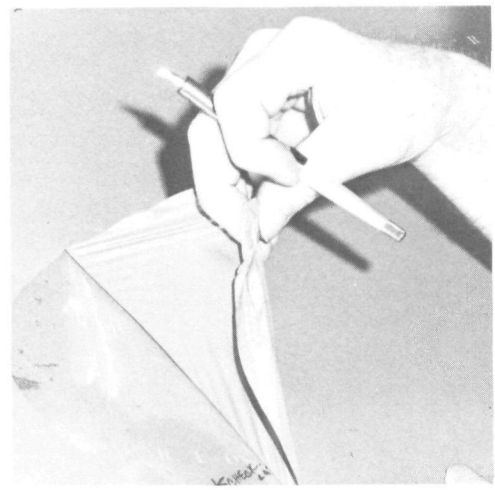
And there wasn't much time to prepare the charts, get them printed, and get them into the hands of the IFYGL users.

To ensure the extremely accurate positioning required by IFYGL, a Canadian network system known as Decca Lambda 6F was selected. It is a transportable electronic positioning system with "master" and "slave" stations that send out radio signals from several points around the lake shore.

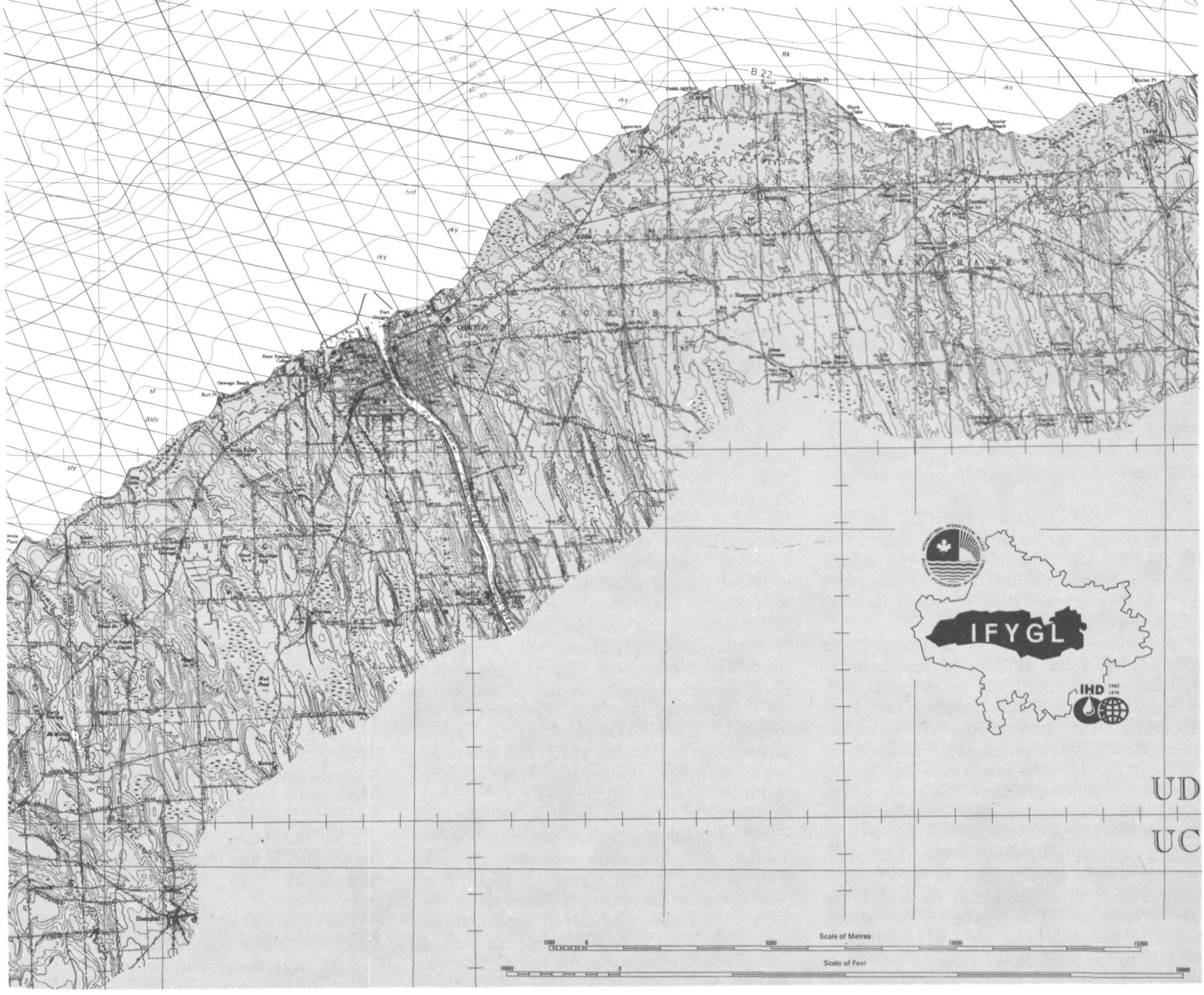
* Joseph Schanta is Chief, Reproduction Branch, Lake Survey Center.



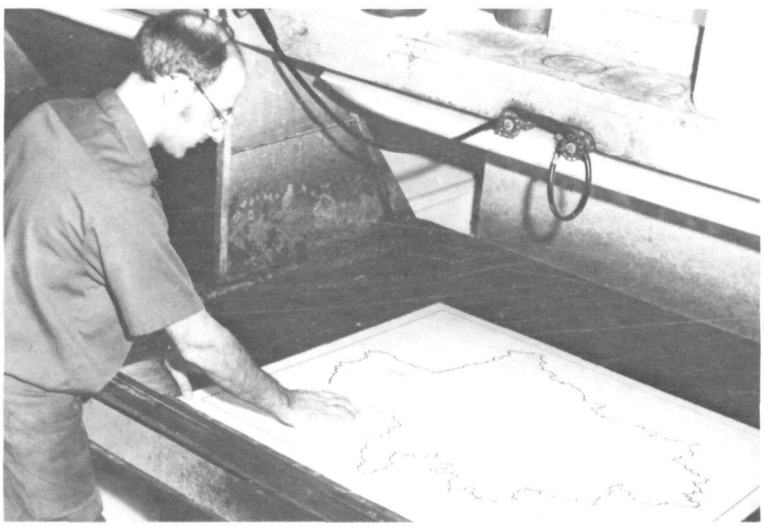
Good eyesight and a steady hand are qualities that this Lake Survey Center negative engraver must have as he engraves details on a chart.

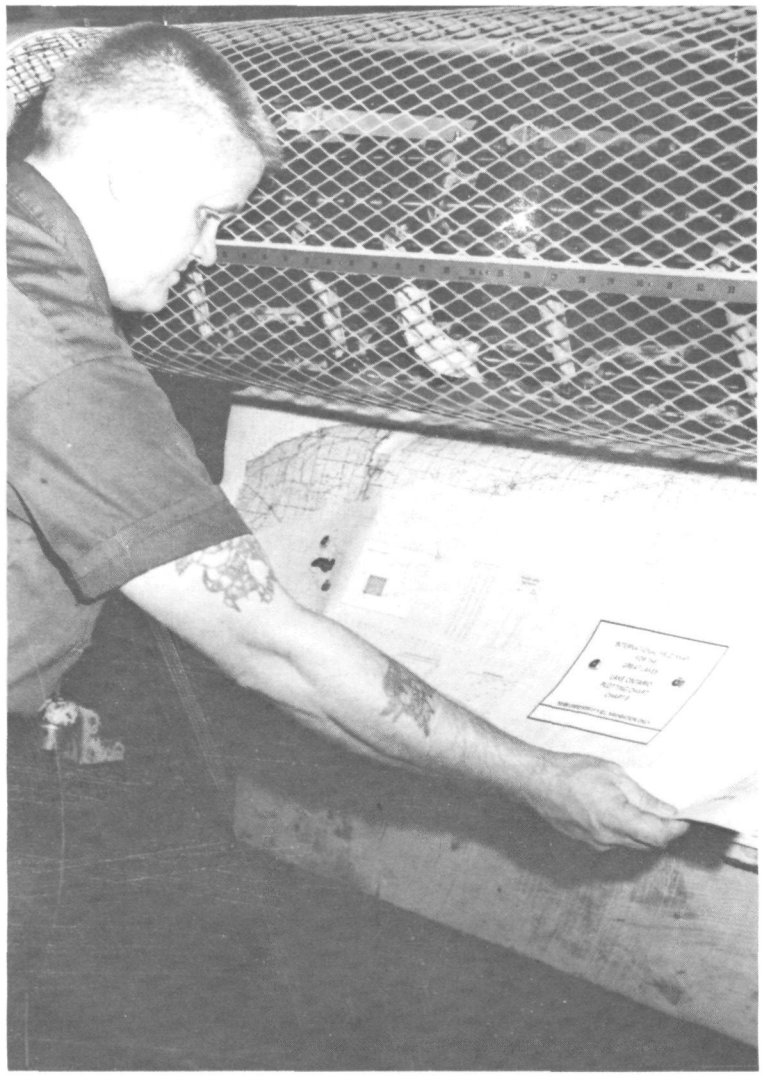


Working on a special IFYGL navigation chart, a negative engraver prepares open window mark on peelable coated material for masking lattice.



Countless details had to be checked at every stage of preparation of the IFYGL charts to ensure accuracy and high quality. At upper left, a cameraman examines final reproduction negative for quality; below, a plateman is processing a color proof used in controlling quality prior to the printing. Once on the presses, the charts are again checked, here by a pressman during the printing stage.





These intersecting hyperbolic patterns form a lattice of zones and lanes. On the charts, the lattice is reproduced in green and red patterns.

With the system installed aboard RESEARCHER, for example, the ship could by picking up at least two of the signals determine her position on the lake with far more exactness than by using conventional navigational systems.

However, there were no charts of Lake Ontario with the IFYGL Decca Lambda lattice. Meetings with the Canadian Hydrographic Service (CHS) resulted in agreement on eight plotting charts, a reduction from the originally-proposed 21 which made possible considerable manpower and money savings. Five charts were assigned to the CHS for preparation and printing, three to LSC.

For special purposes of the field year, various details were needed on the charts—details that were not found on any single set of maps or charts. There are only a few ways to obtain a map or a chart—buy it, reproduce it, steal it, or make a new one. The latter method is the most expensive. In view of the short time frame, it was decided to compile information from existing charts—CHS charts at a scale of 1:50,000, U.S. Geological Survey charts at scales of 1:24,000 and 1:62,500, and Lake Survey Center charts and field sheets at a scale of 1:80,000.

After placing a call to NOAA requesting a 1:80,000 scale master grid prepared on their plotter, the project was under way. The polyconic projections were computed, plotted and engraved. The first five-minute intersections in each corner of the charts were furnished to CHS. Computer-drawn red and green overlays, inked on plastic containing the Decca (6F) lattice system, were furnished. Negatives were prepared from the positive lattice overlays.

The next step was to compute and plot the Universal Transverse Mercator on the master grid furnished, and key the four components. To our pleasant surprise there was complete agreement between the output of the two computer-driven machines and data plotted by a human being, all working independently, many miles apart. The projection, grid and two negative lattices were in perfect registration diagonally over a span of 42 inches.

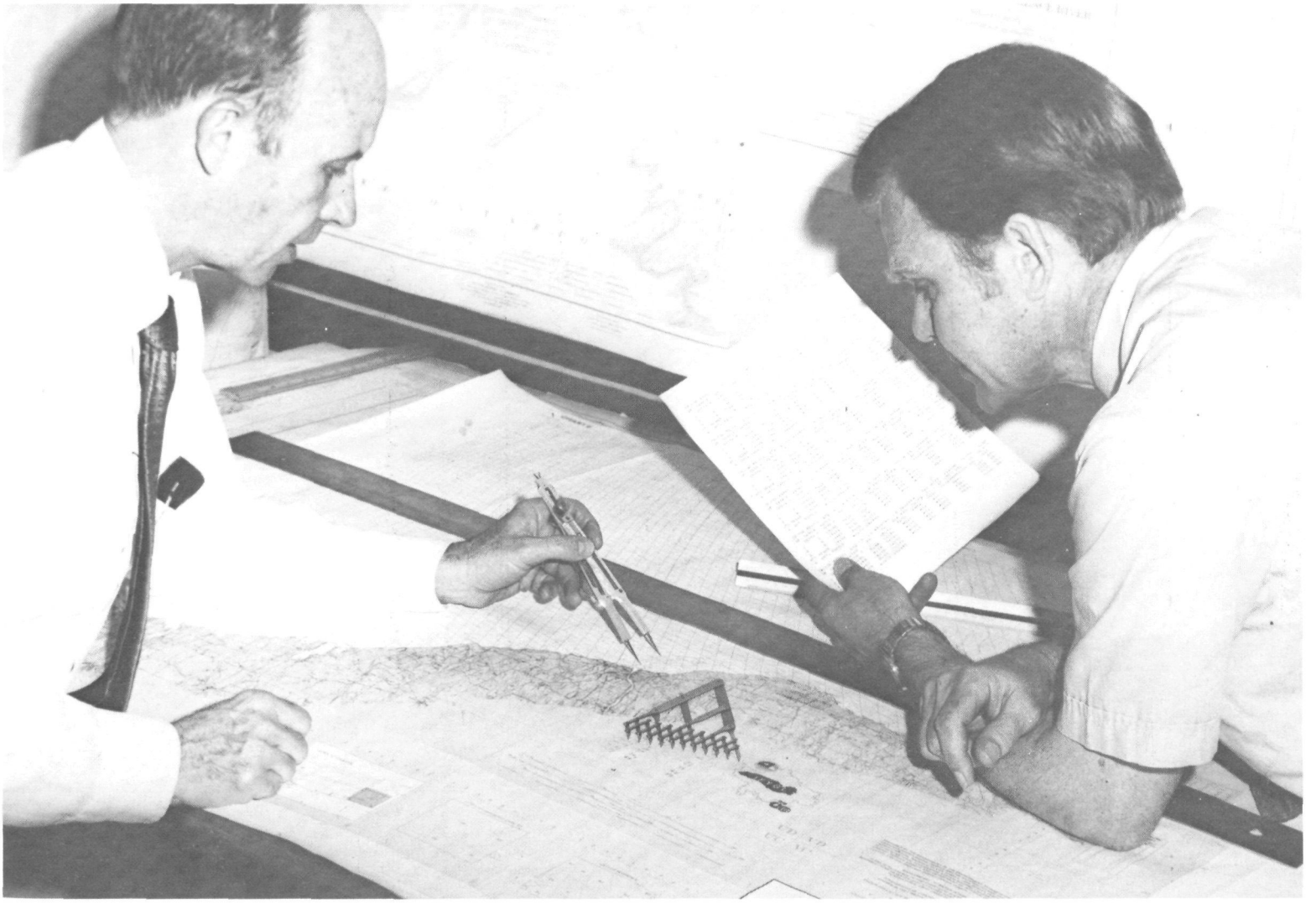
The next major step was to obtain base chart detail along the entire Lake Ontario shoreline. The requirements were to portray only a five-mile band of detail inland from the shore. This was the material compiled from the charts of widely different scales.

The problem now was to reduce the positives and lithos photomechanically to a common scale of 1:80,000, and mosaic the camera-reduced copy to chart format—and the green and blue dropped out, with only the line detail remaining. It worked. And numerous other technical and highly specialized operations were carried on to make the charts both useful and timely. For example, the shoreline of the lake was updated. Bathymetry (lake bottom contours in meters) was taken from charts furnished by CHS. A land area tint was prepared.

Throughout the project, master type cuts were exchanged with CHS.

LSC was designated to prepare a pilot sheet for the project in the final stages. The

Completed in time by Lake Survey Center staff working with Canadian hydrographic personnel, the special charts proved invaluable to IFYGL specialists such as this scientist and his oceanographer colleague, here plotting data.



pilot sheet would ensure that the user requirements had been met and specifications previously agreed upon had been followed. The pilot sheet was carefully studied and reviewed by CHS, LSC and the final user. All the remaining sheets were prepared according to the modified pilot sheet.

The only remaining phase to be completed was the preparation of printing plates, printing and distribution. The printing of charts and maps is not to be taken lightly and is a relatively complicated procedure. As agreed upon, LSC and CHS colors and paper had to be matched. Therefore, to come up with a uniform chart, rigid quality control procedures were exercised and printing schedules were met.

The end result was a series of plotting charts 36 x 48 inches showing the culture, drainage, relief, and Polyconic projection in black. The Decca (6F) lattice system is shown in red and green in the water area only, along with the UTM grid system shown in blue. Since the open water was not shown, the land area was printed in green.

The user requirements were such that an up-to-date navigation chart would also be desirable. Two versions were required, one with the lattice red and green (Decca 6F) shown in the open water only, to be used for sea navigation; the other version would contain the red and green lattice covering the entire chart for possible future air use. The first thought was to surprint, but another difficulty arose. While in storage, the printed charts had shrunk a quarter of an inch, so the Decca positioning lattice would be out of scale. So, LSC navigation Chart 2, Lake Ontario, was processed in the same manner as a new edition chart. Computer-drawn lattices were furnished by CHS and utilized in the same manner as in the preparation of the plotting charts.

The end result was an up-to-date navigation chart printed in the conventional manner but containing a red and green lattice system.

Since most of the data and information obtained during IFYGL would appear in formal or other types of reports, two convenient sheet size chartlets were provided. One chartlet, with a scale of one inch representing approximately 40 miles, depicted the Lake Ontario basin. The second chartlet with a scale of one inch to 24 miles showed only Lake Ontario itself. With only slight modification of LSC base map data already on hand, the chartlets were ready for publication.

A Lake Ontario Planning Chart at the scale 1:500,000 was also required and this was quickly adopted from a Lake Ontario Basin map that had been compiled from World Aeronautical Charts. It showed all detail in black within the basin outline, and had been prepared for another project.

Two versions of the planning chart were finally printed. The first was printed on chart paper for plotting operations. The second version was printed on translucent bond to permit quick reproductions of operations planned.

The work was completed on time, and the results used to aid in the very important data collection during the actual Field Year (1972). Once again, as it has many times in the past, the excellent cooperation between Lake Survey and Canadian Hydrographic personnel has been to the advantage of both countries. □

GO? NO-GO?

ASK THE WALLOPS WEATHERMAN

Among the some 400 duty stations of the National Weather Service, a job at the Space Operations Support unit at Wallops Station, Virginia, is unique. Here, weathermen are not only involved in routine observing and forecasting, but also with the space-age experiments conducted by and with the support of the National Aeronautics and Space Administration.

NASA's Wallops Station is primarily a service facility for experiments to be conducted by scientists from other branches of Government, universities, and private research laboratories, as well as by NASA itself. It offers excellent opportunities for investigations of the atmosphere. Along with a range for the firing of many kinds of smaller rockets, Wallops Station has ultrasensitive, high-powered radars for tracking rocket payloads and other elusive targets. Some of these radars are also well-suited to detailed study of the structure and behavior of the atmosphere.

Wallops Station is situated on the eastern shore of Virginia along the Atlantic coast of the Delmarva Peninsula 40 miles southeast of Salisbury, Md. The 6,500-acre station consists of three distinct areas: the main base, where the airfield is located, Wallops Island, where the rockets are fired, and Wallops mainland, where some of the sensitive radars are installed.

Weather Service personnel are located at the main base in offices on the upper floor of an aircraft hangar, and in a weather-observing facility on the Island itself. Work done at Wallops Station can be explained in detail because the facility is engaged exclusively in nonclassified scientific enterprises. The meteorological work at Wallops is partly paid for by the Weather Service, since the upper air program is part of the national network; but NASA provides NOAA with the major part of the funding for the work done there.

BY EDWIN P. WEIGEL

A random sampling of experiments in which Weather Service personnel have been involved includes a barium-ion-cloud study of the earth's magnetic field 20,000 miles over the Equator above Central America, a series of tests aimed at learning erosive effects of rain on rocket nose cones, ecological photographic missions by high-flying U-2 aircraft, studies by radar of the "signature" and behavior under varying conditions of numerous species of birds, the effect of thunderstorms on communications, studies of ozone in the upper atmosphere, and tests of the effectiveness of numerous rockets and radar-reflecting devices.

A big part of the Weather Service's job at Wallops is participation in experiments involving meteorological sounding rockets. There are small, solid-fuel rockets which carry a payload to around 200,000 feet before releasing it. Payloads may consist of chaff packages consisting of tens of thousands of strands of copper wire about as long as your hand—for measuring wind direction and speed by radar—or rocketsondes consisting of small tubular radio transmitters that send out temperature information at 1680 or 403 MegaHertz. The rocketsondes descend by parachutes which have been metalized to produce strong radar echoes for determination of wind.

The project scientist for the NASA/Wallops meteorological-rocket project is NWS Meteorologist Francis Schmidlin. He plays a major role in guiding NASA's rocketsonde-development efforts, including comparison of their instruments with similar equipment of other countries.

Meteorologist George Foster is operations manager for the three meteorological-rocket networks in which the Wallops unit participates. These, he explains, include the Meteorological Rocket Network (MRN), in which the Department of Defense and NASA are involved; the Experimental Inter-American Meteorological Rocket Network (EXAMETNET), which involves U.S., Argentina, Brazil, Spain, France, Japan and Australia, and the Western Hemisphere Meridional Network, in which rockets are launched along a given meridian to get high-altitude soundings along a plane through the earth's axis. Meteorological-rocket launchings are scheduled three times a week, on Mondays, Wednesdays and Fridays. Goal of these rocket soundings is to

National Weather Service plays major role in NASA's rocket experiments at Wallops Island, Virginia. Above, a Scout liftoff launching a barium ion cloud project in September, 1971.
NASA Photo

learn more about weather very high in the earth's envelope of air and more about the interchange of energy between the Northern and Southern Hemispheres, among other things.

The Wallops weather unit also is responsible for reduction and evaluation of meteorological-rocket data. Meteorologist John Costello is in charge of this work. "Although our main function is handling data obtained here at Wallops," he said, "we also are responsible for quality control of rocket data from Argentina, Brazil, and Spain, our partners in the EXAMETNET. We forward the data to World Data Center A in Asheville, N.C. In addition we are getting data from France's rocket range in French Guiana and from Russia. We also collect data from the network of Department of Defense stations at Thule, Greenland; Fort Churchill, Canada; Cape Kennedy, Fla.; Antigua, British West Indies; and Fort Sherman in the Panama Canal Zone. The information collected is compiled in book form, by month, and made available to the Federal agencies involved and to the U.S.S.R. Data from the U.S.S.R. Eastern Meridional Network is received here at Wallops and distributed to U.S. agencies. Other countries becoming involved are Italy and Mexico. It's an expanding program."

Parameters being processed by Costello's team include air pressure, temperature, density and wind—and the speed of sound—at high altitudes.

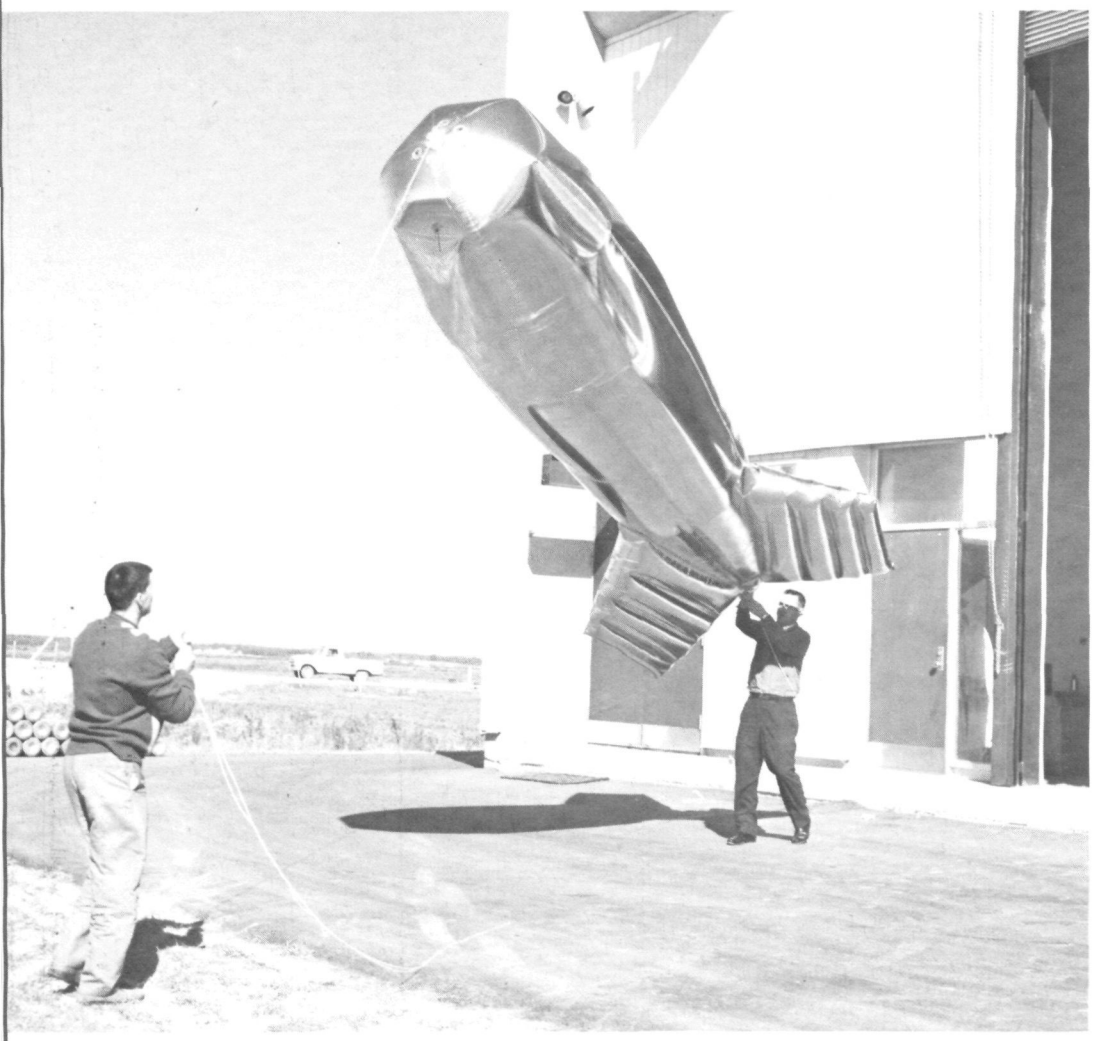
The Wallops weather station is "unique," according to Meteorologist in Charge Lloyd Chamberlain, because "it was the first Weather Service station that actually fired its own rockets." Chamberlain opened the Weather Service station at Wallops in March, 1960—13 years ago. At that time the unit had seven people, including himself. Two of these—Joseph Brewton and Robert Mullin—are still with him. A third, Harold Boone, is retiring this year. The unit now has 23 employees, all told.

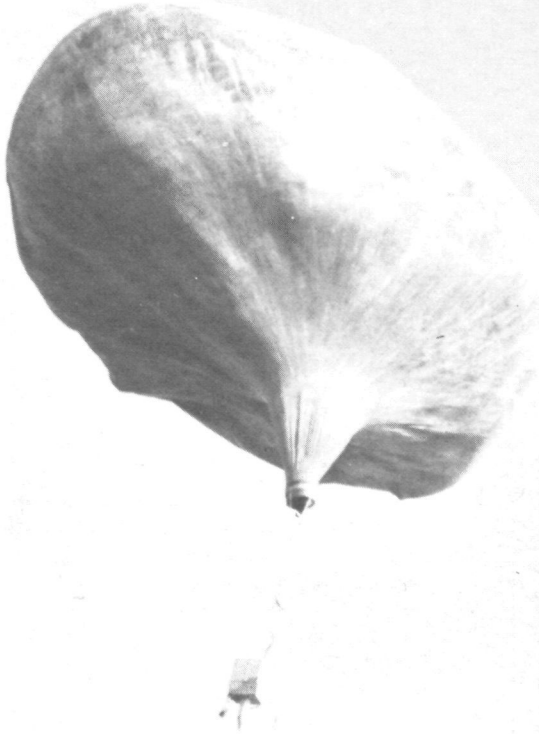
When the station was opened in 1960, meteorological rockets launched from Wallops were all tracked with Weather Service GMD (Ground Meteorological Detector) equipment, and had 1680 Mega-Hertz payloads. "So one of the first Weather Service jobs," explained Chamberlain, "was to track rockets fired by NASA, working right on the pads. This made it easy for Weather Service personnel to learn how to prepare and fire rockets—which they did." Although NASA now handles firing of rockets, Weather Service Electronic Technicians still have a "Go, no go" responsibility for meteorological-rocket payloads.

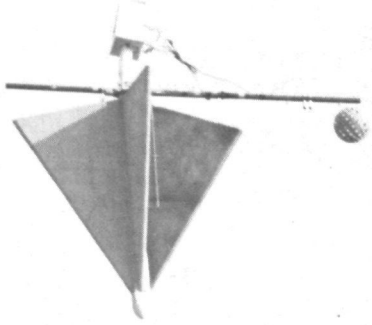
A regular assignment for forecasters at Wallops is to provide weather information for "wind weighting" of all rocket firings. None of the rockets used at Wallops has a guidance system once it has lifted off the pad, except the Scout, said Chamberlain. "The fins are preset. You need accurate wind data so that once a rocket is fired you know how it is going to cock into the wind,

This is Wallops Island rocket-launching strip, showing gantry (enclosed at bottom); two weather station towers for measuring wind velocity, and near upper left, the weather observing station. NASA Photo

Main base of Wallops Station looking northeast is situated on picturesque Chincoteague Bay. The actual launching area for rockets is some miles to southwest, and is located on Wallops Island. NASA Photo



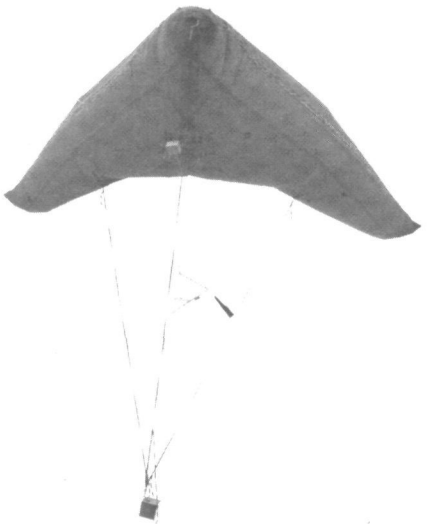




Mylar constant-level balloon, one of the many exotic airborne items at Wallops, waits to go.

U–2 high-altitude planes come to Wallops often for photo missions requiring precise forecasts.

This balloon carries cut-down radiosonde and wind-sensing devices to be released high in air.



Dart tethered balloon (top), contrasts with the Jimsphere, used for precise wind measurements.

where the spent casing is going to land, and also where the payload is going to land." Meteorologist Joseph Bauman elaborated:

"The problem is not at all like figuring wind effect on an artillery projectile, which drifts somewhat with the wind. A rocket tends to cock *into* the wind. So, with a strong wind blowing away from the shore, a rocket tends to angle upward and may drift back over a populated area. NASA's wind-weighting group uses Weather Service data to determine if there is the slightest potential for an accidental shoreward drift. The engineers have tables showing the risk for every type of rocket they fire. If there's one chance in about 100,000 it's no go.

"For range safety, the wind field is extremely important, from the surface all the way to hundreds of thousands of feet."

Weather Service forecasters provide morning briefings for various projects every working day. Said Bauman: "Some experiments call for cloud cover, some for sparkling-clear visibility, others rain. There are many variations. On hand for weather briefings you can expect the test director, the project engineer, project scientists and range-safety people. And these briefings are much more complex than, say, a TV presentation, because most of these people are technical types who understand meteorological terminology." Some attendees are meteorologists themselves, working on a project.

Among the more difficult problems, said Bauman, has been forecasting for "rain erosion of rocket payloads." With a fast-moving payload, he explained, "there is a very serious problem from rain. It can strip away the material on the outside of the nose cone as it is moving through the atmosphere." So NASA has tested a variety of different materials resistant to such erosion.

"Our job has been to forecast periods with the kind of rain they wanted. The requirements were almost self-cancelling. They wanted uniform rain over a wide area from uniform clouds 30,000 to 35,000-feet deep. The rainfall rate they sought was about 2 to 3 millimeters per hour—relatively light. We had to try to forecast 12 hours in advance when would be the most likely time for this kind of rain to occur, since there was a lot of logistics involved in bringing people and a specially instrumented aircraft down from the Air Force Cambridge Research Laboratories in New England. Many individuals were involved.

"Approaching launch time, we sent up big, corner-type radar reflectors by balloon to measure wind. Still closer to launch time, balloons carrying small aluminum reflectors to provide good radar echoes were sent up at 15-minute intervals, almost on a real-time basis. Added to this was wind information, telemetered to us from our two instrumented towers on the island, one 300 feet high and the other 250 feet. Each tower has wind-measuring gear at every 50-foot level, and provides us with constant readouts.

"Using our weather forecasts as a guide, the scientists launched their rockets and measured nose-cone erosion from rain by means of radioactive wires sticking out. As they were eaten away, radioactivity decreased."

Another project calling for precise forecasting has been the U-2 ecological program. The U-2 is the high-flying aircraft once used for reconnaissance. Now, U-2's are being used on long-duration photo missions in which as much ecological photography as possible is crammed into a single flight.

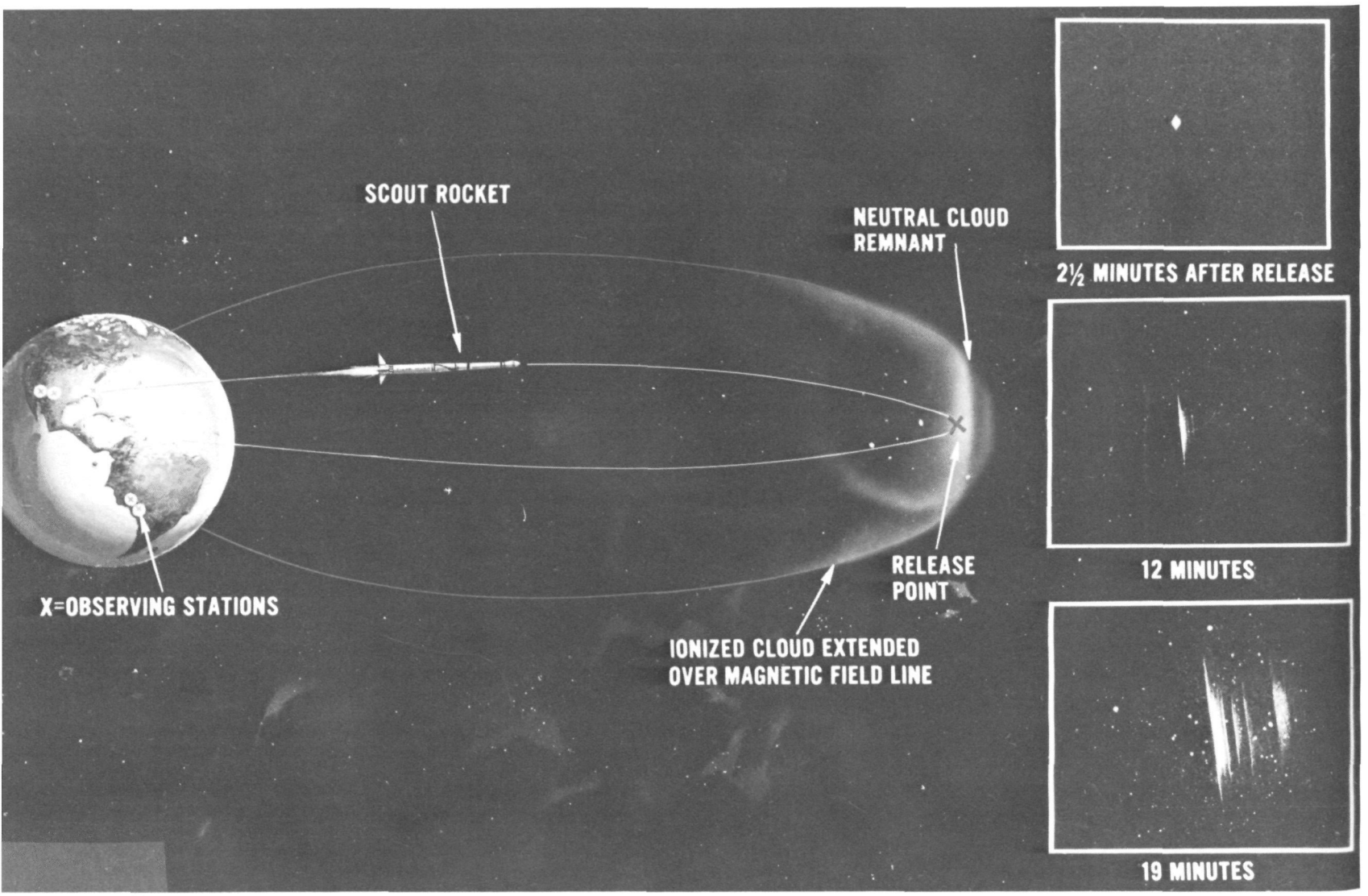
"The U-2's are not based here, but in California," said Bauman. "They'll call us in advance and ask, for example: 'When does it look good for us to photograph much of New England? What's a good 3- or 4-day period for that?' When we tell them, they'll fly here for the operation. On a mission, they navigate by eyeball. They don't want cirrus or even haze. They operate at 65,000 to 70,000 feet. For a given area they have tracks laid out over which they fly back and forth to produce overlapping photos to get stereo and mosaic pictures at the same time. For each flight, U-2 pilots may be working for several different investigators with completely different parameters, requiring, perhaps, different sun angles and different kinds of film. The U-2's come here about once every three weeks now, and are doing fantastic things—for example: looking for the effects of tides on Delaware Bay by means of introduced dye; gaging the amount of defoliation of trees by insects, and how crops are faring. After Hurricane Agnes, there was a whole series of U-2 flights, checking on the amount of flood damage.

"These fellows are really precise; they allow a specific time interval for each portion of a flight. Their fuel problems are tricky. So they depend a lot on our forecasts."

Of all the forecasting assignments carried out by the Weather unit at Wallops, the task of predicting clear skies for the barium-ion-cloud experiment in September, 1971, was undoubtedly the most complex. This experiment called for the release of barium vapor 20,000 miles above the earth over Central America by a Scout rocket launched from Wallops. The experiment was conducted jointly by NASA and West Germany's Max Planck Institute for Physics and Astrophysics. The goal was to observe and photograph telescopically the effect of the earth's magnetic field on barium atoms which had been stripped of one of their electrons—that is, ionized. At the great height of 20,000 miles neutral barium atoms were ionized by the sun's ultraviolet radiation so that they became electrically charged. Once so ionized, the charged barium particles then were drawn down along the lines of the earth's magnetic field in tight spiral paths, causing the barium cloud to become longer and longer during the 1½ hours it was photographed.

The effect is similar to the old physics-

National Weather Service forecasters predicted eight hours in advance when conditions would be clear enough over North and South America for photography of this barium ion cloud experiment. NASA Illustration



class experiment in which iron filings are scattered on a sheet of paper over a horseshoe magnet so that they line up with the opposing poles. The difference is that, with the Wallops experiment, the earth itself was the magnet.

The Wallops forecasters' job was to predict at least eight hours in advance when the weather would be clear enough over two continents—North and South America—for the cloud to be telescopically photographed. Six primary optical viewing sites were involved: the Kitt Peak National Observatory near Tucson, Ariz.; the Smithsonian Astrophysical Observatory at Mount Hopkins, Ariz.; the White Sands, N. Mex., Missile Range; the Smithsonian Astrophysical Observatory at Arequipa, Peru; the European Southern Observatory at La Silla Peak, La Serena, Chile; and the Cerro Tololo Inter-American Observatory at La Serena, Chile. All of these sites are at high elevations—ranging from 5,400 feet at White Sands, to 8,750 feet at Kitt Peak.

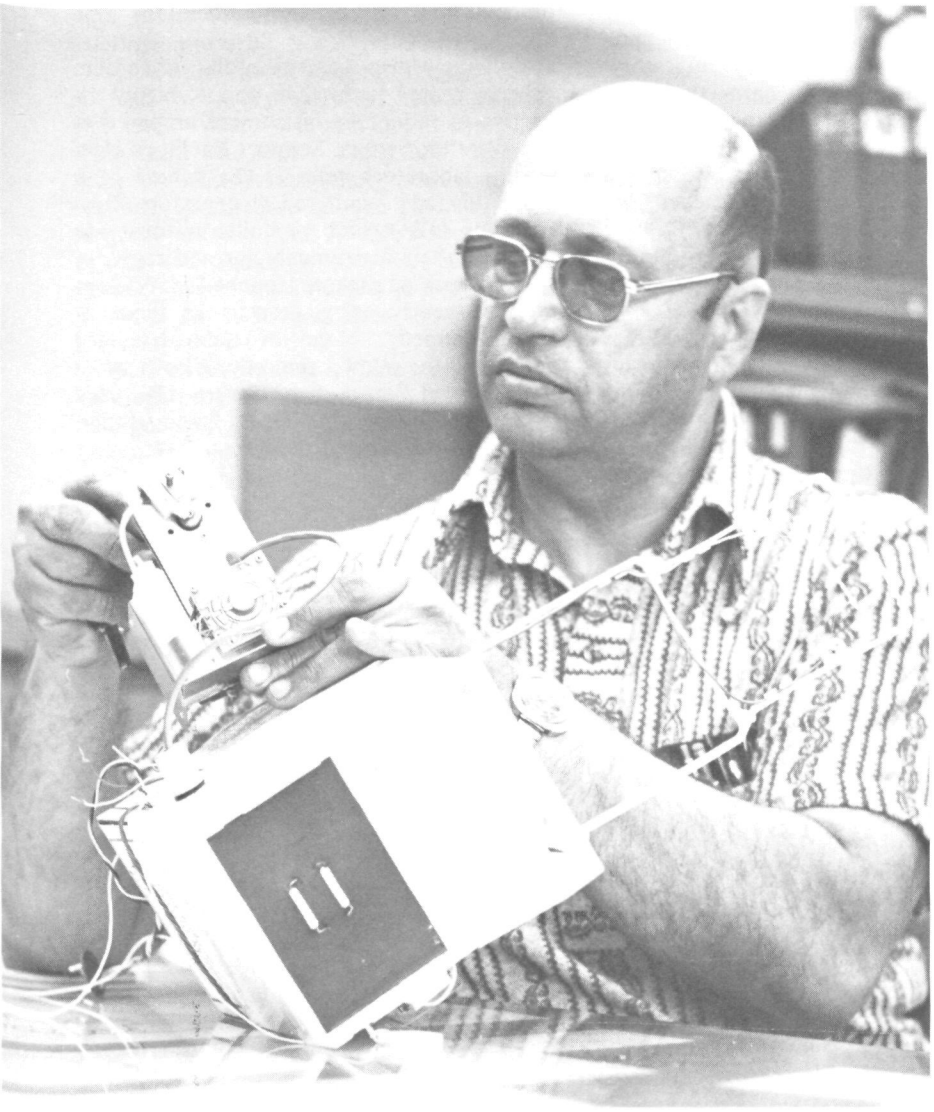
In addition, the Wallops forecasters had to forecast the weather during the experiment for a NASA Convair 990 equipped with special cameras. This aircraft was to fly along a corridor between Bermuda and Wallops Station, and needed assurance there would be no turbulence or lightning during the critical period.

Sightings from widely distributed localities were necessary to determine the exact position and motion of the barium cloud at successive instants by triangulation. A clear, moonless night was required so that sensitive cameras could pick up the faint image of the gradually elongating cloud. Complicating the forecast for the two-hour experiment was the 3½-hour lag between launch of the four-stage Scout rocket and ejection of the barium vapor. This is the time interval required for the rocket payload to reach a 20,000-mile altitude. Chamberlain said the final forecast, one hour before launch, "had to provide reasonable assurance that favorable weather and optical-seeing conditions would exist for seven hours" over the primary viewing sites.

Advance studies had indicated the summer months could not produce these conditions, so launch "windows" in spring and autumn were selected. Several times in the spring of 1971, launchings were scheduled and then cancelled. Finally, on September 20, 1971, at 7:31 p.m. EDT, the Scout rocket soared into the sky with its barium payload. At 11:05 p.m., three hours and 34 minutes later, the vapor was released.

Because of its great height, the barium cloud was within view of almost all of North and South America and the westernmost parts of Europe and Africa. When the barium was released, it became ionized within a minute or so and quickly achieved peak brightness. To the unaided eye, it

Joseph Paranzino, Supervisory Aerospace Observational Specialist, holds a radiosonde bearing a special device for measuring ozone in upper air, and then radioing its information back to earth. Weigel Photo



Electronic Technician Elwood Harte holds meteorological rocket components. In right hand, data-sonde payload which descends from 200,000 feet by a parachute inside the tube in left hand. Weigel Photo

appeared about as bright as the North Star, and grew dimmer as it elongated along magnetic-field lines. It was visible 8 to 10 minutes to personnel at Wallops Island without the aid of telescopes.

On the day of the launch NOAA personnel at several sites participated in the experiment. Wallops NWS weather observers and forecasters had been detailed in advance to most of the telescope-camera sites in U.S. and South America, from which they provided on-site weather observations to the duty forecaster at Wallops. During the day of the launch, the Weather Service's Spaceflight Meteorology Group at Suitland worked closely with the NWS Analysis Center, studying weather maps of the Southern Hemisphere, and monitored "movie loops" of ATS-3 pictures made by the Applications Group of NOAA's Satellite Service. The Suitland Spaceflight Group reported their observations to the duty forecaster at Wallops. NOAA's Satellite Command Data and Acquisition Station—directly adjacent to Wallops Station—prepared "a near real-time Polaroid picture" from the ATS-3 satellite, which was processed immediately by the NASA/Wallops photo lab for study by project scientists.

The result was a series of sharp photographs from several angles showing the cloud turning from a round dot into thin, parallel streaks, confirming some of the scientists' expectations and also raising new questions about the magnetosphere. Next on the list may be a somewhat similar experiment in a polar region, where the magnetic field is much closer to earth.

Besides forecasting for experiments conducted at the Wallops Station, the Weather Service people frequently are called upon to go elsewhere to provide weather support for scientific missions. Wallops personnel have been on assignments to Bermuda, Alaska, Barbados, South America, and aboard ships, making weather observations and forecasts.

In 1965, Chamberlain served aboard NASA's small aircraft carrier that had been converted into a rocket-launching platform. This expedition went as far as 60 degrees south along the west coast of South America. "On that trip, 77 rockets were fired, 76 of which performed perfectly," he said. "Most of the rockets fired were Nike-Cajuns—a really good, two-stage solid-fuel vehicle. And of course some were meteorological rockets, which the Weather Service tracked with onboard GMD equipment."

Meteorological rockets with radio transmitters have payloads that are essentially modified radiosondes, transmitting on 1680 MegaHertz. They are tracked by the same kind of ground equipment used for balloon-borne radiosondes. The main difference is that rocket payloads are tracked on the way down when descending from perhaps 200,000 feet by metalized parachute, whereas the balloon-borne radiosondes are

tracked on their way up to a maximum altitude of perhaps 100,000 feet. The two sets of data combine to provide a complete wind and temperature profile from the ground to the rocket payload's maximum altitude.

The Weather Service station at Wallops is the official network station for rawinsonde measurements of the upper air along that portion of the East Coast. Balloon-borne radiosondes are launched twice daily at 0000Z and 1200Z (8 a.m. and 8 p.m. EDT).

Besides these twice-daily radiosonde launchings, there may be as many as four or five special balloon launchings for one purpose or another on a given day. One type of special launching is the ozonesonde, using a special instrument attached to the side of a radiosonde. By an electro-chemical process, this device measures the ozone content of the upper atmosphere. According to Joseph Paranzino, Supervisory Aerospace Observational Specialist, Wallops Station is the only place in the U.S. where such upper-air ozone soundings are regularly made. Paranzino and his co-workers also make ozone measurements at the surface with Dobson spectrophotometers.

Another balloon-borne experiment conducted on the Island involves migratory birds. Said Paranzino: "To carry the birds aloft we put them in little packages attached to the balloons. A simple fuse releases a door at a given altitude and the bird drops out. Thereafter, the bird is tracked by sensitive radars to determine what kind of echo it makes, the direction and altitude of travel, and so on." Other birds are released from helicopters and similarly tracked.

A somewhat harrowing task for weather observers is associated with thunderstorm experiments being conducted by the Johns Hopkins Applied Physics Laboratory and the Air Force Cambridge Research Laboratories. This one is a potential every night from 4 p.m. until midnight. It calls for personnel at the weather-observing unit to release a radiosonde balloon into any thunderstorm that comes along. Scientists are trying to learn just how a given amount of precipitation affects communications and over how wide an area.

Balloons also carry aloft styrofoam spheres coated with silver paint—highly reflective to radar. An instrument prepared at the Weather Service Support Facility's electronics laboratory releases the sphere at a given altitude, and radar operators then track its fall—which is quite uniform—to calibrate their instruments for accuracy.

The types of rockets launched at Wallops are not nearly so glamorous as those at Cape Kennedy. None of them has, for example, the slow, majestic liftoff of a liquid-fueled Saturn 5 or Saturn 1B—used in launching the SKYLAB space station and the astronauts to man it.

Explained Wallops Public Affairs Officer

Some of the Wallops weather personnel in the forecasting office. Top row, from left: Paul Murphy, Kathy Lewers, George Foster, Richard Kelly, Robert Dittmar (Principal Assistant), Ray Brown. Bottom row, from left: Joseph Bauman, John Costello, Lloyd Chamberlain (Meteorologist in Charge), Herbert Chadwick.

Weigel Photo

Joyce Milliner: "Our four-stage, 72-foot Scout is the largest rocket launched here, but the Scout is the smallest rocket fired at Cape Kennedy. However, the Scout can put a 500-pound satellite into a 300-mile-high orbit. Scout rockets have placed 17 satellites into orbit from Wallops Island.

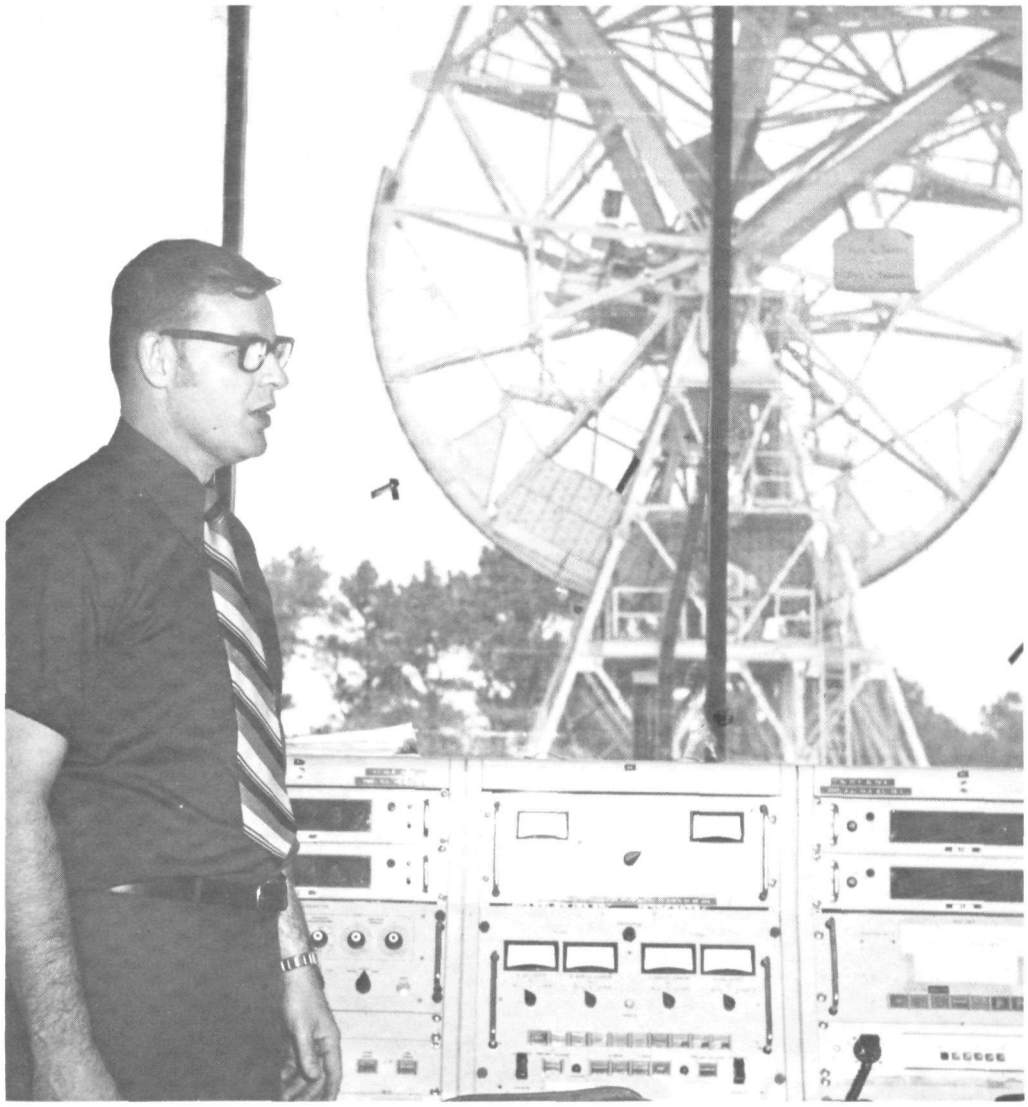
"The little meteorological rockets move so fast you really can't see them go up," she said. "What you see is the smoke of their trail, and that's about all." Fuel in some of them is completely burned in two seconds. From there on, the payloads coast to peak altitude. An ARCAS rocket, one of the old standbys, puts its payload at apogee (maximum altitude) of 200,000 feet in about two minutes. Then the parachute is deployed.

Wallops Station has an active community-relations program and goes out of its way to be a good neighbor to the surrounding population. In mid-April the station participated in a Chincotague Chamber of Commerce affair called "Week End on the Islands," and held open house for all comers, with a variety of instructive exhibits in the main hangar. The Weather Service unit was an active participant, as was NOAA's satellite station immediately adjacent.

Said Electronic Technician David Beatty: "We had 360 visitors over the week end at the satellite station, almost more than we could handle." Beatty is training officer for the satellite station, and provides visitors with a graphic description of NOAA's plans for implementing data retrieval from the new GOES (Geostationary Operational Environmental Satellite), when it is placed in stationary orbit 22,300 miles high sometime next year. "Plans call for two new 60-foot dishes for GOES," he said, "and there will be a separate operations center to control the satellite and process data."

Also part of good neighborliness is the elaborate safety precautions maintained by Wallops personnel with the aid of their supporting meteorologists. At launch time, a special airplane is sent out to sea over the launch area to spot ships or small boats which may have strayed into a danger area. A close-in radar also keeps a watchful eye, and the Coast Guard stands ready to move fast in event of emergency. "Actually, though," explained a Weather Service forecaster, "NASA has no right to make anyone move out of the way. When the fishing is good, commercial fishermen are not about to move elsewhere. Their livelihood is at stake. So NASA waits or shifts the aiming point of a rocket slightly."

The list of experiments and variety of tasks performed at Wallops Island could go on and on. While Wallops Station may lack the fame of the larger space centers, it makes up for this in the diversity of tasks it is performing. As a servant of the scientific and engineering communities, it yields a rich return on the taxpayers' dollar. □



Electronic Technician David Beatty, training officer for National Environmental Satellite Service's Command and Data Acquisition Station, views pedestal for an 85-foot antenna.
Weigel Photo

Not far from Wallops complex is the famed Chincoteague National Wildlife Refuge on Assateague Island. It's home to herons, ducks, geese, shore birds, other animals and the fabled wild ponies.
Weigel Photo

NOAA Profile

Distaff Dynamo

Ola Watford, NOAA's only woman geophysicist, combines a career with marriage, motherhood, community activity, and continuing education.

If energy were measured by a yardstick, Ola Bryant Watford could be described as five feet of dynamic momentum, topped by a computer-quick mind.

She is the only staff female geophysicist employed by the Department of Commerce. She also is married, the mother of six children, active in community organizations, and usually is taking a graduate course at a nearby university.

As a geophysicist with the Environmental Data Service's National Geophysical and Solar Terrestrial Data Center in Boulder, Colorado, Mrs. Watford's major duties and responsibilities are associated with analysis, compilation, charting, and distribution of United States and international magnetic field data information and charts.

She is responsible for integrating all this information from global observatories, repeat stations, and field surveys by land, sea, air, and satellite. She then develops methods and computer programs for the automatic processing of this data, reviews and corrects test runs, and resolves inconsistencies.

Special studies of the earth's magnetic field are required to derive essential navigation data for the complete series of nautical charts issued by NOAA's National Ocean Survey. All of these marine charts must show up-to-date magnetic variation information. More than 900 charts of this series will, sooner or later, arrive on Mrs. Watford's desk.

"The world and regional magnetic charts of the United States, Central and South America are published at five and ten-year intervals," she says. "Only three countries in the world (United States, United Kingdom and USSR) prepare the world magnetic charts."

Consequently, international trainees from many parts of the world come to EDS's geomagnetism division for training. And Mrs. Watford is on hand to meet and train them in the basic procedures required in the compilation of magnetic charts.

"My knowledge of French often becomes most helpful at this time," she says.

In a room papered wall-to-wall with charts, the diminutive Mrs. Watford recalled her early background. "I was the only girl and youngest of five children in my family. My father was a graduate of Biddle University (now known as Johnson C. Smith University). After graduation, he went on to seminary and became a Baptist minister and later, a Bishop in the Southern Baptist Conference. He also owned his own tobacco farm and religious publishing house. My mother was the typi-

Busy life as wife, mother, executive, community leader and student leaves Ola Watford smiling.

cal housewife and still resides at home in Kinston, N.C."

Education was stressed in the family. Her paternal grandfather was a graduate of Shaw University in Raleigh, N.C. Her maternal grandmother was a school teacher in 1885.

Mrs. Watford is a native of Kinston, North Carolina, and valedictorian of her Adkin High School class. She and all her brothers are graduates of Johnson C. Smith University in Charlotte, N.C. At age 19, the youngest member of her graduating class, she went on to graduate study at Howard University in Washington, D.C.

A firm believer in continuing education, she has since studied at D.C. Teacher's College, the Department of Agriculture Graduate School, American University, Industrial College of the Armed Forces, the IBM Education Center, and in several on-the-job training classes.

"If one plans to keep even partially abreast of today's information explosion and scientific advances," Mrs. Watford believes, "you must stay in school."

She plans to enter the University of Colorado in Boulder soon.

The geophysicist met her husband, Alven Watford, a recently retired international economist for the United States Department of State Agency for International Development, in graduate school at Howard University. After marriage, she taught mathematics for two years at Queen Street High School in Beaufort, N.C., before entering government service.

"I began my government career in 1951 as a GS-3 statistical clerk at the Naval Oceanographic Office," Mrs. Watford recalls. Two years later she transferred to the Coast and Geodetic Survey—which later became part of NOAA—and has advanced to her present position.

Mother of six children, ranging from elementary school age through college, Mrs. Watford says: "I've worked all my married life as a financial necessity. The Commerce Department allows its female employees six months' maternity leave, permitting a female employee to retain her employment."

She has successfully managed a career, motherhood, and role of wife principally by employing "live-in" help. "I've always had a live-in housekeeper—an absolute necessity—until we moved to Boulder last November. During the years my children were younger, daycare centers were not readily available anywhere throughout the country. To accomplish regular housekeeping duties, it was necessary to have help to take care of the everyday needs of the children."

Since her brothers were high school principals, Mrs. Watford would employ female graduates her brothers recommended, providing board and room plus salary and tuition so they might attend adult education classes in the large Washington, D.C., metropolitan area.

"This is one of the ways we could help others obtain a good start in life so they wouldn't have to remain on the farm without further education in their small communities," she said. "We considered it a 'help-exchange' because we were helping these young girls further their education, and I was able to continue my career. Of course, this depended upon the ages of my children."

If all the children were in school, the babysitter could also go to school. Until that time, Mrs. Watford had to hire someone to work full-time in the home to care for her pre-school children.

Exploding the myth that "successful" wives, mothers, and career women must be expert at all homemaking tasks, Mrs. Watford readily admits she's not a good cook.

"My culinary activities are rather limited, but I do believe in balanced meals. I'm no seamstress either; I couldn't make a dress any more than the man in the moon.

"I find the day-to-day tasks of running a household very similar to managing a business or institution. A career wife and mother still must assume the traditional duties of taking care of skinned knees and participating in neighborhood car pools."

Despite her busy schedule, Mrs. Watford found time to involve herself in PTA, other school-related parents' clubs, and teach a Sunday school class.

Mrs. Watford has been a member of NOAA's Equal Employment Opportunity committee both in Washington, D.C. and Boulder. She also is EDS Federal Women's Program representative. Mrs. Watford is currently representing NOAA on an interagency task force to augment minority participation in science and engineering. She recently acted as the technical representative in a program to recruit geophysicists, electrical engineers, and mathematicians at minority colleges in Texas and Louisiana.

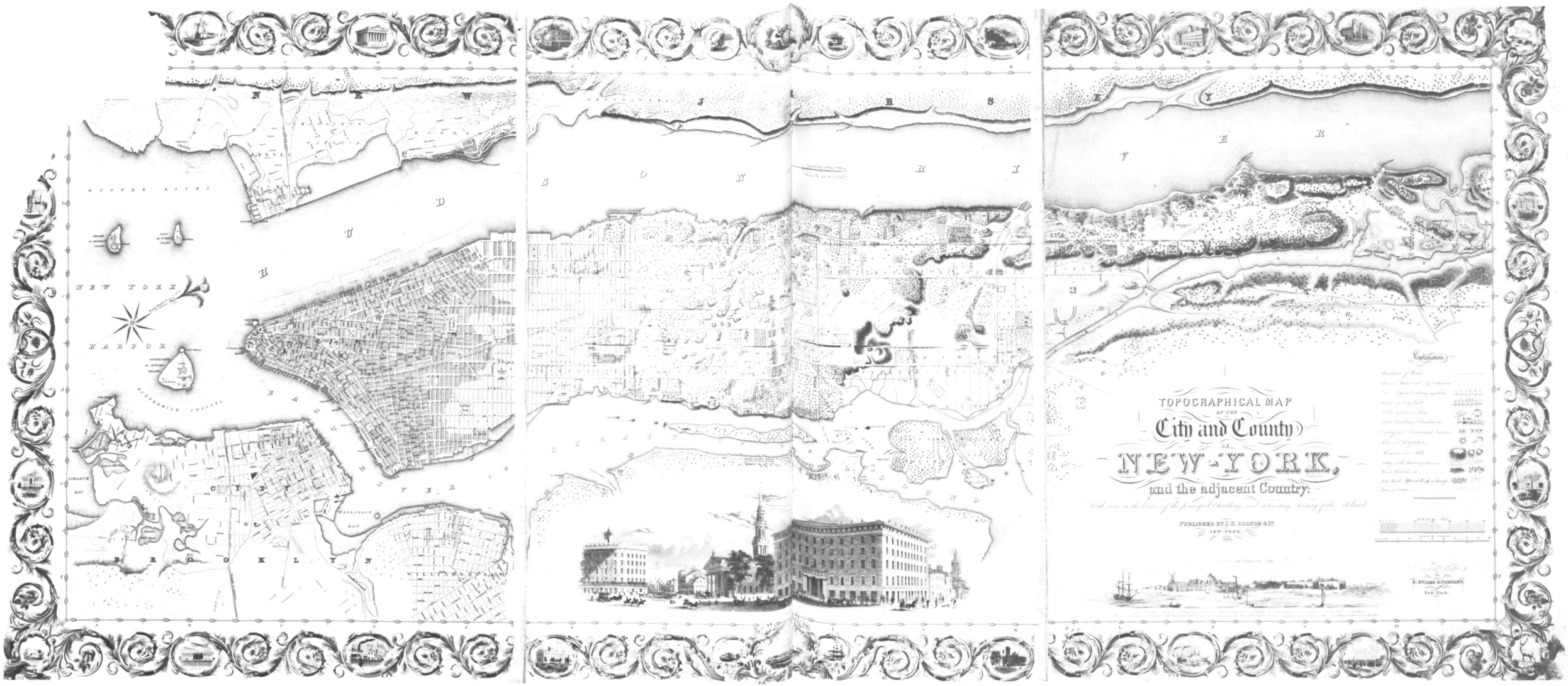
"Few members of the minority groups including women, have been employed in geophysics," said Mrs. Watford. "Past practices limited the number of minority groups, including women, in certain scientific fields."

But rather than dwell on the negative aspects of the past, she prefers a positive outlook for the future. Mrs. Watford's goal is to see many women in all scientific fields, as managers, executives, and true professionals—equal co-workers in jobs well done. □

Mrs. Watford combines a brown-bag lunch under the trees with shop talk with her colleagues.

Captain Cook's blood? Nobody will ever know.

Topographical map of the City of New York, one of many historic and valuable cartographic treasures in National Ocean Survey archives.



Magic Carpets Into History

BY WILLIAM A. STANLEY *

"Journey all over the universe in a map, without the expense and fatigue of traveling, without suffering the inconveniences of heat, cold, hunger, and thirst."

Cervantes, *Don Quixote*

Washington history buffs can go Cervantes one better. Vicariously, they can explore the uncharted globe of centuries ago in safety, fight the American Revolution and the Civil War without smelling gunpowder, and help open up a new America without leaving home.

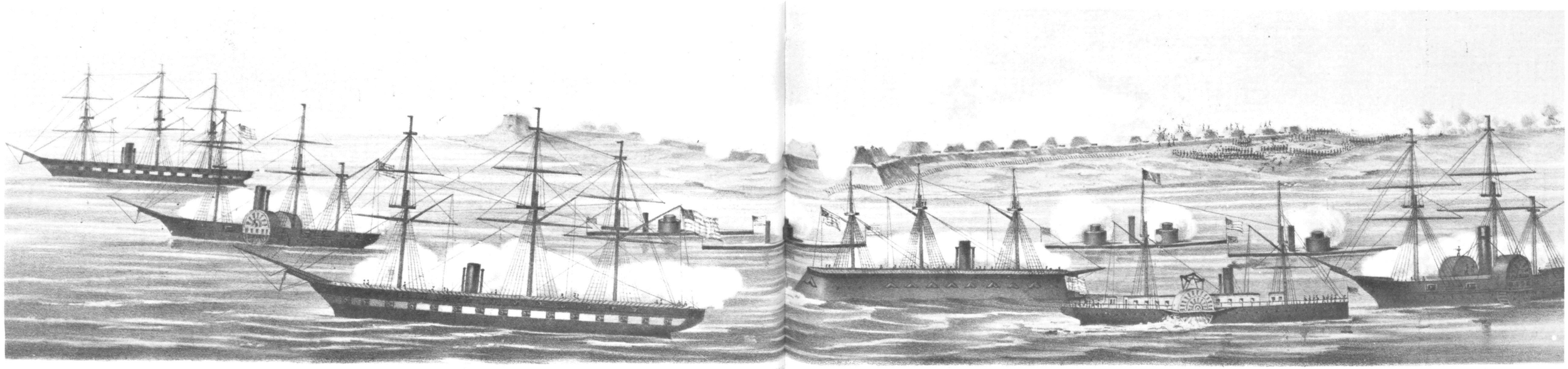
Their keys to this brand of high adventure are vivid imaginations and one of the finest collections of historical maps anywhere in the Federal government—the National Ocean Survey's.

It is kept with loving care by the Survey's Scientific Data Services Division, at NOAA headquarters in Rockville and at nearby Riverdale, Maryland. Its 24,000 pieces contain a fascinating potpourri of large-scale maps and charts, Old World atlases, topographic, magnetic and seismological maps, and other cartographic mementoes of our Nation's colorful yesterdays.

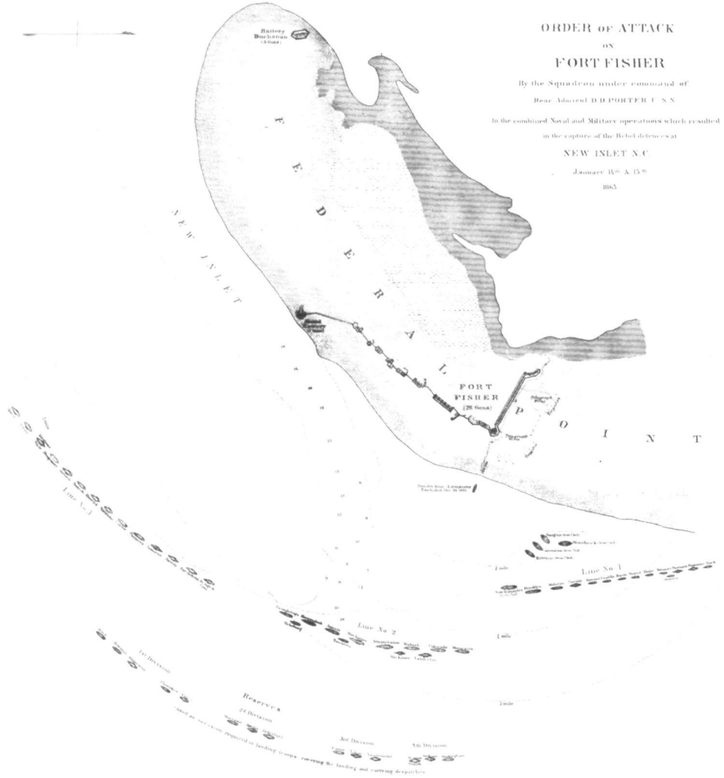
The variegated collection had its beginnings shortly after the American Revolution when the new republic found itself with a growing need for charts to serve a burgeoning country, but with no government-controlled chart producing agency. The maps and charts available at the Revolution's end were those of DesBarres and early explorers and navigators; they were not considered sufficiently accurate for reliable coastal navigation. American cartographers like Aldredge, King and Blunt hurried into the breach with coastal maps which proved financially rewarding and were highly valuable in the evolution of our maritime exploration, colonization and commerce.

In the end, the need outstripped industry's capacity to meet it, and in 1807 the Congress authorized President Thomas Jefferson to "cause a survey to be taken of the coasts of the United States, in which shall be designated the islands and shoals, with roads or places of anchorage, within twenty leagues of any part of the shores of the United States." Thus was born the "Survey of the Coast", later to be known as the U.S. Coast Survey, the Coast and Geodetic Survey and—today—as the National Ocean Survey.

* William Stanley is chief of the Physical Science Services Branch, Scientific Data and Services Division, National Ocean Survey.



BOMBARDMENT OF FORT FISHER N. C.



When the Survey of the Coast came into being, two things began to happen: private concerns began going out of business and the fledgling Federal agency proved a major focal point for the collection of maps already in existence—some of them ancient and rare. Many of the commercially produced charts, ranging from the 1700's to the mid-1800's, are from Edmund Blunt & Company, producers of "The American Coast Pilot," and numerous charts covering the Atlantic coast of North America, and parts of Central America, the West Indies, and the northern coasts of South America.

The Survey's original map custodian was the fabled Swiss mathematician, Ferdinand R. Hassler, who became its first superintendent. Hassler gathered maps and reports wherever he went, keeping them in the bottom of a specially-built carriage. His own first survey in 1816—a baseline measurement of nine miles on New York's Fire Island Beach—is in the map library today.

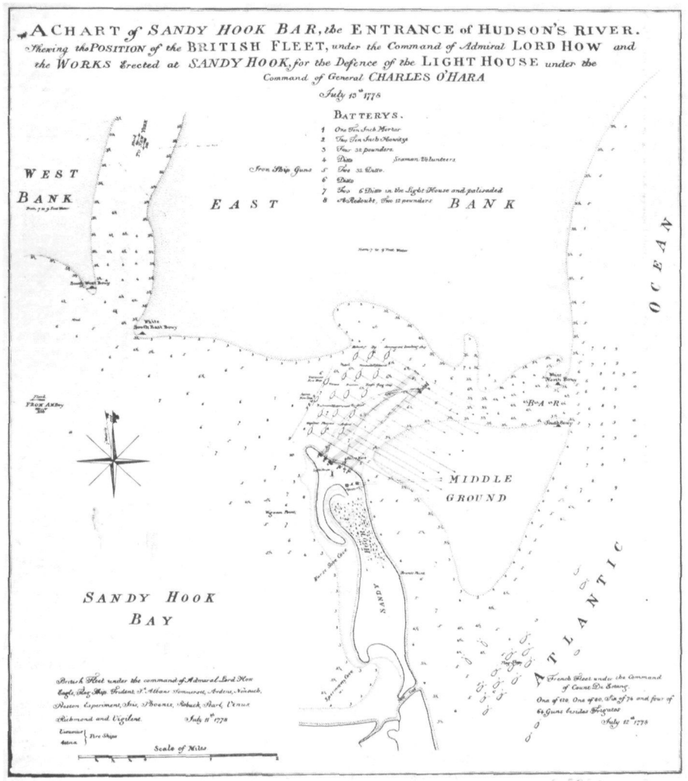
Many of them were made during the New World exploration explosion of the 1700's when Russian, Spanish, British and French explorers all lent their expertise in opening new frontiers for America. Among them was Captain James Cook, who explored the Alaska coast for Great Britain in 1778. The Survey's collection contains several well-preserved maps from his voyages, including one tattered chart plotting the courses of his expeditions and bearing what appears to be a bloodstain in the lower left corner.

Vancouver's exploration of the Pacific coast of North America during 1792–1794 is detailed in the Survey collection. The series done by Captain George Vancouver of the British Navy, extending from the coast of Southern California to Cook Inlet and Kodiak Islands, Alaska, consist of nine detailed maps including one of San Francisco and others with exotic views around borders, showing villages and the familiar symbol of a church, greatly exaggerated, to denote a populated region.

Charts from the historic expedition conducted by Admiral Charles Wilkes, USN, at the request of the Federal government to explore and survey the Northwest coast of America, the Hawaiian Islands, the Islands of the South Pacific, and the Antarctic region, engraved in 1843, are colorful additions to the collection.

The maps resulted from a four-year expedition which circumnavigated the earth and returned to New York in 1842. The collection of Northwest America is in the form of 26 engraved maps and surveys. The plan for the expedition was far-reaching and had many facets relating to the scientific stature of the United States. All disciplines were involved but physical inventories were the most pertinent. The chief fields of exploration were the coast of the Antarctic continent, selected islands of the Pacific Ocean, and the American northwest coast. Hydrographic surveys were made of about 280 islands in addition to the territorial waters of the United States from San Francisco Bay to the Strait of Juan de Fuca and including the Oregon Territory.

By establishing the existence of the Antarctic continent and sailing along its



perimeter, substantial contributions were made to world knowledge of geography. More than 180 charts were constructed by Wilkes as a result of the expedition. Found to be of vital interest even to modern cartographers, the series of some 26 plates in the map library have been lithographed and made available to the public for their historical significance in the evolution of American cartography. The collection includes an interesting map of the Oregon Territory, seven charts of the Columbia River, most of Puget Sound, Sacramento River, San Francisco and San Pablo Bays. Other areas covered are Grays Harbor, Strait of Juan de Fuca, Admiralty Inlet, Port Discovery, and detailed charts of selected ports, harbors, and inlets.

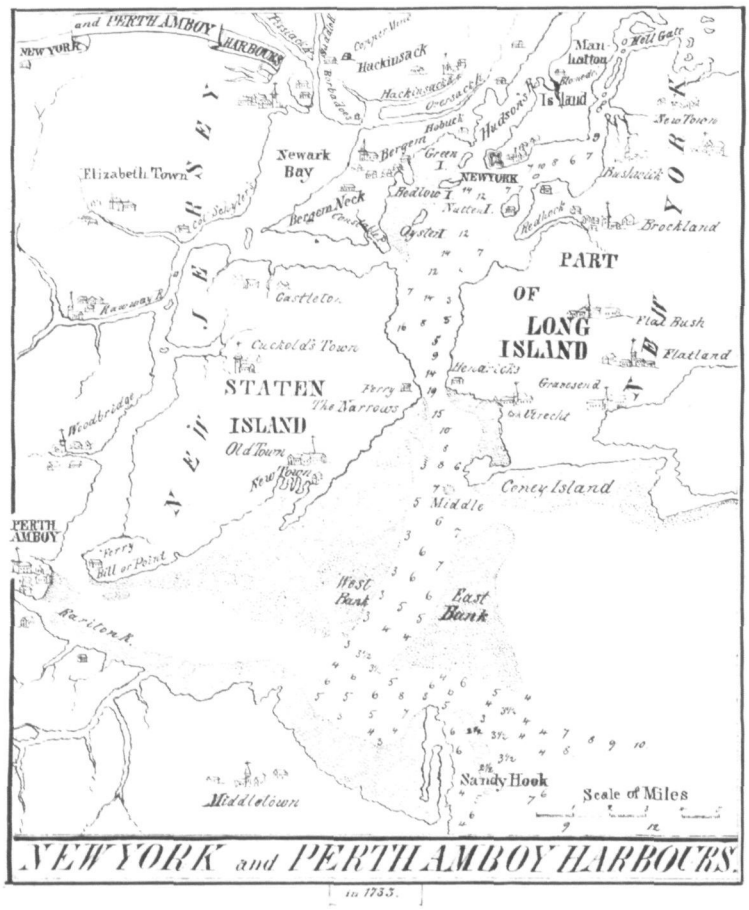
Many atlases are included in the map collection. These are so fragile that they are exhibited only upon request, supervised by one of the map custodians. Such is the case of the *Atlantic Neptune,* a collection of charts, plans, sea coast views, and handwritten notes of portions of the Atlantic coast considered to be one of the finest presentations compiled by early cartographers. Joseph F. W. Des Barres, Esq., is credited with drafting the very accurate hydrographic charts of the colonies. His first edition of the *Atlantic Neptune* came out during the American Revolution.

Reproductions of this atlas now in NOAA's possession were prepared in 1777 at Halifax, Nova Scotia. It is one of only a handful of the original editions still in existence. The famous atlas contains some 257 plates, designed with all of the artistry one would expect from one of the great cartographers of the period. NOAA's copy consists of ninety-five sheets, many of them folded, including a page titled "General Remarks" giving sailing directions, locations of principal harbors and otherwise providing information which could not graphically be exhibited on the charts.

The collection contains several other noteworthy historical atlases. Of special interest is De Bougainville's, entitled "Journal de la navigation authour de globle de la' Fregate la Thetis et de la Corvette L' Esperance 1824, 1825, et 1826". This volume consists principally of pictures—natural scenery, coastal views, pictures of ships, and a number of Old World charts at the end of the book.

Another atlas publication located at the National Ocean Survey's facilities in Rockville is a rare set of Alaska maps. The earliest explorations of Alaska were made by Russians. In 1727, Vitus Bering explored the strait between Siberia and Alaska that now claims his name. In 1741 Bering and Chirikof explored and charted the southern coasts of Alaska and the Aleutian Islands. It was from the early explorations that the Russians gave us the first reliable atlas of Alaska. One of the three known bound sets in the United States is a part of NOAA's permanent collection.

It was compiled as a result of the Imperial Russian government's expedition, under command of Captain Joseph Billings, to explore eastern Siberia and Russian America. Accompanying this expedition was Lieutenant Sarychef of the royal Russian Navy. During the course of the expedition, he made surveys of the Alaskan coast and Aleutian Islands that were subsequently published in atlas form. This collection, identified as the *Sarychef Atlas,* came in 1937 to the permanent files of the Survey. Historians from Harvard University who visited the collection of maps some years



This 1733 English sailing chart of New York's Harbor, using water depth data, from Kohl Report.

Another look at New York, an 1860 chart made by the Westermann Company, from Survey data.

ago marveled at the preservation of the atlas and indicated it was a very rare and valuable manuscript. It is said that the maps were the most complete and reliable publications of the Alaskan Islands that had been published to date.

War, like exploration, breeds a proliferation of maps and charts. The Survey collection includes a 14-by-18-inch Revolutionary War map of Sandy Hook and environs, illustrating the position of the British fleet under the command of Lord Howe, then preparing his attack upon New York. Another map of the same vintage shows the French fleet assembled to attack the British contingent; the date is 1777.

Also on file in NOS is a large war map of Long Island, Manhattan and surrounding New York waters. It probably was executed by DesBarres and is a companion to one on file in the British archives. The map was presented to the Survey in the mid-1950's by Admiral Ritchie, then Hydrographer of the British Navy and now commands a place of honor in the Survey headquarters foyer.

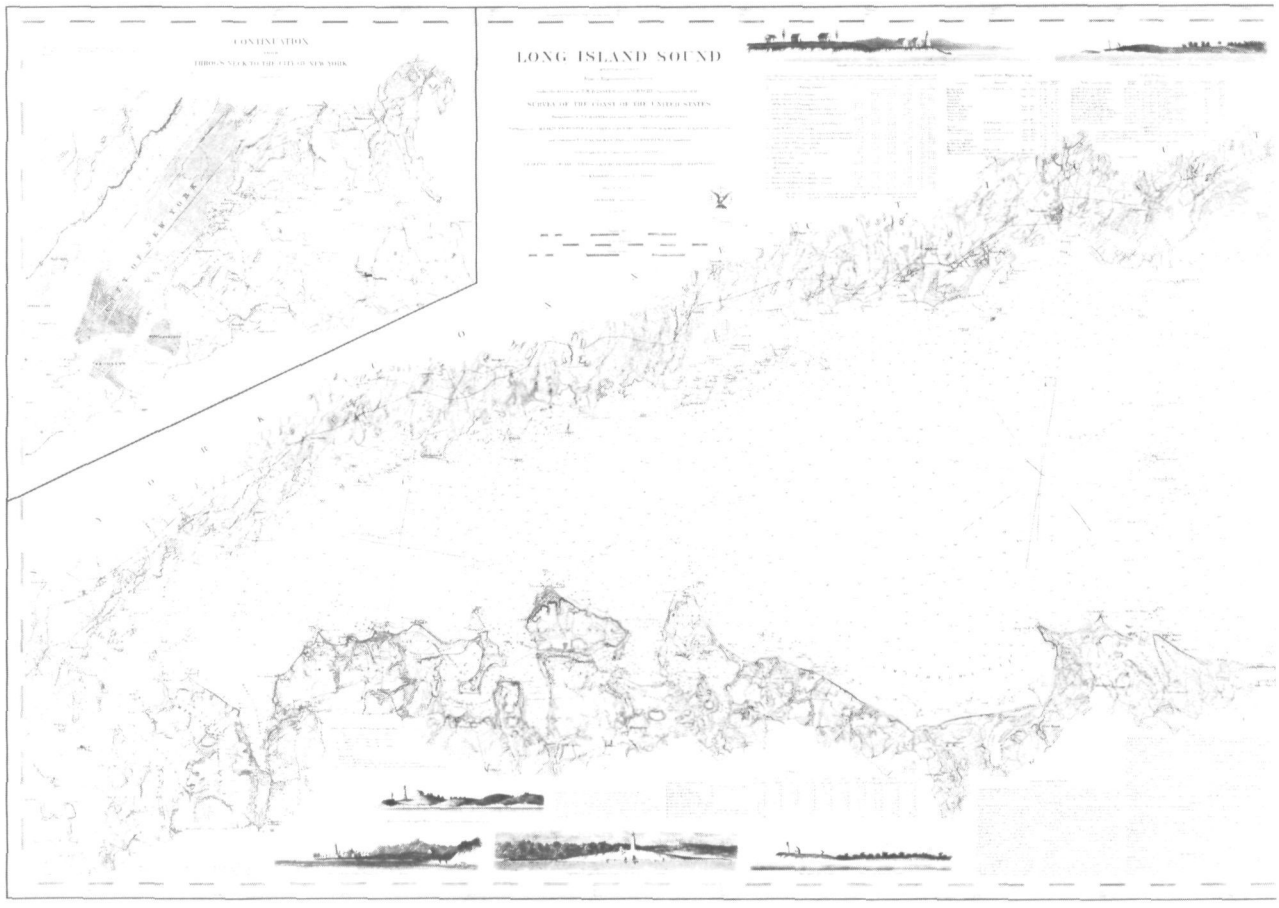
The Civil War collection is one of the most valuable in the Nation today. The Survey played an important role in the war by contributing charts and maps, surveys, and other reconnaissance data to the Union Army. The maps, more than 800 of them covering most of the major military campaigns, are for the most part limited to the territory occupied by the Confederacy.

Their detail made them invaluable to the Union in the prosecution of the war, and now constitute a record of notable value. They range from general topographic maps to sketches showing minute details of battlefields, forts, and fortifications; and from comparatively small-scale hydrographic charts to detailed surveys of harbors, channels, and obstructions.

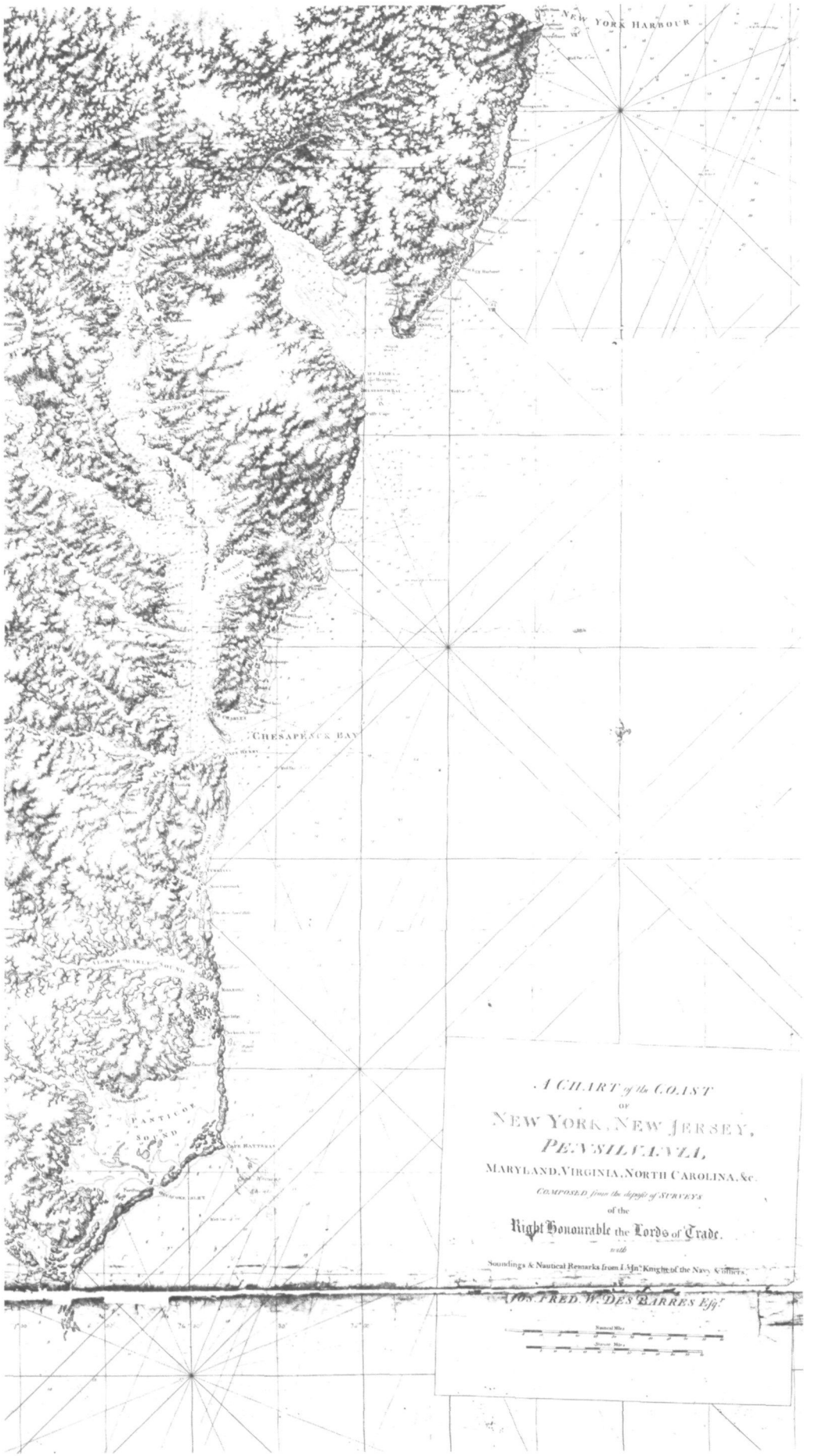
Late in the summer of 1861 Professor Bache, then Superintendent of the U.S. Coast Survey, began his preparations in support of anticipated requests from the Union Forces. Among the first projects were surveys made by F. W. Dorr and Cleveland Rockwell, who proceeded in the company of General Tyler to map and survey the approaches which eventually plotted the location of the First Battle of Bull Run.

One of the most interesting items contained in the Civil War section of the files is a sketch drawn by W. T. Crane dated August 23, 1863 of Fort Sumter, illustrating the extensive damage caused by the Confederate bombardment of the fort at the opening of the war. Other sketches portray the Union Naval facilities at Norfolk, Virginia soon after they fell into Confederate hands in April 1861. Many show work accomplished behind southern lines—for indeed work of the Survey was highly regarded by both North and South. This enabled the Coast Survey to continue its hydrographic and topographic field work undeterred by its impending war. However, insurgents at Charleston, South Carolina, seized one of the survey vessels, the FIREFLY, early in the conflict. This led Bache to order all field parties to discontinue regular work in the South and return to Washington.

Almost every major battle of the Civil War is reflected in maps, charts, or manuscripts found within the historical collection. Throughout the war thousands of additional maps and charts were produced for the military. In 1864 alone the Coast Survey prepared and distributed 37,000



Early U.S. Coast Survey nautical chart of Long Island Sound shows coastal section with harbor.



The east coast of America, from New York to North Carolina, part of the "Atlantic Neptune" compiled in 1778 by Joseph F. W. Des Barres.

copies of its regular nautical charts. The collection contains a photographic copy of a report made by Superintendent Bache near the end of the war which states: "The tangible evidence of utility thus presented to a class of minds eminently practical has continued to elicit the warm commendation which marked our first connexion with the military and Naval forces of the Government at the outset of the war".

One of the most significant sections of the NOS collection is that with the first maps of the Nation's Capital, representing a complete record of the Federal city's early mapping, and including early reproductions of the Pierre Charles L'Enfant Plan of 1791 and the original Andrew Ellicott map (1791–93), adopted by the Congress in 1802 as the official Washington map.

In 1887 a basket containing bits and pieces of varnished paper was delivered to the Coast and Geodetic Survey. They were all that remained of L'Enfant's original manuscript, executed in 1791. The manuscript's condition was so bad that restoration, comparison, and verification had to be accomplished under solar light reflected by mirrors and with the aid of magnifying glasses and colored screens. An exact tracing was then produced.

The Coast Survey cartographers recreated each line with care. Features not distinguishable on the original were omitted from the restored copy. Reproductions in color were then lithographed and made available to the public—a service continued even today. For the price of a soft drink you may buy an exact copy of the plan of the Nation's Capital as seen by L'Enfant.

In 1792, Thackara and Vallance of Philadelphia engraved and published the final version of Andrew Ellicott's Map. One of the original prints and the copperplate engraving are contained in the collection. Another interesting map is entitled "Plan of the City of Washington" drawn from the original plan adopted and bearing the signature "John Adams, President of the U.S." dated 1822. The map was published by W. Elliot of Washington the same year. Also in the Federal City group is a copy of the "Stone Plate" of Washington, engraved by W. J. Stone about 1839. A feature is the clarity with which it shows the course of Tiber Creek and its tributaries as it once flowed above ground. This particular creek still runs beneath the City of Washington and can be observed in several locations including the subbasement of the Department of Commerce building where a small trapdoor can be lifted to view the running water.

Albert Boshke, at one time an employee of the Coast Survey, produced some noteworthy maps of Washington. His map published in 1857, in addition to being a valuable historical record of the city's

growth at that time, is an elegant and thorough piece of cartographic work. The copy not only portrays the wards and street plan, but for each block shows the boundaries of lots and the configuration of building lines. The map's border is decorated with government buildings and other important structures engraved to blend with the embellishments made around the map. Soundings are shown in the Potomac and Anacostia Rivers. Its overall size of nearly four by six feet makes the map an impressive addition to the archives.

The library has two maps by William Forsyth, a former surveyor of the District of Columbia. One map of Washington shows the built-up suburban areas, dated 1870; the other a map of Georgetown, dated 1871. They display an unusual minuteness of detail; the Washington map illustrating not only the customary street names and numbers, important buildings and the like, but also portraying the dimensions of blocks and sidewalk building lines.

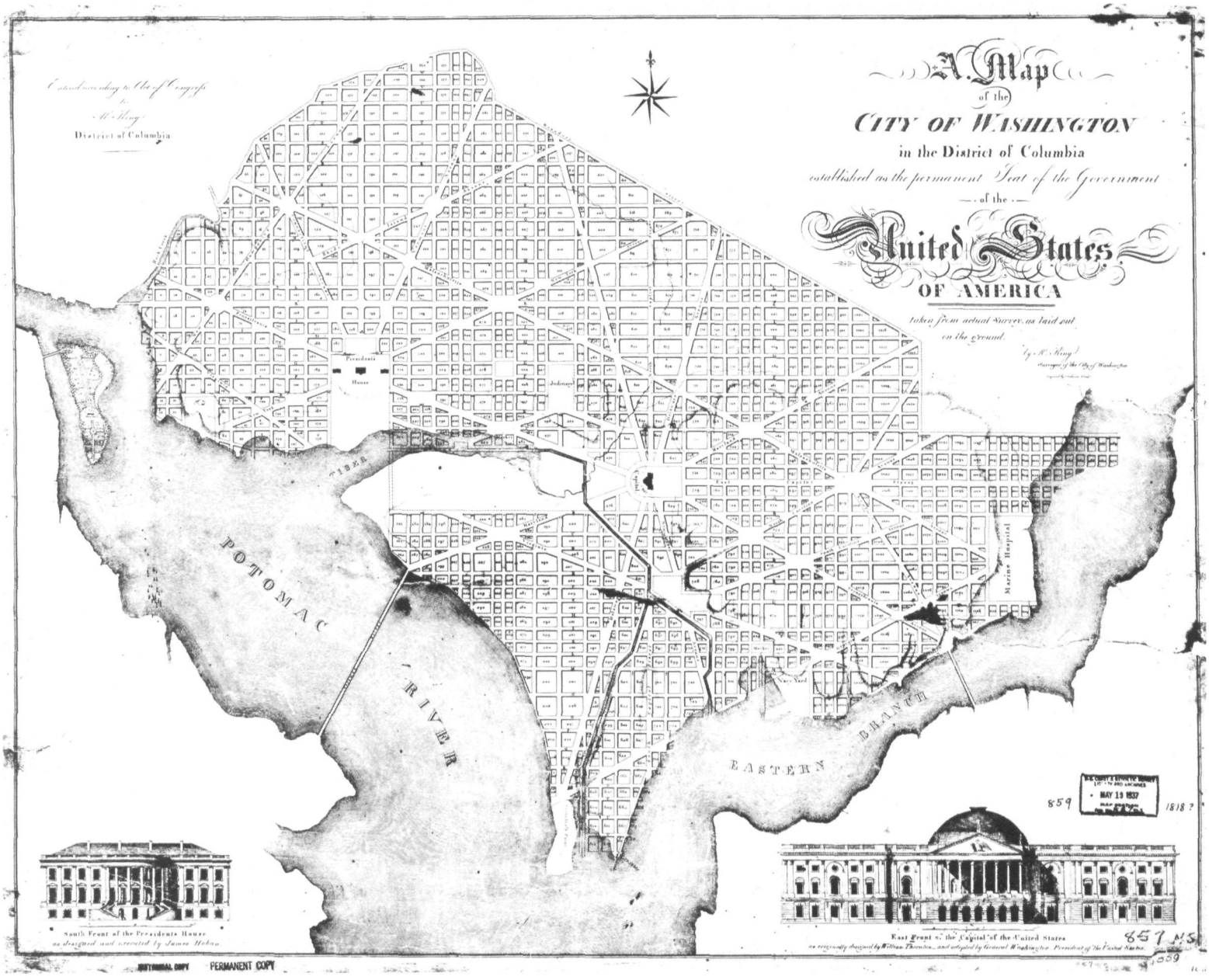
The Survey is included in the Federal City section of the collection with a series of fifty-eight sheets of the District of Columbia made from its own surveys. Topographic maps at a scale of 1:4,800 were originally issued between 1881–1893. They have received such wide use in the city's planning over the years including the Metro-System, that photographic prints are still being prepared in response to urgent requests.

Many old items of historical value are to be found in the Special Maps Section, including an atlas relating to terrestrial magnetism. Seismological publications are to be found, as well, and one map shows the "Ring of Fire" on a global chart dated 1906.

Numerous New York City maps are in the collection, including an 1836 issuance approximately nine feet wide, four feet high, and illustrating Broadway during what seems to have been a Fourth of July parade and showing New York as seen in 1659, complete with small cabins.

South Carolina, Massachusetts, Maine, the New England coast, Georges Banks, and a complete set of the Survey's own published nautical chart editions dating from the early 1840's—these are only a few of the unusual publications in the map library.

While its primary purpose is to serve NOAA's research needs, the collection is also open to members of the public with an interest in it—under suitable restrictions. □



One of the King Plats of Washington, dated 1818.

THE SPARING OF SUMNER'S CHILDREN

"Some people call it a miracle, and some call it careful planning"

Dr. George P. Cressman, NWS Director, recognized 19 individuals and organizations for life-saving actions during a tornado that demolished much of the Sumner, Mississippi school on April 24, 1973. Seen with Dr. Cressman at the awards ceremony are (left to right) Robert O. Cole, meteorologist-in-charge of the Jackson WSFO; Joseph H. Box, senior vice president of the Mississippi Power and Light Co.; and Thomas A. Dallas, the company's manager of system operations. Photo on left shows concrete, cinderblock, lumber and glass atop desks of fifth grade classroom.

Photos at ceremony courtesy of Delta Farm Press.

Damage photos courtesy of Clarksdale (Miss.) Press-Register.

The people of Sumner, Mississippi, gathered at the Tallahatchie County West District School on June 19 in thanks that more than 800 of their children were spared from death on April 24, when a tornado demolished much of the building.

Dr. George P. Cressman, Director of the National Weather Service—visiting the tiny delta community at the invitation of the Town Board—stood on a flag-draped flatbed truck and looked out at the youngsters in the crowd.

"This is no ceremony," he said. "This is a celebration."

Indeed it was; Sumner was in a festive mood. The injured had recovered; the rubble had been cleared away; reconstruction had begun. It was an hour for reminiscence, and for the recognition of those whose effort had saved the children's lives.

"Some people call it a miracle that these young people are here today, and some call it careful planning," said Dr. Cressman. "Have it as you will—miracle or disaster prevention—the preparations that happened here in Sumner are the kind that make miracles happen."

An effective storm warning system, he said, is dedicated to the proposition that there is no need to die in a tornado, but achieving this goal requires considerable effort at all levels of government and action by individuals and organizations on a voluntary basis:

"The best forecasts and warnings by the Weather Service are useless if other parts of the warning system don't come together and work," he said. "They did come together on the morning of April 24, because the planning and preparedness programs were set in motion years before."

The state of Mississippi has been tornado-conscious since February 27, 1971, when an outbreak raked the countryside and killed 113 persons. The tragedy triggered what has become a highly successful preparedness program. Weathermen not only forecast and warn of natural disaster; they devote major programs to community preparedness for coping with them. In Mississippi, as elsewhere, the Service works closely with the State Department of Education, national, state, and county civil defense organizations, and the newspapers, radio, and television—all vital links in the safety chain.

The Mississippi program has been an especially outstanding one. Teachers across the state have been trained as preparedness instructors. The NOAA film "Tornado!" has been shown more than 1,500 times. Literature, wallet cards, radio, television, and newspaper campaigns all had their effect.

On the night of April 23, the Weather Service's Jackson office, 125 miles south of Sumner, was monitoring extremely unsettled weather across many of the 57 Mississippi counties for which it has forecast responsibility. Early-morning radar reports showed moderate to heavy thunderstorms increasing in northern Mississippi. Flash-flood warnings were issued as conditions worsened steadily.

At 7:23 on the morning of April 24, the Jackson office issued Tornado Watch 171, from the National Severe Storms Forecast Center in Kansas City. It covered northwest Mississippi and nearby areas, including Tallahatchie County. By then, television and radio stations were featuring the news of violent weather in surrounding counties.

Watch 171 set several processes in motion. Tom Reardon, manager of Radio Station WROX in Clarksdale (the Emergency Broadcast Station for that area), instructed his staff to give the storm full coverage. Other stations in the area—six of which use the NOAA Weather Wire—also went into action.

A tornado watch, which means that tornadoes may develop and advises readiness for them, is common. A warning, which means that a tornado has been identified, occurs less often, although 600 or so strike every year. Stories of the Tallahatchie County watch, and of warnings elsewhere, constituted the top of the radio news that morning, and were the major topic of conversation as students and teachers arrived at the school.

That morning, as another result of the 1971 tornadoes, forecasters had a new technique. The 1971 storms caused eight major transmission lines controlled by the Mississippi Power and Light Company to fail. This led to a plan to report to the Weather Service all powerline breaks in severe storms. Walter A. Schulz, Weather Radar Specialist at the Jackson Weather Service Office, and

Two mobile classrooms were reduced to kindling and the south wing of the Tallahatchie County West District School was demolished when the tornado hit. More than 800 students and teachers were holding a tornado drill at the time. About half of them would have been in the classrooms that were destroyed. School officials estimate that more than 100 would have died.

Thomas A. Dallas, manager of system operations for the Company, jointly developed a system for spotting and reporting the breaks. The power interruptions were studied quickly against images on the Weather Service's radar screen. Together, on April 24, they told a grim story.

The staff of the Jackson forecast office under the direction of Robert O. Cole, Meteorologist-In-Charge, saw a steady, 30-mile- an-hour northeastward march of powerline breaks, matched by echoes on the radar screen. At 8:01, Rosedale; at 8:29, Pace; at 8:44, Cleveland; at 8:48, Drew and Webb, only minutes from Sumner. At 8:13, the Jackson staff issued Mississippi's first tornado warning. Others followed, including, at 8:55, one covering Sumner. However, action was underway before that time in Sumner, based on the tornado watch and warnings issued for nearby Bolivar and Sunflower counties.

The school, a mile out of the Delta farm town on Route 49E, was a substantial structure, housing in its south wing the fifth and sixth grades, of which James M. Cox is the principal; and in the rest the junior high school, of which Rogers H. Bearden is the principal.

Mr. Cox and Mr. Bearden, aware of the

Dr. Cressman gets first hand report from Carol Jo Perry, fifth grade student, who escaped serious injury as she participated in tornado drill. Carol Jo suffered minor back injury and was released from the hospital the same day. Rogers H. Bearden, principal of the junior high school, and James M. Cox, principal of the elementary school, receive the NWS Public Service Award for "the most fortunate single decision ever made in Sumner"—the calling and conduct of a tornado drill 20 minutes before the twister hit.

tornado threat, met shortly after 8:30 and agreed to hold a tornado drill. Without doubt, it was the most fortunate single decision ever made in Sumner. They announced over the public address system that a drill would be held at some time during the morning.

At 13 minutes before 9:00 the power went off. At 9:05, the principals dispatched runners to the classrooms and Mr. Bearden, lacking a public address system, hustled through the corridors banging an old school bell. Among the places emptied were two mobile classrooms where remedial reading classes were underway.

Tornado precautions are as simple as they are important; in schools, students and teachers move quickly to shelter areas in interior hallways on the lowest floors. Gymnasiums and auditoriums with wide-span roofs are particularly unsafe.

The drill was held without incident. By 9:20, teachers and students were on the way back to their classrooms. Suddenly the sky darkened and hail began first peppering, then shattering the windows. Quick action is the essence of survival in a tornado; and everybody acted quickly. In moments, they were huddled on the hallway floors again. It struck at 9:25.

"I was telling the students to stay down," said Mr. Cox, "and then the roof started falling in."

"I had my arm around one student when the hall wall fell on us," recalled teacher Virginia Reid. "We were pinned to the floor. I felt I was suffocating when all of a sudden someone was pulling the concrete blocks off us. . . ."

Elbert Burten, a teacher, had the only flashlight in the school. "I walked up and down the hall trying to calm the children. I saw the hand of a little boy sticking out from under the concrete blocks. . . ."

The floor was covered with bloody water, a gas line was leaking in the driving rain, nearly 40 persons were injured. Somehow, the school was evacuated without serious casualty.

The tornado's path had been only about 400 feet wide, but it wrought nearly half a million dollars' damage to the school. The mobile classrooms, predictably, were reduced to kindling. Statistically, a death toll of more than 100 persons would not have been unexpected.

These memories were still green as Dr. Cressman presented Public Service Awards to 19 persons and organizations. They were:

Messrs. Bearden and Cox; the West Tallahatchie School District; E. E. Polk, State Supervisor of Civil Defense Education, State Department of Education, and to the Department; the Mississippi State Civil Defense Council and the Tallahatchie County Civil Defense Organization; Thomas A. Dallas of the Mississippi Power and Light Company; and to the Company; and to the following radio and television stations in Mississippi:

Clarksdale: WROX, WKDL. Cleveland: WCLD, WDSK. Drew: WDRU. Greenwood: WGRM, WSWG, WABG/TV. Indianola: WNLA.

As the youngsters enjoyed soft drinks and ice cream after the presentations, and officials toured the school, storm clouds built higher in the Mississippi sky. A few hours later, another tornado struck not many miles away. The nation appeared on its way to a record tornado season, with about 850 reported by June 30.

The Sumner story spread across the South, carried by radio, television and the press. It won national attention on NBC's *Today* Show. Its lesson was clear and simple:

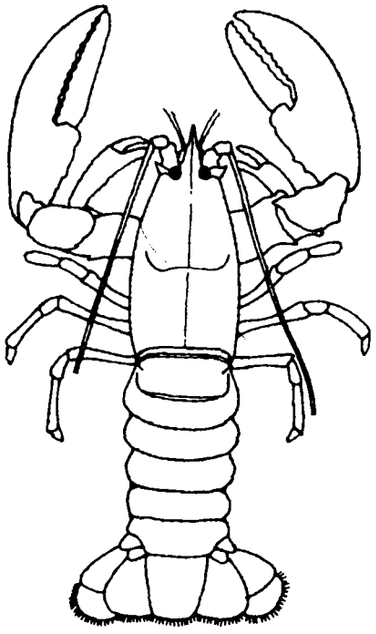
There is no need to die in a tornado, but the only way to make sure of the miracle is to plan and work for it. □

Being a bouillabaisse of fascinating facts about

FISH: The most-asked questions Part 2

More of the most repeatedly asked questions and answers about life in the sea have been collected from marine scientists in the National Marine Fisheries Service. This is the second in a series of articles designed to satisfy the curiosity about marine invertebrates that people often express in queries to NMFS: **Shellfish and Other Invertebrates.**

How many kinds of lobsters are there in this country, and why are different varieties called lobster?
Two kinds of lobster-like crustaceans exist in United States waters. The "true" lobster (the American lobster) is designated as such to differentiate it from the other form found here, the spiny lobster. The two, from different families, display two differences: The true lobster has claws on the first four legs, lacking in the spiny lobster; the spiny lobster has a pair of horns above the eyes, lacking in the true lobster. To avoid confusion over common names, it is best to call the true lobster the "American lobster," and the spiny lobster just that. The item marketed as "lobster tail" usually is a spiny lobster. The spiny lobster is found in warm waters off Florida, in the West Indies, and off southern California. Record weight for the American lobster is 45 pounds.



Does the deepwater northern lobster population differ from that found just off the coast?
The species in each population are identical in all respects.

How far do lobsters travel?
Inshore lobsters tend to stay in one place, seldom moving more than a mile or so, but deepwater lobsters farther out on the Continental Shelf follow a seasonal migratory pattern shoreward in summer, returning to the Shelf again in the autumn. The record travel so far is 225 miles covered by a lobster tagged off the Continental Shelf and recovered at Port Jefferson, Long Island, New York.

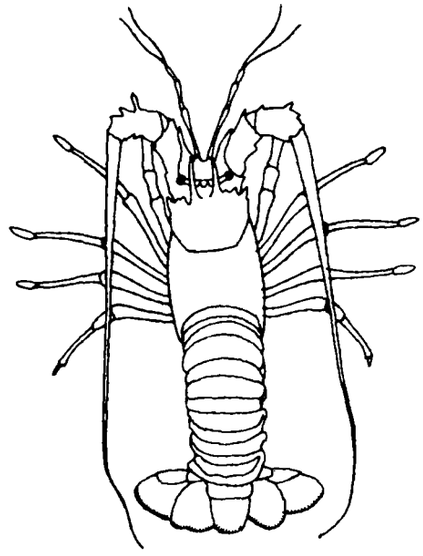
What does a lobster eat?
Mussels, crabs, clams, and seaworms, as well as dead fish.

What color is a lobster's blood?
Colorless. When exposed to oxygen, it develops a bluish color.

What is "tomalley"?
Tomalley is the lobster's liver. It turns green when cooked and is considered a delicacy.

What is the coral colored material often seen in a cooked lobster?
Coral is the egg mass of a female lobster. Cooking colors the tiny eggs a deep coral or red.

How does a lobster grow?
It sheds its hard shell and grows a new, larger one. Since the skeleton is on the outside, this molting is essential to growth.



How many times must a lobster molt before it reaches market size?
Between 20 and 30 molts take place before a lobster reaches the one-pound market size.

How old is a one-pound lobster?
No one knows exactly, but aquarium studies suggest 5 to 7 years.

How many one-pound lobsters are needed for a pound of lobster meat?
Five, on the average.

How long can a lobster live out of water?
Several days if kept in a cool, moist environment. The lobster is a gill-breather, and moisture is essential to survival.

Can a lobster be kept alive in fresh water with ice?
No. Fresh water is lethal to a lobster. The animal has salty blood and tissue, which require a seawater environment if life is to be maintained.

Why does a lobster turn red when cooked?
The red pigment is the most stable component of the coloring in a lobster shell. The greens and browns which darken the shell in a live lobster are destroyed by cooking.

How can one tell if a boiled lobster was alive when cooked?
Upon the death of a lobster the tail loses its elasticity and ability to curl under the body. When plunged into boiling water, a live lobster curls its tail under. It remains in that position during and after cooking.

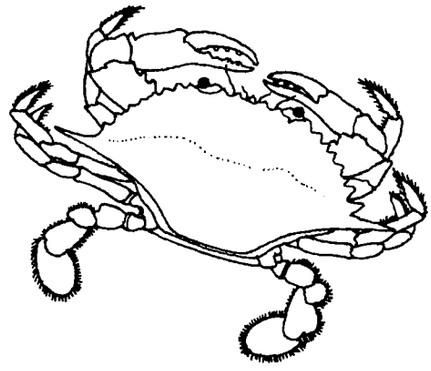
Have people been poisoned by eating lobsters that were allowed to die before being cooked? Is it true that a dead lobster deteriorates very rapidly? What happens when a live lobster is frozen?
Lobsters are not poisonous if they die before cooking, but cooking should not be delayed. Many lobsters sold commercially are killed and frozen before cooking. Lobsters and other crustaceans do spoil rapidly after death, which is why many buyers insist on receiving them alive. If the lobster is "headed" before or soon after death, the body meat will keep fresh longer. This is because the so-called head includes the thorax, the site of most of the viscera and gills, which spoil much more rapidly than claw or tail meat. Freezing slows deteriorative changes and harmful chemical actions that follow death.

Is it possible to raise lobsters on a commercial basis?
No, but research is underway to develop rearing techniques and to assess the economic feasibility of rearing lobsters commercially. Success is doubtful. It is difficult to rear the lobsters from egg stage through a long larval life—usually several months long. Juvenile lobsters can be collected from the natural environment, but the expense of collecting, holding, and feeding them to market sizes is prohibitively high. An additional problem is that lobsters are cannibalistic when crowded together.

Have Maine lobsters been successfully transplanted to the west coast?
Attempts have been made to transplant American lobsters to Pacific waters, but none have been successful, probably because of different ecological conditions.

I've heard that lobsters molt, but I've never seen a cast-off shell. Why?
Lobsters often eat the cast-off shell to regain needed minerals.

Can crabs swim?
Most crabs "walk" or run across the ocean bottom. Some, such as the commercially caught blue crab of the Atlantic coast (a member of the one family of "swimming crabs") can swim. Their rearmost pair of legs is modified for swimming and legs are paddle-shaped.



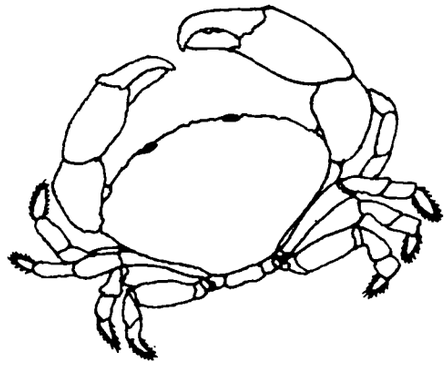
How do crabs grow?
By shedding their outgrown shell. The rigid shell imprisons the crab and limits growth. Once the shell is shed, the crab can absorb water and expand into its newgrown shell.

How much does a blue crab increase in size on molting?
Under normal conditions, about a one-third increase occurs with each molt.

What is the difference between soft- and hard-shell crabs?
They are the same species. A soft-shell crab is one that has just discarded its shell. Crabs which have just shed their shell hide in rocks or bury themselves in sand and mud to escape predators. They emerge after the new shell hardens, a quick process.

How old does a blue crab get?
A female may live 2 years, a male 3.

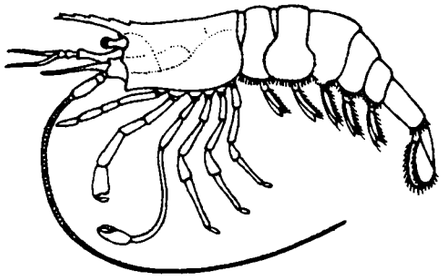
What is a "coconut crab"? Where do they live?
A large, land hermit crab, which lives on tropical Pacific islands. The crab is so named because it eats coconuts, is even caught on coconut used as bait. The meat is considered a delicacy in the islands.



Is a stone crab harmed when its large claw is broken off?
Fisherman often break off the large claw and throw the crab back into the water. If the break is made at the first joint, the crab is not harmed. The stone crab can and does sever its own claw at the first joint (by muscular contraction) to escape from danger.

What are the small crabs found inside oysters? Are they harmful to oysters? May humans eat them?
These are "pea" crabs. They live, often in pairs, inside the oyster shell, eating food collected on mucous strands in the oyster. Because they do cause damage to oyster mantle and gills, the crabs are considered parasites. Pea crabs are not harmful to man.

How do prawns, crayfish, and shrimp differ?
As so often happens, common names are used loosely and inconsistently in the shrimp family. The "prawn" of Great Britain and other countries is essentially the same animal as the shrimp of the United States. In this country, the term "shrimp" applies to all crustaceans of the *Natantia* group, regardless of size. "Crayfish" or "crawfish" are names given to both a common freshwater crustacean and to the saltwater spiny lobster.



Is there more than one kind of shrimp?
Numerous varieties exist, among them brown, white, pink, royal red, brine, and rock shrimp.

How big do shrimp grow?
Depending on the species, size ranges from about ½ inch long on the west coast of the United States, to almost 12 inches elsewhere.

How long do shrimp live?
The life cycle varies geographically and by species. Some live as long as 6½ years, others live only a year.

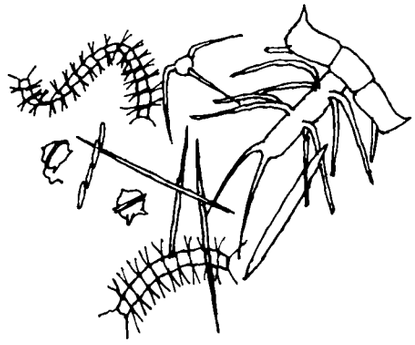
How many eggs does a shrimp produce in one spawning?
About 500,000.

How much shrimp is produced in the United States, and where is the largest catch taken?
The annual catch has been running close to 400 million pounds for several years. The Gulf States usually lead in shrimp catches, with Texas and Louisiana the leading States. Alaska has been an important shrimp producer for the past several years. The shrimp fishery has the highest market value of all U.S. fisheries.

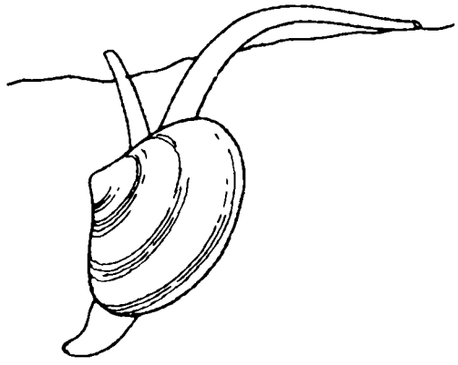
What are the commercially important shrimp on the east coast of the United States, and what are their ranges?
Three shrimp species are of primary commercial importance: Pink shrimp from Cheseapeake Bay through the Gulf of Mexico and the West Indies to Brazil; white shrimp from Fire Island, New York, to Cape Kennedy, Florida, in the Gulf of Mexico from Pensacola, Florida, to Campeche, Mexico, in Cuba and Jamaica; brown shrimp from Massachusetts down the east coast through the Gulf of Mexico, and the West Indies to Uruguay.

What is the biggest bivalve mollusk, cephalopod mollusk, and crustacean known to man?
The biggest bivalve mollusk is the clam *Tridacna,* native to the Indo-Pacific, which reaches a weight of 500 pounds. The giant squid, nearly sixty feet long, is the biggest cephalopod. The Alaskan king crab is the largest of the crustaceans, weighing up to 15 pounds, and measuring four to five feet across shell and claws.

What do oysters and clams eat?
Called filter feeders, oysters and clams eat plankton. By pumping water through their bodies, the mollusks strain the microscopic organisms through their gills, which act as sieves.



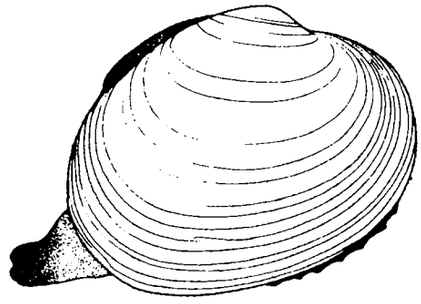
Clams seem to squirt water through their siphons. What purpose does the siphon serve?
Three main purposes: breathing, obtaining food, and eliminating waste products. Since clams are relatively immobile and movement is usually limited to burrowing in the sand, their double-tubed siphon—which operates much like a snorkel—is their lifeline. Inflowing water is pumped through the siphon, passed over the gills, and strained to remove food particles. After receiving carbon dioxide from the gills and other waste products from the digestive tract, the water is expelled through the outgoing siphon. Constant circulation of the water is maintained by the beating of a multitude of microscopic hairs (called cilia) located inside the tube and in the gill chamber.



What causes a reddish color in the liquor of shucked oysters and clams?
The red algae they sometimes consume, often composed of the microscopic one-celled dinoflagellates which appear in planktonic mass.

How does a clam shell grow?
A thin tissue that adheres to the inner surfaces of the shell, called the mantle, and a thickened rim of muscular tissue at the mantle edge deposit new shell material at the shell edge. Rings on the shell indicate how many years old a clam may be.

How do clams establish themselves on the sea bottom?
Certain kinds of clams, in early stages of life possess a gland that produces a thread-like material (byssus) that serves to anchor them to grains of sand or rocks. Other types of clams lack a byssal gland and use the foot to burrow into the seabed. As the clam grows, its wedge-shaped foot, which expands and contracts as it moves, becomes more important as a burrowing tool.



How do clams reproduce?
Eggs and sperm are released into the water seasonally, generally in mid-summer when water is warm and planktonic food is abundant. After fertilization of an egg, cellular division produces larvae and eventually tiny clams that settle to the bottom. In a few species, the larval stage is completed within the mantle cavity of the parent.

Which of the clam species is of greatest commerical importance to the United States, where is it fished, and what quantities are landed?
The oceanic surf clam is the most important commercial species. The largest clam of the U.S. east coast, it sometimes reaches a shell length of more than eight inches. Landings of surf clams in New Jersey and Virginia account for about half the total U.S. annual landings of all clam species. The surf-clam catch in recent years—in shucked meats—ranged from about 41 to 63 million pounds.

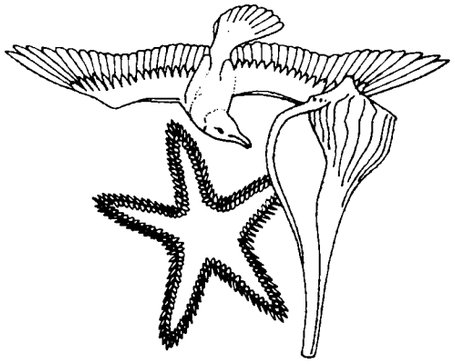
How are soft-shell clams harvested?
They are dug from the intertidal flats of bays and estuaries at low tide in New England, using a short-handled fork to obtain clams living in burrows six to ten inches below the surface. In Chesapeake Bay, because the beds are mostly subtidal, a hydraulic dredge washes clams from the bottom and onto an endless belt that conveys the clams to the dredge boat.

How are hard-shell clams harvested?
Long-handled tongs, rakes, and small dredges operated from small skiffs in shallow subtidal zones of bays and estauries. The larger hydraulic escalator dredge is used for hard-shell clams as well as soft-shells.

How are surf clams caught?
A large (about 1½-ton) hydraulic dredge washes clams off the bottom and carries them aboard 60- to 100-foot vessels.

What is the biggest clam caught and eaten in the United States?
The geoduck (pronounced gooey-duck) clam caught in Northwest Pacific waters, weighs an average three pounds and yields over a pound of flavorful meat. Now sold commercially, geoduck clam meat can be used in minced form or in steaks.

What kinds of predators attack clams and oysters?
Man, water birds, rays, starfish, whelks, drills, and sponges, among others.



What are oyster borers?
An oyster borer, or drill, is an aquatic snail that preys on oysters, especially thin-shelled young oysters. Using a band of scraping teeth (a radula) and a shell-dissolving secretion, the gastropod drills a hole in the oyster shell and eats the creature within.

How do oysters produce pearls?
Pearls begin with the presence of a foreign substance, such as a grain of sand, that lodges in the shell. The oyster's body reacts by depositing layers of nacreous (pearllike) material around the foreign body to wall it off and reduce irritation.

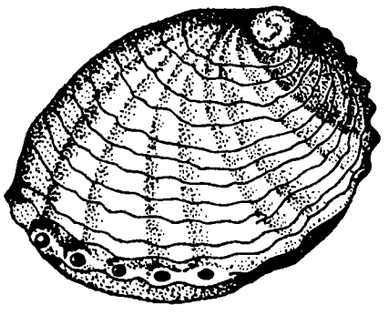
Do all oysters produce pearls?
Many oysters—as well as some clams and mussels—manufacture material like the pearl-producing substance. True pearl-producing oysters, however, inhabit waters of the Indo-Pacific.

Is it safe to eat oysters during the months without R's?
Yes. Fresh oysters properly refrigerated are wholesome and nutritious throughout the year. They spoil rapidly at high temperatures, however. The belief that oysters were unsafe to eat in May through August arose in earlier days when refrigeration was less prevalent than it is today.

How does a scallop move?
It compresses the valves of its shell and forces water backward in jets near the shell-hinge. The force drives the scallop in the direction of the shell opening. The bivalve appears to be clapping the two sides of its shell together.

Are any snails commercially caught for food off the coasts of the United States?
The most commonly eaten snails in this country are the abalone, caught in the waters off California, and various conchs from Atlantic waters.

What purpose do the holes along the edge of an abalone shell serve?
Internal gills discharge water through the holes, as part of an abalone's respiratory process.



Are there any poisonous marine snails?
Yes. Cone shells (family *Conidae*) include members with toxic venom. These mostly tropical forms can be highly toxic, even fatal, to man. Their poison is injected by a spear-shaped rod called a radula.

What is the sand collar that one often sees on beaches at low tide?
A sand collar is the egg case made by moon snails, of the family Naticidae. The eggs are laid in a gelatin-like matrix with which sand grains are mixed. The individual egg capsules can be seen under a magnifying glass or microscope. When the little snails hatch, they swim around for a while before settling on the bottom.

What is chitin?
The structural material that forms the shells of crustacea, such as crab, shrimp, and lobster.

How does the consumer know that shellfish are safe to eat?
Clams and oysters in the shell should be alive and the shells should be closed tightly or should close when the mollusks are tapped. The U.S. Public Health Service, in cooperation with the States, has a sanitation control program that covers the labeling and shipment of clams, mussels, and oysters. These shellfish may be harvested only from non-polluted waters and processed for shipment in sanitary plants inspected by State shellfish inspectors. Authorities periodically test water for sewage pollution and ban catches from polluted areas.

How unsafe are shellfish from polluted waters?
They are dangerous to man, causing mild to severe illness, sometimes death. Both sewage and industrial wastes can affect shellfish.

Will cooking make sewage-polluted shellfish safe to eat?
Not entirely. Cooking will kill bacteria that cause some diseases, but it is not known whether certain virus diseases, such as infectious hepatitis, can be prevented by cooking.

Is it possible to purify shellfish from sewage-polluted water for safe eating?
Yes. Sewage-polluted shellfish transplanted to clean water purify themselves rapidly and become safe to eat.

Do shellfish contain mercury levels dangerous to man's health?
No. Tests of shellfish to date have shown mercury levels to be below those considered dangerous to humans.

After BOMEX, CEDDA and a unique bridge

BETWEEN SCIENCE AND SHIRT-SLEEVES

BY MAY LAUGHRUN *

"Much more exciting to me than exploration of the moon," says Dr. Joshua Z. Holland, Director of the Center for Experiment Design and Analysis, "are current international efforts to solve the mysteries of the tropical ocean and atmosphere—an environment different from any other on earth."

A vital part in these efforts is being played by the Center—called by its acronym, CEDDA—which was transferred last year from NOAA's Research Laboratories to the Environmental Data Service. Currently, it is working on three major field projects—the Barbados Oceanographic and Meteorological Experiment of 1969, the International Field Year for the Great Lakes in 1972–73, and the GARP Atlantic Tropical Experiment, or GATE, to be conducted in 1974.

According to Dr. Holland, who served as chief scientist for the air-sea interaction portions of the Barbados-based investigation, "BOMEX solidly demonstrated for the first time that the atmosphere over the tropical ocean is chemically different from the atmosphere above the rest of the earth, with planetary boundary layer turbulence and convection being driven by water vapor rather than heat. I think GATE will give us a real chance to learn more about why it is so different.

"Satellites have revealed the tropical cloud cluster and are going to be indispensable in gathering data we need and have never before been able to get. That is why I like to think of GATE and future large-scale field experiments as a space program on earth.

"It is also very exciting," he adds, "to see so many nations getting together—playing a global pingpong game in communications—to ensure optimum experiment design and execution."

The Center's role in these projects is to assist in planning, design, and execution to see that data needs are met, to provide data management services and support, and to perform scientific analyses.

Experiment design—which comprises half of the Center's name and mission—is a very broad concept. "When we named CEDDA," Dr. Holland recalls, "I thought some people might fear that we are trying to preempt from the scientific directors—and from the scientific groups which promote and create large field experiments—their prerogatives of deciding what the objectives of a given experiment are and how the experiment is to be run.

Dr. Joshua Z. Holland

"Now," he feels, "our role in experiment design is coming to be better understood. In any large field project, there is an intermediate job between that of the theoreticians and basic researchers on the one hand, and that of the managers of logistics, operations, and hardware systems on the other.

"Initially, the scientific planning groups recognize a need for certain kinds of information about the environment. They conceive a plan for a field project to acquire this information; they look at the observational resources that exist; and they propose a time period, locale, and scale.

"Then we in CEDDA are available to advise on all the nuts-and-bolts decisions from the point of view of attaining the maximum scientific yield within existing constraints.

"Suppose, for example a project has a certain number of ships and airplanes; they are equipped with temperature, wind, and humidity sensing instruments of a certain accuracy; and observations can be made at a specified frequency. With this information, CEDDA devises arrays, flight tracks, observing schedules, data-processing procedures, and analysis schemes for answering the scientific questions which motivated the project.

"Another example," Dr. Holland continues, "would be a project seeking to learn certain things about the current structure and dynamics of the ocean. Instruments that can be lowered to the bottom of the ocean are available, and these instruments measure temperature, salinity, and current velocity with a certain accuracy. Based on the given accuracy, CEDDA would decide how many observations need to be averaged together for scientific analyses, prescribe formats for recording the data to achieve the greatest ease and speed of processing, and do trial calculations with test data to make sure nothing had been overlooked in planning.

According to Dr. Holland: "There are two very large aspects of experimental field operations that neither the scientific groups nor those responsible for field operations are really particularly interested in or very well prepared to carry out. The first consists of specifying the contents and formats of all data records so that they can be easily read, edited, and processed. We try to develop procedures which are not vulnerable to illegible handwriting or a tired technician entering data in the wrong column, or spilling a cup of coffee on the log sheet.

"The second job, which we also do, is that of detailing instructions for the engineers who are building and testing the sensor and recording systems, for the ship captains and airplane pilots, and for those

* May Laughrun is an editor with the Environmental Data Service's Environmental Science Information Center.

responsible for the observational schedule.

"These are the kinds of activities we are concerned with. We accept the experiment's objectives as formulated by the scientific planning committees. We accept the overall scope in terms of platforms available. Then we work out how these are to be used to ensure that the objectives of the experiment will, indeed, be met."

The Center for Experiment Design and Data Analysis is an outgrowth of the Barbados Oceanographic and Meteorological Analysis Project, established after completion of BOMEX to reduce, process, and validate data collected by participating Federal agencies.

As CEDDA, it continues to carry out its responsibilities for BOMEX data, including salinity-temperature-depth soundings to a depth of 1,000 meters; shipboard meteorological observations and rawinsonde data; low-level atmospheric soundings made with the specially designed Boundary Layer Instrument Package; aircraft dropsonde data and other meteorological observations; shipboard and land-based radar observations; high-level panoramic cloud photographs; and satellite cloud imagery. A permanent BOMEX data archive will be established this summer, following final data processing by the Center.

On the strength of its experience in reducing and analyzing BOMEX data, CEDDA was given a lead role in data management of the International Field Year for the Great Lakes, a joint United States-Canadian research program aimed at achieving more effective management of the Great Lakes water resources. Lake Ontario and its basin were chosen as the site of field operations, which were conducted from April 1, 1972, to March 31, 1973.

During the planning phase, the Center advised on acquisition systems that would yield the most comprehensive and accurate physical, chemical, and biological information possible. At the beginning of the observation program, a field data center was established at IFYGL headquarters in Rochester, N.Y. Through this field office, CEDDA monitored the continuous flow of data from ships, aircraft, buoys, towers, and land stations, and maintained close control over the quality of the data collected. Some of this data is being processed at NOAA's Lake Survey Center and by individual investigators, but CEDDA is processing, editing, and reducing the bulk of the data collected by U.S. systems and will place them, together with data processed elsewhere, in a permanent archive.

Now the Center is participating in planning for the 1974 GARP Atlantic Tropical Experiment, in which its major responsibility is to establish data management procedures before actual field operations, ensure that these are followed during the field program, and later to reduce part of the data collected by U.S. acquisition systems into final archieve form.

"The progression from BOMEX to IFYGL to GATE has been one of increasing complexity," Dr. Holland says. "I feel that there has been, and will continue to be, an equal increase in overall competence.

"One of the many things BOMEX taught us is that field tests are needed well in advance of experiments. Actually, there was a pre-BOMEX field test in the summer of 1968, but unfortunately Dr. Ben Davidson, the scientific director, died before the results of the tests could be applied to detailed design of the experiment.

"If we are going to be sure that ships are headed into the wind for certain periods of time or are drifting or anchored —or that navigation systems on the airplanes will give wind measurements with the accuracy that was assumed in designing the experiment—we must have field tests. We have to decide what backups are necessary in case of system failure. Anything can fail in an experiment, and usually does.

"For GATE, the Center has been involved in sea-trial testing of the computer recording system to be used on the U.S. ships. Tests also have been made of the Omega wind-finding system. And one of our scientists is monitoring closely the development of the Boundary Layer Instrument System to be used.

"Also," as he points out, "we have much lead time to prepare for GATE data processing, and hope to be able to do it very promptly. All the nations participating are making a commitment to finish data processing within about a year after the experiment.

"This means a lot of preparation and testing, which we are engaged in now."

As important as the data management programs are the Center's research activities. For BOMEX, its specific task was analysis of the core experiment—to evaluate the energy budget of the atmospheric volume over the experimental array and the heat budget of the ocean within the array, and to estimate energy fluxes through the sea-air boundary.

Three IFYGL research tasks are assigned to the Center—boundary layer flux synthesis, atmospheric water balance, and evaporation synthesis. Work has begun in all three areas.

For GATE's environmental budget studies, the Center will analyze atmospheric budgets of the Atlantic area near Africa where intensive, concentrated observations will be made. It also will analyze radar data and conduct studies of the planetary boundary layer.

"One of the interesting things about our research work," Dr. Holland says, "is the way in which particular kinds of scientific analyses turn out to be valuable in a whole series of experiments. Of primary importance in BOMEX was the core experiment, the analysis of the atmospheric budgets—water vapor, heat, and momentum. In IFYGL, these budgets will also be a big part of the scientific program, telling us how much water vapor, heat, and momentum is transferred between Lake Ontario and the atmosphere, and how the atmosphere is modified as it passes over the lake.

"When we started talking about GATE, we thought we could contribute by computing budgets there, too, but at first there was more interest in the strucure of cloud clusters. Gradually, however, attention has turned toward these budgets and, beyond them, to bulk analyses of the vertical profiles of heat sources and sinks, as a key to the dynamics of the whole system. So now we find ourselves in a very central place in GATE. As we go on, I think atmospheric budget computations will continue to be a very important line of analysis."

CEDDA's twin functions of data management and scientific research are reflected in its organization. The Data Management Services Division, headed by Daniel Mitchell, has technical responsibilty for data management from delivery by acquisition personnel in the field to specification and archiving of required products. The Research Division, under Eugene M. Rasmusson, assists in recommending and testing data acquisition systems and procedures, and carries out scientific analyses of the data collected. Both divisions are aided by the Center's ADP Support Group and Technical Support Group. The former, headed by James A. Disbrow, is concerned with systems analysis, computer programming, automatic data processing, and data storage and retrieval. Under its chief, Calvin E. Anderson, the latter assists all CEDDA personnel in many ways, including manual data processing, graphical analysis, drafting, chart reading, plotting, data transcription, digitizing, review, and editing.

In the future, Dr. Holland hopes, the Center will become more and more involved in early planning and design of large-scale field experiments. "The reason for CEDDA is basically to carry over experience from one such program to another, so that the same mistakes are not made over and over again. Certainly, it is a distinct advantage not to have to create new data management and data analysis groups from scratch each time." □

Sea Fare

SAVING WITHOUT SLAVING

Searching for economical foods, more and more shoppers have been heading for fish counters in recent months.

In supermarkets everywhere, they find fish sticks and portions, canned fish, whole fish, and fresh and frozen fillets—ingredients for a variety of main dishes that are palatable and nourishing, as well as money-saving.

And because of its tenderness, fish cooks quickly—an added boon to the family cook during the hot months of summer.

Especially economical is the fillet—the prime part of the fish, cut lengthwise away from the bone. These tender pieces of flesh are ready to cook as purchased, practically boneless, almost 100 percent edible, and contain plenty of protein, with a generous supply of other nutrients.

As a rule, most fish fillets can be interchanged with other varieties in casseroles, salads, sandwiches, and combination dishes. This flexibility offers the shopper an opportunity for even greater savings, by buying lower-priced fillets. Fillets cut from plentiful fish cost less than those from scarcer varieties. The prices are determined by supply and demand, not by taste or nutritive value.

To help homemakers keep grocery spending down, the National Marketing Services Office of NOAA's National Marine Fisheries Service has been developing a series of budget-wise recipes such as those presented here.

SALMON PIZZA SANDWICH

1 can (16 ounces) salmon
1 can (8 ounces) spaghetti sauce with mushrooms
2 tablespoons instant minced onion
1 teaspoon oregano
¼ teaspoon basil
⅛ teaspoon instant minced garlic
6 hot toasted sandwich rolls
6 slices (½ ounce each) Mozzarella cheese

Drain salmon. Break salmon into large pieces. Combine all ingredients except rolls and cheese in a 2-quart saucepan. Cover and simmer over hot coals for 8 to 10 minutes, stirring occasionally. Place approximately ⅓ cup salmon mixture on bottom half of roll. Cover with a slice of cheese and top half of roll. Makes 6 servings.

FASTER FLOUNDER

2 pounds skinless flounder or other fish fillets, fresh or frozen
2 tablespoons grated onion
1½ teaspoons salt
⅛ teaspoon pepper
2 large tomatoes, cut into small pieces
¼ cup melted margarine or cooking oil
1 cup shredded Swiss cheese

Thaw frozen fillets. Place fillets in a single layer on a well-greased bake and serve platter, 16 by 10 inches. Sprinkle fillets with onion, salt, and pepper. Cover fillets with tomatoes. Pour margarine or cooking oil over tomatoes. Broil about 4 inches from source of heat for 10 to 12 minutes or until fillets flake easily when tested with a fork. Remove from heat and sprinkle with cheese. Broil 2 to 3 minutes longer or until cheese melts. Makes 6 servings.

SPICY PAN-FRIED WHITING

3 pounds pan-dressed whiting or other pan-dressed fish, fresh or frozen
1 cup yellow cornmeal
1½ teaspoons paprika
1 teaspoon salt
½ teaspoon celery salt
½ teaspoon pepper
¼ teaspoon dry mustard
¼ teaspoon onion powder
Fat for frying
Lemon wedges

Thaw frozen fish. Clean, wash, and dry fish. Combine cornmeal and seasonings. Roll fish in seasoned cornmeal. Place fish in a single layer in hot fat in a 12-inch fry pan. Fry at a moderate heat for 4 to 5 minutes or until brown. Turn carefully. Fry 4 to 5 minutes longer or until fish are brown and flake easily when tested with a fork. Drain on absorbent paper. Serve with lemon wedges. Makes 6 servings.

SAUCY SEAFOOD WITH SPAGHETTI

2 pounds thick fish fillets, fresh or frozen
2 cups sliced onions
2 cloves garlic, minced
¼ cup cooking oil
1 can (1 pound 12 ounces) tomatoes
1 can (8 ounces) tomato sauce
1 can (4 ounces) sliced mushrooms, drained
1½ teaspoons salt
1½ teaspoons basil
1 teaspoon crushed rosemary
6 servings hot, cooked spaghetti
Parmesan cheese, shredded

Thaw frozen fish. Cut fish into 1-inch pieces. Cook onions and garlic in oil in a 6-quart Dutch oven until tender. Add tomatoes, tomato sauce, mushrooms, ½ teaspoon salt, and herbs. Cover and simmer for 20 minutes or until flavors are blended. Uncover and simmer for 10 minutes or until sauce is thickened. Add fish and remaining 1 teaspoon salt. Simmer uncovered for 10 minutes or until fish flakes easily when tested with a fork. To serve, spoon over spaghetti and sprinkle generously with Parmesan cheese. Makes 6 servings.

OCEAN PERCH ITALIANO

2 pounds ocean perch fillets, fresh or frozen
¼ cup butter or margarine
1 teaspoon salt
2 cups thinly sliced onion
1 small clove garlic, minced
1 can (8 ounces) tomato sauce
½ teaspoon sugar
½ to 1 teaspoon oregano
Lemon or lime wedges

Thaw frozen fish. Melt 2 tablespoons butter or margarine in large (12-inch) frypan. Arrange fillets, skin side down. in frypan overlapping fillets slightly, if necessary. Sprinkle with ½ teaspoon salt. Cook over moderate heat until lightly browned on underside, 8 to 10 minutes. Melt remaining 2 tablespoons butter or margarine in a second pan. Add onion and garlic. Cook until onion is tender but not brown. Add tomato sauce, sugar, and remaining ½ teaspoon salt; mix. Simmer over low heat 5 minutes. Spoon hot sauce over fillets. Cook over low heat about 5 minutes or until fish flakes easily when tested with a fork. Just before serving, sprinkle with oregano. Serve with lemon or lime wedges. Makes 6 servings.

SUMMER SEAFOOD SWIFTY

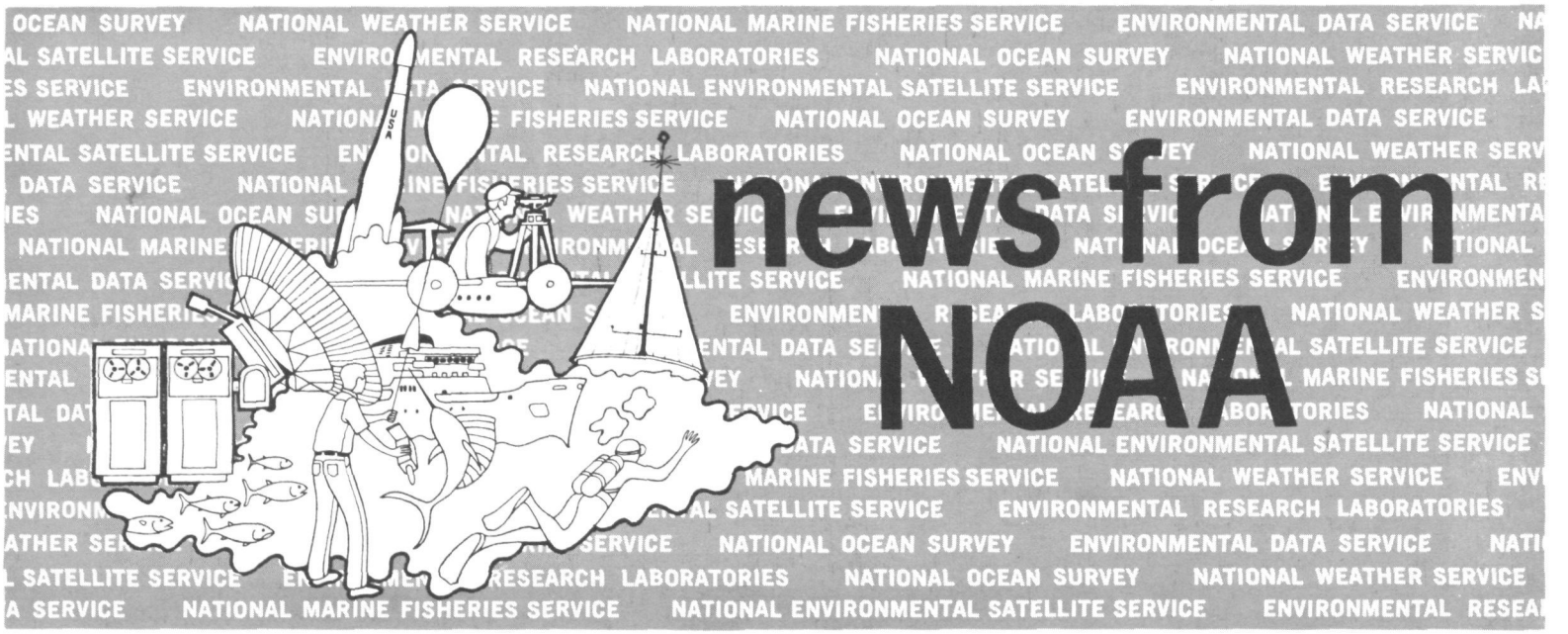
2 pounds thick, skinless fish fillets, fresh or frozen
2 cups chopped onion, fresh or frozen
¼ cup margarine or cooking oil
1½ teaspoons salt
¼ teaspoon pepper
2 tomatoes, sliced
1 lemon, sliced
1 large bay leaf
¼ cup water
1 teaspoon sugar
1 teaspoon cider vinegar
Fresh parsley
French bread

Thaw frozen fillets. Cook onion in melted margarine or cooking oil in a 10-inch frypan until tender. While onion is cooking, cut fillets crosswise into strips about ½ inch wide. Arrange fish over onion. *Sprinkle with salt and pepper. Cover fish* with tomato and lemon slices. Add the bay leaf. Combine water, sugar, and vinegar. Pour over fish mixture. Cover and simmer 10 to 15 minutes or until fish flakes easily when tested with a fork. Garnish with fresh parsley. Serve with French bread. Makes 6 servings.

PLANTATION PORTIONS

12 (2½ to 3 ounces each) frozen fried fish portions
1 can (1 pound 4 ounces) pineapple chunks
1 cup pineapple juice
2 tablespoons sugar
2 tablespoons vinegar
½ teaspoon soy sauce
Dash garlic salt
¼ cup coarsely chopped green pepper
1½ tablespoons cornstarch
2 tablespoons water

Place frozen fried fish portions in a single layer on a well-greased cooky sheet, 15 by 12 inches. Bake in a hot oven, 400° F., 15 to 20 minutes or until heated through and crisp. While fish portions are heating, drain pineapple, reserving juice. Combine pineapple juice, sugar, vinegar, soy sauce, and garlic salt; bring to a boil. Add pineapple chunks and green pepper. Combine cornstarch and water to make a thin paste. Add gradually to hot sauce and cook until thick, stirring constantly. Serve hot sauce over fish. Makes 6 servings.



Exhaustive Five-Year Investigation Of New York Bight Set By MESA

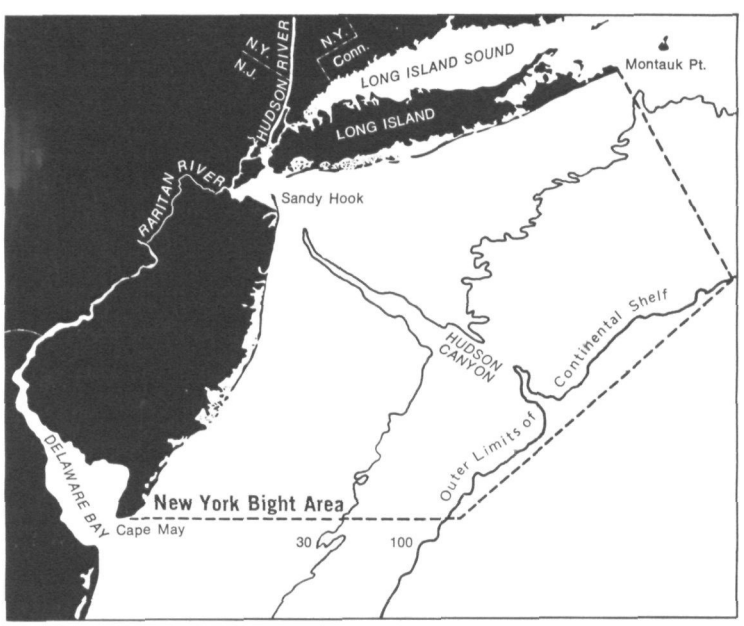
A 15,000-square-mile area of ocean waters and continental shelf off New York and New Jersey will be the subject of the most comprehensive marine ecological investigation ever undertaken.

The five-year investigation of the New York Bight—that portion of coastal waters from Montauk Point, Long Island to Cape May, New Jersey—will be the first regional ecology project undertaken by NOAA's Marine Eco-Systems Analysis (MESA) program.

The New York Bight is one of the most complex, heavily-used coastal marine areas in the United States. The project is designed to find the bight's natural processes, what organisms live there, and what effect man's present and proposed activities are having on them, and to provide basic information on which management decisions about the bight can be made.

A major man-made stress on the bight at present stems from its use as a waste disposal area. Many wastes from the New York-New Jersey metropolitan area end up in the bight from direct discharges, from ocean dumping such as at the New York city dump sites, and from the outflow of the Hudson, Raritan, East, and other rivers.

Other present or proposed activities affecting the bight include coastal land use and development, and possible construction of offshore structures such as ports, nuclear facilities, and waste disposal islands. Use of sand and gravel resources in the bight, to help supplement fast-disappearing sources on land, is also a possibility for the future.



Initial work will be concentrated on developing environmental baselines—finding out what is in the bight now. Baselines will cover the general distribution of fish, shellfish, and bottom organisms. They will establish the general speed and direction of current movement, patterns of plankton development, and how bottom sediments are distributed. They should show where areas of high wave energy are located—energy that may be incompatible with shoreline development or construction of offshore structures.

Several NOAA vessels will be assigned to work on this phase of the project. They include the RESEARCHER, NOAA's most modern major oceanographic ship; FERREL, a coastal circulation vessel; WHITING, a hydrographic survey vessel; and two fisheries ships, ALBATROSS IV and RORQUAL.

As baseline information is developed, a parallel effort will begin —the construction of models for assessing and predicting the consequences of man's actions in the bight. Ecosystems models combining biological and physical systems will be used to show such processes as the rates at which nutrients are taken up by photoplankton, converted to zooplankton, and thence to fish. These will be combined with physical models such as water circulation and sediment movement.

Research and technological units have already been actively investigating the New York Bight. Among them have been the project managed by NOAA's National Environmental Satellite Service, which dyed the waters of the bight green. A fleet of boats and aircraft dropped dye markers in the bight, and the spread of the non-toxic biodegradable dye was recorded by aircraft and satellites, to track surface currents. The Sandy Hook (N.J.) laboratory of the National Marine Fisheries Service has long conducted biological investigations in the bight. Scientists from the Atlantic Oceanographic and Meteorological Laboratories have used submersibles for on-site studies of the effects of deep-water currents on the bottom topography of the continental shelf, and to look at sediment transport in the Hudson Canyon, a pronounced geological feature of the bight.

Results of these and other investigations will be incorporated into the New York Bight project. Capabilities of the National Ocean Survey, National Weather Service, Environmental Data Service, and National Sea Grant Program will also be used in the bight project.

The New York Bight project is the first activity undertaken by MESA, headed by Dr. Allan Hirsch.

Michigan's Epstein To Become An Associate Administrator

Secretary of Commerce Frederick B. Dent has announced the appointment of Dr. Edward S. Epstein as Associate Administrator for Environmental Monitoring and Prediction.

Dr. Epstein, who is 42 years old, is Chairman of the Department of Atmospheric and Oceanic Science at the University of Michigan. He is internationally known in his field.

He succeeds Dr. Richard W. Hallgren, who has become Deputy Director of NOAA's National Weather Service.

Dr. Epstein, a teacher, researcher and administrator, has headed the Department of Atmospheric and Oceanic Science since 1971. During that period, he has broadened its scope to include studies of aeronomy and planetary atmospheres. He is a member of the College Standing Committee, and the University Research Policies Committee.

He was born in New York City, was graduated from Bronx High School of Science in 1947, Harvard College in 1951, and received an M.B.A. degree from Columbia University Graduate School of Business Administration in 1953. During this period he participated in Columbia's Conservation of Human Resources Project.

From 1953 to 1957, he served as an Air Force officer, performing research. In 1954 he received a Master of Science degree from Pennsylvania State University, and in 1960 received his Ph.D. from that institution.

His affiliation with the University of Michigan began in 1959. He served there as a lecturer and research associate, to 1961; as assistant professor from 1961 to 1963, associate professor from 1963 to 1968, and full professor since that time.

From 1962 to 1964, he served as consultant to the Assistant Secretary of Commerce for Science and Technology; and from 1968 to 1969 as visiting scientist at the Meteorology Institute, University of Stockholm.

Dr. Epstein is a Fellow of the American Meteorological Society, the editor of the Journal of Applied Meteorology, a trustee of the University Corporation for Atmospheric Research and Chairman, budget and program committee, of the National Center for Atmospheric Research; panel member on committees of the National Science Foundation and the National Academy of Sciences-National Academy of Engineering; and a member of the American Geophysical Union, the American Statistical Association and the Royal Meteorological Society.

Dr. Epstein is a certified consulting meteorologist. He is married and has four children.

WILLIAM TERRY, IA DIRECTOR, DIES

William M. Terry, 52, director of international affairs for the National Oceanic and Atmospheric Administration since 1971, died suddenly May 6.

He had participated extensively in the work of major U.S. fishery commissions, and in recent years also served as principal U.S. fishery representative at meetings of the Food and Agriculture Organization of the United Nations.

From 1969 to 1971, Mr. Terry served as acting deputy director of NOAA's National Marine Fisheries Service. His career with the Federal fisheries agency began in 1951, when he became a foreign affairs specialist in the Fish and Wildlife Service. In 1958, he was named director of the agency's Office of International Affairs, and in 1966 became assistant director for international affairs in the Bureau of Commercial Fisheries (predecessor of the National Marine Fisheries Service), serving in this post until he was named acting deputy director.

A native of Philadelphia, Mr. Terry was graduated from the University of Delaware in 1942, and did graduate work at Sophia University in Tokyo and George Washington University in Washington, D.C. He served for five years in the U.S. Army, being discharged with the rank of captain. He began his work in fisheries in Tokyo as a member of the Natural Resources Section, Headquarters of the Supreme Commander of the Allied Powers, in the fall of 1945, when he was detailed to accompany the first post-war Japanese whaling expedition to the Antarctic.

Mr. Terry is survived by his wife, Jane, Vienna, Va., and two daughters and one son.

Schoning To Direct NMFS; Roedel To Recreation Post

Secretary of Commerce Frederick B. Dent has announced the appointment of Robert W. Schoning as Director of the National Marine Fisheries Service.

Mr. Schoning has served as Deputy Director of NMFS, an agency of the National Oceanic and Atmospheric Administration, since September, 1971.

Mr. Schoning succeeds Philip M. Roedel, who was recently appointed NOAA's Coordinator of Marine Recreation Programs, with responsibilities across the entire agency.

A well-known fishery scientist and administrator, Mr. Schoning served as State Fisheries Director, Oregon Fish Commission, 1960-1971, following two years as Assistant State Fisheries Director. Prior to that, he was Director of Research for the Oregon Fish Commission.

Born in Seattle, Wash., in 1923, Mr. Schoning holds a bachelor of science degree in fisheries from the University of Washington and has done postgraduate work in fisheries and mathematics.

Mr. Schoning saw active service in the Marine Corps in both World War II and the Korean conflict and is currently a colonel in the U.S. Marine Corps Reserve.

He is known for his writings on salmon and other fishery matters of the Pacific Northwest, and holds membership in a number of professional and conservation organizations including the American Institute Fisheries Research Biologists, American Fisheries Society, Pacific Fisheries Biologists, and Izaak Walton League of America.

Plastic Litters Remote Amchitka Island Beaches

Thousands of pieces of plastic, ranging from tiny scraps to lengths of fishnet 100 feet long, litter Alaska's remote Amchitka Island beaches.

Personnel of NOAA's National Marine Fisheries Service believe about 24,000 plastic items, including an estimated 12 tons of trawl web and perhaps 7,000 gillnet floats, have washed up along 60 miles of Amchitka shoreline.

The estimate was based upon items found by NMFS during surveys of 6.2 miles of shore last year to obtain information on the kinds and extent of plastics littering the beaches of the North Pacific Ocean and the Bering Sea. The surveys were incidental to other fisheries programs underway in the area.

In mid-February, NOAA announced that oil globules and plastic debris in massive proportions were found in nearly 700,000 square miles of ocean water from Cape Cod to the Caribbean, becoming part of the habitat of countless numbers of prized game and commercial fish species.

That announcement was made following analysis of results of three cruises by NOAA vessels as part of the Marine Resources Monitoring, Assessment, and Prediction Program (MARMAP)—a major program to evaluate the living resources in waters off the shores of the United States.

Plastic garbage dumped into the world oceans has obvious physical effects on man and other creatures. Several U.S. and Canadian fishing vessels have been disabled in the North Pacific Ocean and the Bering Sea when propellors were entangled in floating synthetic ropes and nets. Diving sea birds and fish have been captured in scraps of netting—NMFS biologists have observed their skeletal remains in many of the nets found along the Amchitka beaches.

Fur seals and other marine mammals are injured or drowned when caught in derelict nets. In 1972, among the thousands of seals migrating to the Pribilof Islands, 81 were observed with netting around their necks, and six of these animals were dragging heavy ropes. Another 52 seals had put their heads through what can be described as "plastic collars" the animals could not remove.

Some species of sea birds eat bits of floating plastic, presumably mistaking them for morsals of food. Ornithologists at Amchitka and in the Atlantic off Newfoundland have found plastics in bird gizzards frequently enough to be of concern to scientists.

Most of the contamination of Alaska waters by plastics is believed to be from foreign fishing vessels.

U.S., U.S.S.R., Canada, Japan Agree On St. George Fur Seal Harvest Ban

For the first time since man's earliest known visits to the Pribilof Islands in 1786, no fur seals will be commercially harvested this year on St. George Island.

A NOAA proposal to end the harvest on the small Pribilof Island in the Bering Sea experimentally for an indeterminate period has won international approval.

The U.S. delegation to the 1973 meeting of the International North Pacific Fur Seal Commission in Tokyo received approval of the proposal from the USSR, Canada, and Japan. David H. Wallace, NOAA Associate Administrator for Marine Resources, was principal advisor to the delegation.

Other members of the U.S. delegation were: Walter Kirkness, Commissioner; Dr. George Harry, Chief Scientist; Dr. Ancel Johnson, Mammal Biologist; and William Pack, Manager of the Pribilof Fur Seal Program; Stewart Blow, State Department; James Brooks, Commissioner, Alaska Department of Fish and Game; and Clint Atkinson, Fisheries Attache, U.S. Embassy.

Unanimous agreement in the Commission was required for action in reducing the harvest and establishing a research control area. Under the terms of the Interim Convention on Conservation of the North Pacific Fur Seal Treaty, NOAA's National Marine Fisheries Service manages the seal herds on St. George and St. Paul (the larger of the two main Pribilof Islands); and the Soviet Union manages those on Robben and Commander Islands. Canada and Japan each receive 15 percent of the harvests from the operations managed by the U.S. and the USSR.

The harvest will continue on St. Paul, under Federal supervision. Last year 4,220 seals were taken from St. George and 33,615 from St. Paul.

The experimental ban on St. George will be a key element of a major research effort by NMFS to identify the principal factors governing the seal population level. In the past three years there have been unexplained downward trends in the male populations despite careful management by government scientists.

Research into the populations of different age groups on both islands including the reproduction rate, feeding habits on land and at sea, disease, and genetic factors will be undertaken. Scientists of the other nations involved have been invited to participate in the planning and execution of the research projects.

By comparing changes in the populations of harvested and unharvested rookeries it is hoped to get a clearer picture of the extent to which various factors affect those populations, and whether seal harvesting has any important impact on the level of fish stocks available to commercial fishermen.

Chesapeake Bay Area Is Sinking, NOS Finds

The entire area surrounding Chesapeake Bay has sunk from 1½ inches to almost six inches since 1934, the National Ocean Survey has found.

The report is based on a 1,034-mile survey of the shores of Chesapeake Bay and adjacent areas by the National Geodetic Survey. The $375,000 survey was requested by the Army Corps of Engineers to aid its evaluation of the bay's resources.

While the land subsidence over approximately the past third of a century is comparatively small, if the sinking continues at the present rate, the implications can be more serious if projected over a century. In that event, at least six areas that were surveyed may show an overall subsidence of approximately 12 to 16 inches in another six decades. These are Dover, Del., and Portsmouth, Smithfield, Williamsburg, Saluda, and Norfolk in Virginia.

Since the slope of the coastal zone is usually quite flat when the land sinks the shoreline may move inland a distance many times the amount of subsidence. Furthermore, in inland areas distant from the shore, subsidence causes a change in the runoff features of streams, increasing the flow in some areas and stagnating it in others where a bowl effect occurs.

The six areas are among the 17 localities where the survey found appreciable subsidence. The survey, which took more than a year, involved a determination of the elevations of a network of tidal gaging stations which record the rise and fall of the tides. Relative elevations of the gage sites were surveyed to enable engineers to simulate the slope of the water for an estuarine model of the bay being designed by the Army. The model will serve as an environmental tool in determining a baywide plan for the maintenance and enhancement of Chesapeake Bay's environment.

John Gottschalk Goes To New Post

John S. Gottschalk, for the past 2½ years Assistant for Sport Fisheries to the Director of the National Marine Fisheries Service, retired on April 28. His 28 years of Federal service included 25 with the Interior Department's Bureau of Sport Fisheries and Wildlife, the last six as Director.

He has accepted the position of Executive Vice President of the International Association of Game, Fish and Conservation Commissioners, an organization with offices in Washington, D.C., primarily serving the interests of State and Canadian Provincial fish and game agencies.

Educated at Earlham College and Indiana University, he was with the Indiana Department of Conservation for 11 years before entering the Federal service.

One Millionth Correction Made By Controllers

The Technical Control Section of the Weather Service's Communications Division has made its one millionth correction since 1969 on bulletins rejected by the NMC's telecommunications computer. Savings attributed to the correction procedure are estimated at more than $10 million. The estimated savings are based on the cost of taking the observations and delivering them to NMC.

Winfield M. Bogle, Section Chief, designed the facility for computer rejection and line monitoring, procured the equipment, supervised its installation, and trained the seven men who now comprise the Section.

In 1969, as at present, the major cause of rejected bulletins was improper bulletin preparation by originators. Since data are received from other government agencies and many foreign countries, a problem of standardization has always existed. An effort was undertaken, and is continuing today, to have all originators of meteorological information prepare their bulletins in conformity with World Meteorological Organization standards and procedures. In the meantime, as much data as possible will be rescued by Mr. Bogle and Technical Controllers Allen Driscoll, Charles Powell, John Lanzaro, Joseph Foti, Patrick Barge, Tracy Wright, and Alvin Wildeman.

They receive from the computer any information it rejects for any reason, and correct them.

SKYWAVE RADAR SEES SEA STATE MANY MILES OUT

Skywave radar has successfully observed sea conditions over an area extending hundreds of miles from shore-based antennas.

According to Dr. Donald E. Barrick, an electronics engineer with the Wave Propagation Laboratory, the skywave radar technique appears to be an ideal method for remotely sensing sea state and other oceanic conditions out to great distances from land. For example, he reports that one skywave radar site in Kentucky could observe the ocean's surface behavior along the entire Atlantic coast and some 1,200 nautical miles out to sea, in virtual real time.

The radar-scanning technique would also help in predicting destructive wave activity along our coasts, permit routine computations of average wind conditions over the scanned areas, and provide a means of locating and tracking ships and small craft in distress anywhere within the radar's range.

Skywave radar beams high-frequency radio signals toward the ionosphere, the electrically charged region of the upper atmosphere, which reflects the signals earthward at great distances from the radar. Echoes—or backscatter—returning to the transmitting site over the same path can be used to infer the ocean wave heights, length, and direction of travel.

"Such knowledge of sea conditions can provide quite accurate information for preparing predictions concerning where and when these high waves will reach other areas, and in particular improve warnings to coastal areas and ships likely to be damaged by the waves," Barrick explains.

Since ocean waves are produced by winds, a knowledge of wave heights and directions can be used to infer the average wind conditions near the surface for the prior 6 to 24-hour period.

This kind of information would be useful to ocean and coastal weather forecasters and to scientists developing global atmospheric weather prediction models and related research.

"Skywave radar's high-frequency system has great potential for communication and lifesaving operations with ships and personnel in the scanned area," Barrick points out. "Ships within radar range could be informed of sea conditions ahead of them by the same high-frequency transmitter used for monitoring sea conditions. Ships in distress could be located and tracked, as could small craft or lifeboats equipped with low-power, high-frequency beacons."

Salmon Egg Projects Aiding Fisheries Here and Abroad

Korea, Canada, and a private entrepreneur in Maine are benefitting from salmon eggs from the west coast of the United States in projects aided by the National Marine Fisheries Service.

Three million eggs were flown to the Republic of Korea from Portland, Oregon, and arrived in good condition 48 hours after shipment, largest in a five-year history of the Korean program, which is attempting to establish new coho salmon runs in that nation. A half-million eggs went to Ontario, Canada, for use in the Canadian Great Lakes system, and 100,000 went to the Maine businessman. The eggs were surplus to U.S. rearing needs on the west coast.

The shipments were coordinated by NMFS. The eggs came from the Eagle Creek National Fish Hatchery in Oregon, the Willard National Fish Hatchery in the State of Washington, and the Oregon Fish Commission's Sandy Hatchery. The National Fish Hatcheries are operated by the Bureau of Sport Fisheries and Wildlife, Department of the Interior, with all 21 hatcheries in the Columbia River Program funded by NMFS.

In the Korean operation, the eggs are hatched and reared for one year at two hatcheries built in Korea with the assistance of the Agency for International Development. Thus far the hatching and rearing has been excellent, but the return of adult salmon has been low. It is hoped that the larger number of fingerlings released within the next year will increase the return. Most coho normally return to spawn at age three or four.

Canada will hatch and rear its shipment of coho eggs in Canadian hatcheries for release into the Great Lakes system as part of the International Field Year for the Great Lakes, sponsored by the United States and Canada. The Canadians have also reported excellent success in hatching and rearing, but it is too early for a report on adult returns.

In Maine, Frederick Towle arranged to purchase 100,000 coho eggs and pay the shipping expenses to a privately owned fish hatchery at West Buxton. In six months, in 50° F. water, the eggs are hatched and reared to a length of four inches in much less time than it would take in the wild. In July, Towle plans to move the young fish to large pens along the Sheepscot River where the Central Maine Power Station at Wiscasset cooperates by making available discharged cooling water which reaches a temperature of up to 90°. With this water, Towle maintains the temperature in the pens between 40° and 60°. The salmon eat plankton brought in by tidal action, and in addition are fed four times a day.

NOS Deep-Sea Tide-Current System Scores

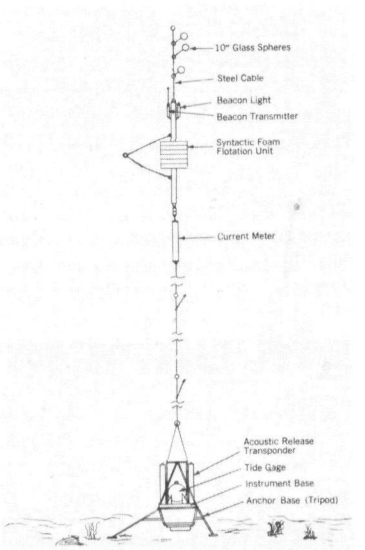
The development of a free-falling deep-sea instrument system which can automatically measure bottom tides and currents for as long as six months has been announced.

The system, developed over a period of 18 months at a cost of approximately $50,000, was pronounced operational after it was recovered from more than two miles of water and found to have operated perfectly.

The deep-sea tide-gage and current-meter system was dropped to the ocean floor last May in about 11,000 feet of water about 100 miles southeast of San Juan, Puerto Rico. It popped to the surface at an acoustic signal from the NOAA Ship DISCOVERER.

The system was developed by the Engineering Development Laboratory of NOAA's National Ocean Survey. The development, deployment, and retrieval were handled by the laboratory's Miami-based Ocean Engineering Branch under the supervision of Jack Falkenhof.

M. E. Ringenbach, Director of the Engineering Development Laboratory, said this was the first time to his knowledge that such long-term tidal and current data have been obtained from the deep ocean.



Deep-sea tide-gage and current-meter system developed by National Oceanic and Atmospheric Administration. The free-falling instrument system can automatically measure bottom tides and currents for a long as six months.

"When the instruments were recovered and their data examined, it was found that they had performed 100 percent," he stated. "It is significant that we were able to obtain both tidal and current data from the sea floor. Current data have been obtained before from the deep sea, although not over such a lengthy period. About one month has been the limit."

The measuring instruments consist of a tide gage and current meter. The tide gage is a sphere which sits on a tripod anchor base about 12 to 15 feet across. An acoustic release system allows the anchor base to remain at the bottom and the instrument package to separate and come to the surface at a signal from the ship. The current meter is located approximately 100 feet off the bottom, supported by a flotation unit and is connected to the system by a cable.

Beachgoers' Bane Challenged

Sea Grant Study Seeks To Control Biting Flies

The bane of the beach-goer, those small but indomitable biting flies that can ruin a holiday (or a resort area), have come under the scrutiny of scientists at the University of Delaware where tests show there may be ways of controlling these pests other than by ecologically dangerous chemical methods.

Supported by a Sea Grant, Dr. E. P. Catts and other entomologists at the university are studying the hunting behavior of several types of salt marsh flies in order to design and test traps for capturing them.

Salt marshes are prolific nursery grounds for a formidable battery of pestiferous biting flies, including mosquitoes, punkies, greenhead flies, and deer flies. Greenhead flies and deer flies in particular are active throughout the daylight hours. They range far from their breeding sites and their persistent and painful biting make them important deterrents to most coastal recreational or business enterprises.

Chemical controls of these flies require relatively high dosages of toxic materials applied to open marshes for larval control or to wooded areas for adult control. Such measures can give dramatic results, but are expensive and ecologically unsound. The University of Delaware researchers seek an alternative control; the physical trapping of the free-flying insects.

While the deer fly, the specific target of the Sea Grant sponsored project remains elusive, scientists have had remarkable success with research on greenhead flies sponsored by Delaware's Department of Natural Resources and Environmental Control. They hope to duplicate this success with the deer flies this summer.

According to Dr. Catts, in July of 1972, a single month of the May through September "fly season", the university researchers trapped 350,000 greenhead flies. Significantly, nearly 50 percent of these were trapped in only a few of the traps set out. This leads scientists to believe that there are certain routes the flies take regularly. If these "flyways" could be mapped, control agencies could concentrate trapping and killing devices.

As for the deer flies, this summer Dr. Catts will continue testing flat, shiny black vertical surfaces coated with slow-drying adhesives. Refinements in size, shape, positioning, and trap movement will be tested to improve trap effectiveness. Trap spacing and various baits (attractants) will be tested. Potential attractants are weak lactic acid solutions, and weak concentrations of diethyltoluamine (a commercial "repellent"). The range of attractiveness of combined trap and attractant will be determined by releasing marked flies at various distances from salt marsh-situated traps.

Harshbarger To NWS's Overseas Operation Wing

Harold B. Harshbarger, former Chief of the Climatological Services Division in the National Weather Service Office of Meteorological Operations, is now Special Assistant to the Chief of the NWS Overseas Operations Division.

Between 1965 and 1971 he served on the staff of the Director of the Environmental Data Service. He joined the Weather Service in Washington, D.C., in 1946 as a meteorologist, and subsequently was Principal Assistant at Hartford, Conn.; Official in Charge of the Weather Records Processing Center in Albany, N.Y.; Chief of the Climatological Services Division's Records and Processing Section and of its Climatic Field Services Branch; and Manager of the Field and User Services Division. He was a Station Weather Officer while in the Army Air Corps during World War II. He holds a B.A. in mathematics from Gettysburg College, and has done graduate work in meteorology at New York University.

all in the family

PERSONNEL NOTES

Samuel V. Wyatt, Aviation Safety and Quality Control Program Leader of the National Weather Service's Weather Analysis and Prediction Division, has been redesignated by NWS Director Dr. George P. Cressman as Chief Pilot for the NWS.

Edward Jessup, meteorologist, who recently returned from a tour of duty at South Pole Station in the Antarctic, has been assigned to the Surface Systems Branch of the National Weather Service's Data Acquisition Division.

Robert B. Orton, who has been Climatologist for the State of Texas since 1960, has been selected Meteorologist in Charge of the National Weather Service Office at El Paso, Texas.

Mrs. Claire P. Mancuso, a Forecaster and Weather Service Specialist at Grand Island, Neb., is the new Official in Charge at the Weather Service Office in Valentine, Nebr.

Ronald E. Drummond, a Weather Service Specialist at Elkins, W. Va., has been appointed to head the Weather Service Office at Beckley, W. Va.

Commander Richard H. Allbritton, who was formerly Executive Officer of the DISCOVERER, has been assigned to the Office of Oceanography in the National Weather Service.

John A. Gonzalez, formerly an electronic technician at the San Francisco Weather Service Forecast Office, Redwood City, Calif., has been assigned as the Physical Science Technician at the cooperative rawinsonde station in Empalme (Guaymas), Mexico.

Vail P. Schermerhorn has been selected Hydrologist in Charge of the Portland, Oreg., River Forecast Center.

Warren E. Sunkel has been appointed Meteorologist in Charge of the Weather Service Meteorological Observatory in Marseilles, Ill.

James L. Stamy is the new chief of the National Data Buoy Center's Systems Analysis Division. He was formerly manager of NASA's Michoud Assembly Facility in New Orleans, La.

Thomas E. Johnson has been appointed Chief of the Electronic Computing Division's Planning Branch at the Rockville, Md., headquarters of the National Ocean Survey.

Christina Jackson has been awarded the Lake Survey Center's first "Woman of the Year" plaque for "significant ethical contributions and dedication to the service and morale of the Lake Survey Center."

Commander Darrell W. Crawford is now Operations Officer at the National Ocean Survey's Lake Survey Center in Detroit, Mich. He was last assigned as Director of the NOS National Geodetic Survey Operations Center in Kansas City.

Commander Sidney C. Miller has become Deputy Associate Director of the Office of Fleet Operations at the Rockville, Md., headquarters of the National Ocean Survey. He last served as Executive Officer of the FAIRWEATHER.

Lieutenant Commander Karl W. Kieninger, who has been Commanding Officer of the NOAA Ship FERREL for the past two years is the new chief of the Processing Division at Atlantic Marine Center in Norfolk, Va.

Ensign John L. Oswald of Columbus, Ohio was top man in the recently concluded 43rd NOAA Officer Training Class at the U.S. Merchant Marine Academy, Kings Point, N.Y.

Lieutenant Commander Walter F. Forster, II, is the new chief of the Processing Division of the National Ocean Survey's Pacific Marine Center. He was formerly Executive Officer of the DAVIDSON.

Dr. Edward F. Klima, former Officer-in-Charge of the Pascagoula Fisheries Laboratory, Southeast Fisheries Center of the National Marine Fisheries Service, is now a Program Analyst for the Plans and Policy Development Staff of the NMFS Washington Office.

Dr. Eric G. Barham, former head of the Marine Biology Branch of the Ocean Sciences Department at the Naval Undersea Warfare Center in San Diego, Calif., has been named Porpoise Program Manager at the National Marine Fisheries Center, La Jolla, Calif.

Dr. Reuben Lasker a physiologist in charge of Behavior-Physiology Investigations at the NMFS Southwest Fisheries Center, La Jolla, Calif., has been reappointed Scientific Editor of the **Fishery Bulletin,** the principal scientific publication of the National Marine Fisheries Service.

Kiyoshi G. Fukano who has been an editor with the Scientific Publications Staff of the National Marine Fisheries Service in Seattle, Wash., since its establishment in 1970, has been named Managing Edtior of the Fishery Bulletin.

Lieutenant Commander Kenneth F. Burke, whose last assignment was executive officer of the WHITING has been named Commanding Officer of the NOAA Ship FERREL.

Commander Jeffrey G. Carlen who was previously executive officer of the MT MITCHELL has been appointed Commanding Officer of the NOAA Ship WHITING.

Lieutenant Commander C. Dale North, Jr., is the new Executive Officer of the NOAA Ship WHITING. He was formerly assigned to High Speed Launch 1257.

Lieutenant Martin R. Mulhern is the new Operations Officer of the NOAA Ship PEIRCE. He was previously assigned to Albuquerque (N. Mex.) Seismological Center.

Commander Charles A. Burroughs has been named Commanding Officer of the NOAA Ship FAIRWEATHER. He was formerly the executive officer of the SURVEYOR.

Lieutenant Commander Frank P. Rossi is the new Operations Officer of the NOAA Ship FAIRWEATHER.

Lieutenant Commander Philip C. Johnson, who was previously Operations Officer of the NOAA Ship MT MITCHELL, is now the ship's Executive Officer.

Lieutenant Carl R. Berman, who has been the MT MITCHELL's Navigator and Assistant Operations Officer for the past 15 months, has become her Operations Officer.

Lieutenant Ronald L. Crozier is the new Field Operations Officer of the NOAA Ship DAVIDSON.

Dr. George C. Reid has been appointed Acting Deputy Director of the Boulder, Colo.-based Aeronomy Laboratory of the Environmental Research Laboratories. He was Acting Director of the Aeronomy Laboratory from 1970 until September 1972, when he relinquished the position to Dr. E. E. Ferguson so that he could continue in his field of research.

Captain Richard H. Houlder has reported to NOAA's Office of Environmental Monitoring and Prediction at Rockville, Md., headquarters, to serve as head of the GATE Field Operations Group. He was formerly Commanding Officer of the FAIRWEATHER.

Dr. James Ridlon of the National Oceanographic Data Center has been named to coordinate the activities of all Environmental Data Service data centers in management tasks associated with NOAA's Marine Ecodsystems Analysis Project.

John C. Sylvester has been named Southeast Liaison Officer for the Environmental Data Service's National Oceanographic Data Center. He works out of a newly established NODC regional office for the southeastern United States, located at the Miami-based Atlantic Oceanographic and Meteorological Laboratories.

Dr. Michael D. Hudlow has been permanently assigned to the Environmental Data Service's Center for Experiment Design and Data Analysis as a hydrometeorological task area leader.

NEW COMPUTER SYSTEMS TO AID NOAA PROGRAMS

NOAA is acquiring two IBM 360/195 computer systems which will provide a fivefold increase in the capacity of the agency's computer complex at Suitland, Maryland.

The contract, awarded by the General Services Administration, calls for expenditures of $22.7 million over the next five years. First-year costs will be $3.5 million.

The Suitland computer complex, operated by NOAA's Office of Management and Computer Systems, is used to process environmental satellite data, analyze global weather observations and prepare forecasts, process triangulation data gathered for accurate earth measurement, and to model hurricanes mathematically. It serves the National Weather Service, National Environmental Satellite Service, National Ocean Survey, and Environmental Research Laboratories.

The increased computer capacity provided by the dual system is needed to handle the more complex and detailed global weather forecasting models which have been developed by the National Weather Service's National Meteorological Center, but cannot be used operationally with the equipment to be replaced by the new system.

Every day, the National Meteorological Center receives more than 40,000 weather observations from around the world, and these are processed by computer to produce hundreds of weather analyses and forecasts for various levels of the atmosphere and different geographical areas. These products serve as the foundation for local and regional forecasts issued by meteorologists in Weather Service offices throughout the nation.

The expanded computer capacity afforded by the twin IBM 360/195 systems also is required to process the increased quantity of data from the forthcoming SMS/GOES (Geostationary Operational Environmental Satellite) system, in which two earth-synchronous spacecraft each will be providing continuous day and night observations of the earth's surface and cloud cover over an entire hemisphere.

Communications computers operated by the National Meteorological Center and the National Environmental Satellite Service will be connected directly to the new system, which will be able to keep more than three billion characters in on-line storage.

The first 360/195 computer system is scheduled for installation at Suitland in September; the second in February, 1974.

Fish Consumption 12.2 Pounds Per American in 1972

Americans are eating more fish, preliminary data gathered by the National Marine Fisheries Service reveals.

In 1972, the per capita consumption of fishery products was 12.2 pounds per person, reports NMFS. In 1971, the per capita consumption was 11.4 pounds.

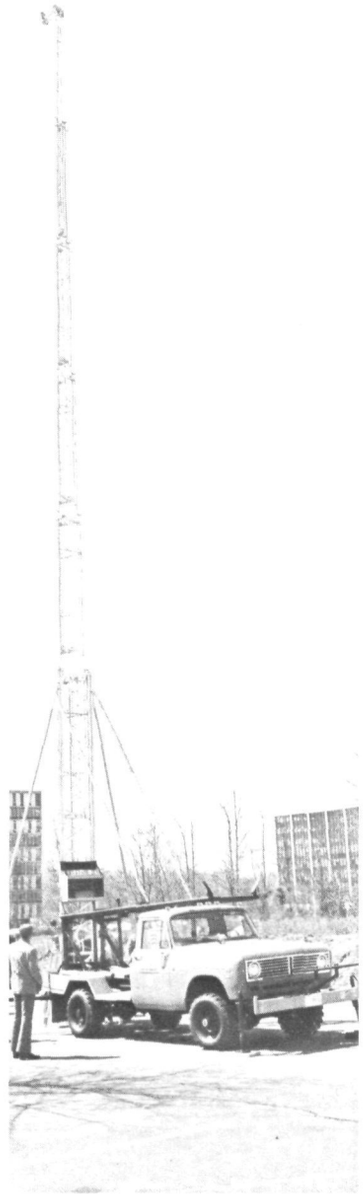
The 1972 consumption figure ties the record U.S. figure set in 1927. It shows that the American housewife was buying more fish for her family months before meat prices became headline news early in 1973.

And, according to further preliminary figures, commercial fishery landings in the United States in 1972 were worth about $704 million to the fishermen, up nine percent over the 1971 value of $643 million. This catch sold for an estimated $2.1 billion at retail, according to NMFS. The volume landed in 1972 is expected to total 4.7 billion pounds, a six percent decline from 1971 landings of five billion pounds, but still five percent above the annual average landings for the previous five years.

Total commercial fishery landings by U.S. craft at ports outside the United States were 183.7 million pounds valued at $61.9 million in 1972. Tuna landings by U.S. fishing vessels in Puerto Rico and American Samoa accounted for four-fifths of the total quantity and half of the total value; shrimp and spiny lobster landings at Central and South American ports accounted for the remainder.

San Pedro, Calif., remained the leading port in value of landings, and moved into first place in volume supplanting Cameron, La., which slipped to second. Tuna is the primary species landed at San Pedro, while menhaden, a fish used for industrial purposes such as fishmeal, accounts for most of the landings at Cameron.

One Man \ One Tower
Survey Is Developing Quick-Rising Towers



Quickly erected portable towers for geodetic programs are under development by National Ocean Survey.

The National Geodetic Survey is developing portable steel towers which can be erected in a comparatively few minutes for use in geodetic surveying. One is a truck-mounted electrically-operated tower; the other a trailer-mounted hydraulic-powered structure.

A geodetic survey is an extremely precise land survey which provides the basis for maps and for determining boundaries.

The towers can be employed in conjunction with the portable Bilby steel towers now used by the National Geodetic Survey in its measurements throughout the United States, and by foreign nations. These towers, in use since 1927, normally take five to six men about a day to erect and another three or four hours to dismantle. The towers under development can normally be erected by one man in 20 to 30 minutes.

Further development of the new towers, which are now more limited in scope than the Bilby towers, could provide important assistance to the Survey, which maintains the nation's horizontal and vertical control networks.

The towers can be erected to an effective operational height of 75 feet. They can be utilized in three ways: with a ground-controlled TV camera at the top to scan the area for obstructions between sites that would interfere with a clear line of sight for survey operations, with a mirror or reflector on which geodimeter observations could be made or with a light on which angle measurements could be made with a theodolite.

The towers were developed at the National Geodetic Survey's Instrument Support Branch at Corbin, Va., under the direction of George Lesley and Lt. Cdr. David M. Wilson. The hydraulic-powered trailer-mounted tower has limited maneuverability after being detached from the towing vehicle.

Marine Mammal Rules Tightened

The National Marine Fisheries Service has ruled that applications for economic hardship exemptions involving the taking of marine mammals for the purposes of scientific research or public display will not be granted to persons or organizations engaged solely in the capture of marine mammals for sale. Such exemptions, when granted, will be issued only to the person or persons intending to display or conduct research with the animals such as zoos, oceanaria, or scientists.

NMFS has also promulgated a regulation to prohibit the placing of radio transmitters on the backs of porpoises. The action followed reports that some fishermen had attached transmitters to the backs of porpoises to assist them in locating tuna. Porpoises tend to swim above tuna schools and are widely used to locate them. When transmitting antenna is above the ocean surface, a beeping radio signal is broadcast which helps fishermen maintain contact for up to 15 miles.

NMFS said the tuna industry had taken steps to conform immediately with the ruling when this problem was brought to its attention, even before the new regulation had become effective. The Service took this step since it was not clear whether or not it was legal to place transmitters on porpoises. The industry agreed that clarification was desirable.

U.S., France Plan Cooperative Programs At Miami Meeting

The United States and France have announced plans to increase significantly their cooperative programs in the oceans. Collaborative efforts in such vital areas as a joint exploration of the Mid-Atlantic Ridge, pollution abatement, aquaculture, man-in-the-sea, data buoy technology, and instrumentation will be accelerated, it was announced by Dr. Robert M. White, Administrator of the National Oceanic and Atmospheric Administration, and Yves LaPrairie, Director-General of France's National Center for Exploitation of the Oceans (CNEXO).

The announcement ended a three-day meeting of the U.S.-French Cooperative Program in Oceanography, held at NOAA's Atlantic Oceanographic and Meteorological Laboratories in Miami. The program was initiated by the two nations in 1970.

Dr. White and M. LaPrairie termed the sessions a major step forward in nation-to-nation scientific cooperation.

The two nations announced programs in the following fields:

Deep-diving U.S. and French submersibles will conduct a three-year study of the Mid-Atlantic Ridge, a major feature of the earth's surface not yet investigated at close range. The program is called FAMOUS, for French-American Mid-Ocean Undersea Study.

The Mid-Atlantic Ridge is a giant undersea mountain range extending from the Arctic Ocean the entire length of the North and South Atlantic. By using submersibles in an area 200 miles south of the Azores, scientists will obtain samples direct from the rift valley in the center of the ridge. Knowledge concerning the formation of mineral deposits and understanding of ancient geological structures should result from a closer understanding of the area.

Several joint research and operational man-in-the-sea programs are planned. Use of a U.S. Navy-developed intravascular bubble detector to monitor the onset of diving sickness will be considered for the next French deep-chamber dive experiment. A joint, integrated diving research program investigating the basic nerve mechanisms, respiratory functions at great depth, and the study of gas formation in blood at depth is planned. Efforts will be continued to develop a joint program to test pharmacological preparations protecting against decompression sickness.

A joint study will be made toward development of an international data bank on long-term health of divers. French marine scientists will be invited to join the U.S. in research involving new decompression schedules.

Dr. Robert M. White, NOAA Administrator (right) Andre Brin, director of programs for France's National Center for the Exploitation of the Oceans (left), and Yves LaPrairie, Director-General of the Center, work on details of U.S.-French agreement for ocean cooperation at Miami meeting.

The U.S. and France will cooperate in tests of equipment designed to contain and clean up oil spills at sea. The Coast Guard will deliver to the French National Center for the Exploitation of the Oceans (CNEXO) 250 feet of a high-seas oil containment boom by September 15 for a six-month period. The French will use the boom and CNEXO's vortex (an oil recovery device) in tests near-shore and 50 to 100 miles at sea. CNEXO, in turn, will provide a vortex device to the Coast Guard for a six-month test with Coast Guard-developed high-seas oil-recovery equipment.

The United States and France will establish a working group on molluscan, crustacean, and fin fish aquaculture. The countries agreed that a long-term program of disease and genetic study is needed and recommended a joint research effort between U.S. and French laboratories specializing in the pathology of marine organisms. Emphasis will be placed on oyster culture.

U.S. and French satellites will be used, and satellite equipment exchanged, for the study of ocean current and meteoroogical conditions from drifting buoys. The effort follows a project in which the U.S. supplied a drifting buoy hull and sensors and the French a location and communications package compatible with France's EOLE satellite.

Cooperative use of a unique wind tunnel at Luminy, France, will be continued and a cooperative study initiated between NOAA and the Institut de Mecanique Statistique de la Turbulence, using the Luminy tunnel to study the generation of capillary waves and associated water motion.

Both NOAA and CNEXO are starting projects to study the environmental impacts of undersea sand and gravel mining.

The two nations will start a systematic exchange of ideas, techniques, and results. U.S. and French scientific teams will meet later this year in Boston to review the state of biological investigations, physical oceanography and sedimentology, laboratory experiments, and mathematical modeling.

Specifications for a high-pressure facility for the Oceanographic Center of Brittany, and an Statistique de la Turbulence calibration facility, have been agreed upon. The existing NOIC "failog" program for reporting field instrument failures will be considered for incorporation in the Brittany Center's data bank on instrumentation. In turn, NOIC will examine a consolidated instrument format being developed by France for possible common use.

Hallgren Is Named NWS Deputy Director

Dr. Richard E. Hallgren, Associate Administrator for Environmental Monitoring and Prediction since September 1971, has been appointed Deputy Director of the National Weather Service. Before being named Associate Administrator, Dr. Hallgren was Assistant Administrator for Environmental Systems. This is the position he also held in the Environmental Science Services Administration before NOAA was created in 1970.

He previously was the Director of the ESSA Office of World Weather Systems, and earlier, for two years was Scientific Advisor to the Assistant Secretary of Commerce for Science and Technology.

Since last September, he has served as Federal Coordinator for Meteorological Services and Supporting Research, and was responsible for coordinating and planning all Federal weather service and supporting research programs.

In 1968, Dr. Hallgren won an Arthur S. Flemming Award, as one of ten outstanding young men in the Federal government, and in 1969 he received a Department of Commerce Gold Medal for his direction of the design and management of the Barbados Oceanograph and Meteorological Experiment.

From 1954-56, he was a staff weather officer and operational weather forecaster in support of the Strategic Air Command. He subsequently joined IBM's Space Guidance Center as an operations research analyst and from 1963 to 1964 managed the company's Washington System Center Meteorology Systems Department.

Mitchell Deputy At EDS Center

Daniel B. Mitchell has been appointed Deputy Director of the Environmental Data Service's Center for Experiment Design and Data Analysis. He will be primarily responsible for developing policies dealing with the management of data from large-scale international scientific experiments. A retired Air Force colonel, Mr. Mitchell's last duty assignment was Commander, Air Force Global Weather Central, a centralized environmental production system for the Air Force in which he supervised the collection and processing of all types of environmental information from ground-based, airborne, and satellite sensors.

After 27 Years, Aloha To Honolulu For Pacific Tide Party

The National Ocean Survey's Pacific Tide Party is leaving Honolulu after more than 27 years and being relocated at the Pacific Marine Center in Seattle, Wash.

The four-man party will move from Pearl Harbor as soon as practicable after July 1. The party is headed by Commander F. D. Moran and includes Lieutenant (junior grade) Bruce L. Crumley, Lieutenant Raymond Louis and Mickey Moss. It is responsible for the maintenance of tide gages in the Pacific, including 19 in Alaska, 19 on the West Coast, and 12 west and south of Hawaii.

Lieutenant Thomas W. Richards will head the party after it is relocated. A commissioned officer since 1969, he has served aboard the MT MITCHELL and PEIRCE, and with various geodetic field parties.

The Pacific Tide Party was established January 26, 1946, by the Coast and Geodetic Survey, predecessor of the NOS. Its first chief was H. A. Marmer, a noted authority on tides and currents, and subsequent chiefs have included Rear Admiral Norman E. Taylor, now PMC Director, and Captain Herbert R. Lippold, Jr., who will succeed Admiral Taylor on July 1.

South Florida Skies Scene of Summer Tropical Weather Modification Studies

The atmosphere over southern Florida and nearby ocean areas will be the laboratory this summer for a series of experiments aimed at improving man's ability to comprehend, predict, and modify tropical weather.

Project scientists hope to end the season with a significantly improved understanding of the cause-and-effect quantities involved in seeding cumulus clouds to increase cloud size and precipitation, the energy distributions and sea-air interactions associated with tropical storms and hurricanes, and new ways of observing these and other processes in the tropical atmosphere.

The experiments will also test—and provide additional data for—numerical models developed to simulate and predict the behavior of seeded and unseeded cumulus clouds, processes in and around tropical cyclones and wave action beneath active hurricanes.

A cooperative undertaking of NOAA elements in the Miami, Fla., area—the Experimental Meteorology Laboratory, National Hurricane Research Laboratory, Research Flight Facility, and Atlantic Oceanographic and Meteorological Laboratories, all of NOAA's Boulder, Colo.-based Environmental Research Laboratories, and the National Hurricane Center of NOAA's National Weather Service—and the Universities of Miami and Virginia, the project, now underway, will run through November.

The experimenters will use data from virtually the entire family of earth-orbiting environmental satellites to be launched next month. They will also use heavily instrumented research aircraft, sophisticated new radar systems, and a dense network of surface wind- and rain-measuring devices in the project area south of Lake Okeechobee.

The cumulus cloud-seeding experiment is scheduled to begin July 1 and run through August or until a usefully large data sample—about 20 experimental days, with seeding or approximately 10 of those—is obtained.

Hurricane and tropical storm research—no storm seeding is planned this year—will investigate various physical and dynamic features of these violent storm systems, and will have priority after August 15. This study will continue as storms come within range through November 30.

Dr. Joanne Simpson, director of the Experimental Meteorology Laboratory, notes that, although the 1973 field season is not in any sense operational, it does represent an important advance over the experiments of past years.

"What we are doing this year," she says, "is examine the details of cloud-seeding causes and effects with a greatly improved array of instruments, both on the ground and aboard research aircraft. The dense surface network operated this year by the Department of Environmental Sciences of the University of Virginia, the dual-Doppler-radar system from the University of Miami's Division of Atmospheric Science, digitized radar at the National Hurricane Center, and the aircraft should give us an extremely detailed picture of atmospheric processes in, around, and under seeded and non-seeded cumulus clouds."

According to Dr. James D. McFadden, acting director of the Research Flight Facility, "Flight and seeding operations will begin July first, using our C-130 as the seeder aircraft. A second NOAA aircraft, a DC-6, will begin operations about a week later to obtain meteorological data around the base of the experimental clouds and to make flux measurements with the turbulence system developed jointly by the Research Flight Facility and NOAA's Wave Propagation Laboratory in Boulder."

According to Dr. R. Cecil Gentry, director of the National Hurricane Research Laboratory, "we will be participating with the Experimental Meteorology Laboratory in a rather extensive cloud physics program, which should give us some new insights into a hurricane's supply of water, and how and where this water and its energy are distributed through space and time within the hurricane. And we will be cooperating in cumulus studies, which are closely related to the collection of 'super-cumuli' we call a hurricane. We will be investigating the interactions between the ocean and hurricanes and we will continue to study the natural variability of hurricanes."

NOAA Associate Administrator Dr. John W. Townsend, Jr., at press conference, describes plans to relocate NOAA at Fort Lincoln in 1976. With him are D.C. Mayor Walter Washington (center) and Commerce Secretary Frederick B. Dent. (See Message From the Administrator, Page 3.)

Lippold to Seattle, Appointed Admiral

Captain Herbert R. Lippold, Jr., has been appointed Director of the Pacific Marine Center in Seattle, Wash.

The 23-year NOAA commissioned officer will assume his new post in July, at which time he will receive the rank of Rear Admiral. He succeeds Rear Admiral Norman E. Taylor, who has headed the marine center for six years, and is retiring after 30 years of federal service.

As PMC Director, Capt. Lippold will head NOAA's Pacific fleet of 15 oceanographic, hydrographic and fishery research vessels based in Seattle, San Diego, Calif., Auke Bay, Alaska, and Honolulu, Hawaii. Approximately 275 civil service and commissioned personnel are employed at the marine center.

Lippold is Commanding Officer of the NOAA Ship OCEANOGRAPHER. He began his commissioned career as a ship's watch officer in 1950 and since then has served aboard eight vessels in various positions, including commanding officer of three of them. He served also as chief of the Satellite Triangulation Division in Rockville, Md., where he payed a key role in the establishment of a worldwide satellite triangulation network. Other assignments have taken him to Honolulu, Mt. Pleasant, W. Va., the Arctic coast and to various states with geodetic field parties.

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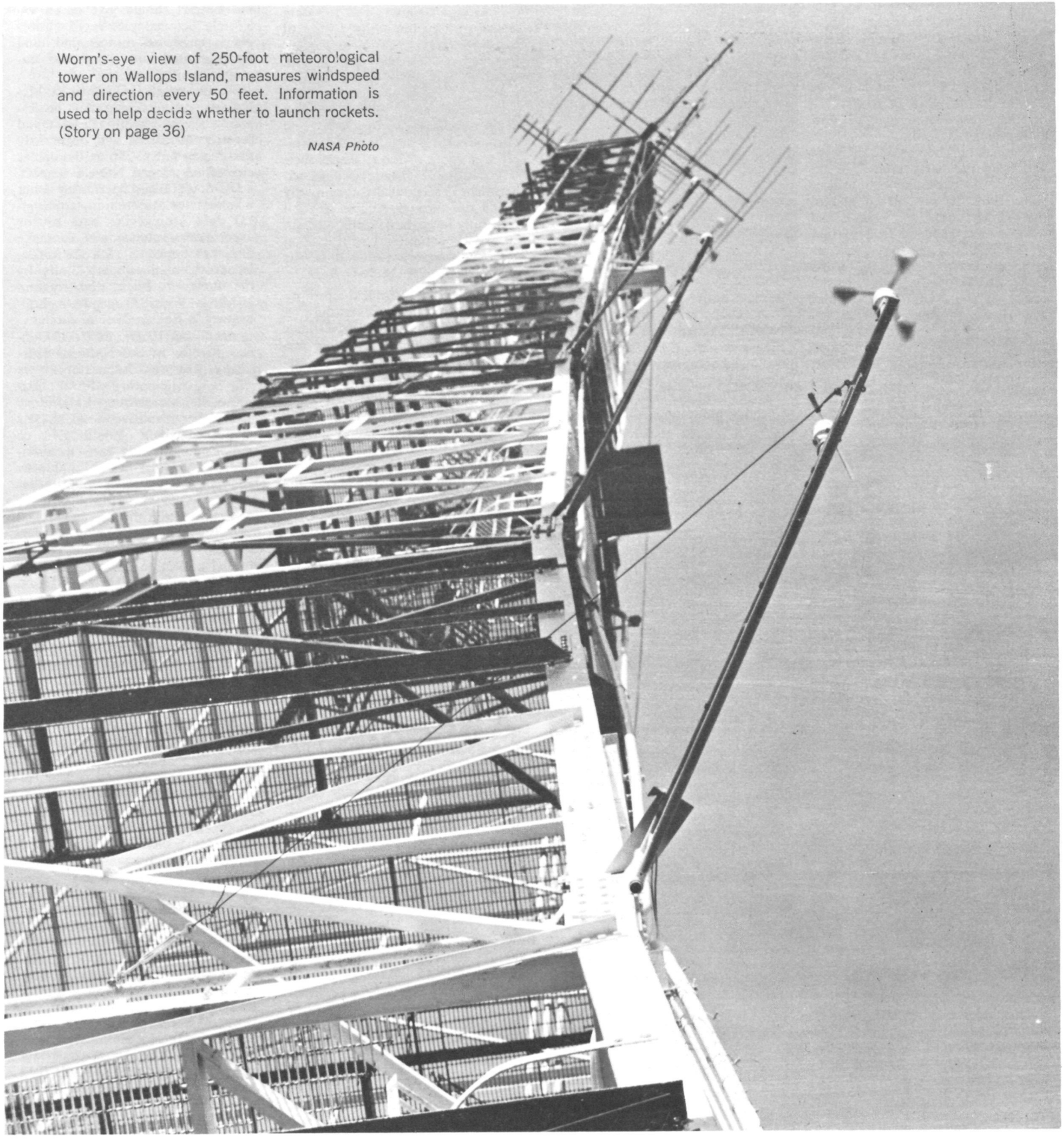

Worm's-eye view of 250-foot meteorological tower on Wallops Island, measures windspeed and direction every 50 feet. Information is used to help decide whether to launch rockets. (Story on page 36)

NASA Photo