VOLUME 4 NUMBER 2 APRIL 1974

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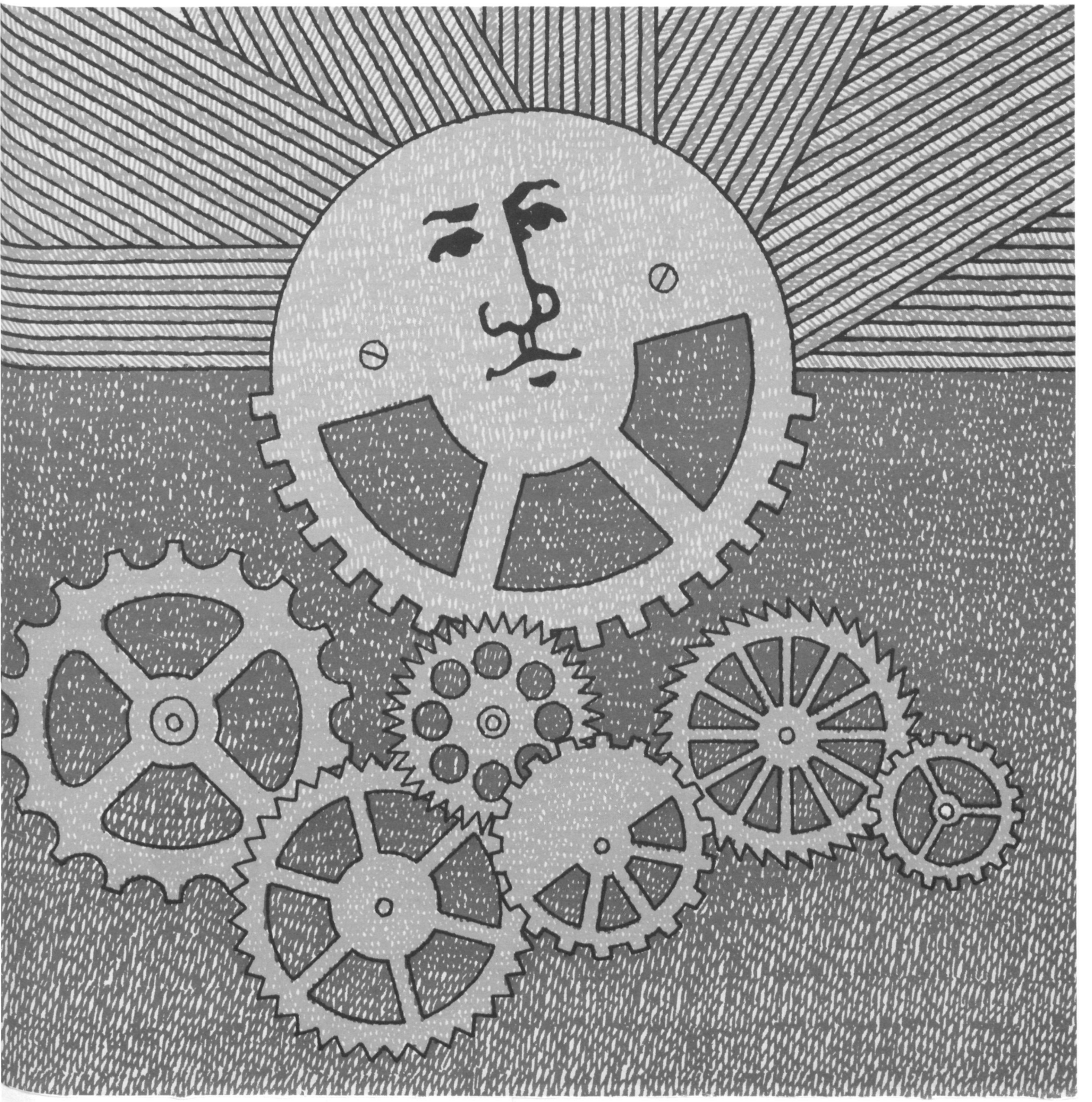
Special Section: Energy '74



National Oceanic and Atmospheric Administration

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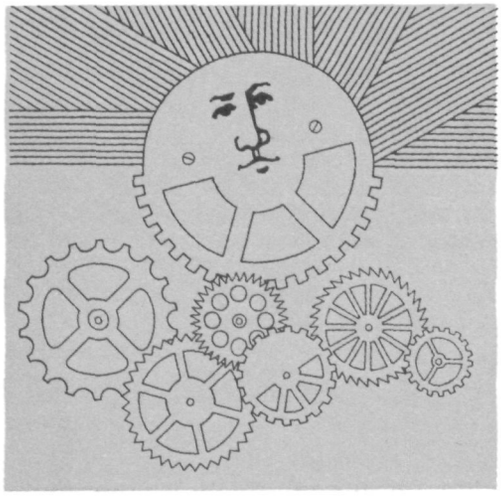

Cover design by William N. Welsh.

3. Editorial

Special Section: Energy '74

4. Turn On The Sun—*by Kurt R. Stehling*
10. NOAA Profile: More Sunshine In Your Life—*by Joan Vandiver Frisch*
14. Building To Save Energy—*by Patrick Hughes*
18. Helping Power To Be A Good Neighbor—*by Ronald Stewart*
24. Keeping Your Cool
26. Energy and the U.S. Fisherman—*by Joseph Pileggi and John A. Guinan*
30. Carpooling by Computer
32. An Energy Balance Sheet—*by John Hanna*
34. Success Story in Kansas—*by Edwin P. Weigel*
42. Tunas—Something For Almost Everybody—*by Ann Weeks*
48. Sales Up, Prices Down—*by Raymond Wilcove*
52. From Ms To Ensign—*by Ann Cook*
58. That Man May Walk Away—*by Carl Posey*
62. Sapping The Storm Wave's Fury—*by Barbara A. Firger*
66. Keeping Watch Over The Lakes—*by Donald R. Rondy*
69. Sea Fare: Fish Dishes for Energy Savings
72. NOAA/update

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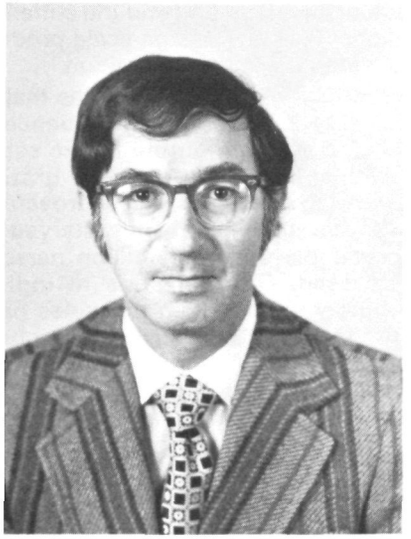
GATE-An Experiment For The Future



Dr. Edward Epstein

From June through September 1974, scientists and technicians of many nations will be probing the atmosphere and waters of the tropical Atlantic in man's most ambitious attempt to understand the underlying causes of the weather.

The tropical oceans are the source of much of the energy that drives atmospheric circulation. As a result of earlier experiments, it is known that this energy is injected into the atmosphere in pulses associated with convective clouds and cloud clusters on scales that are too small to be treated explicitly in the computer models used for predicting global weather. A prime goal of the Atlantic Tropical Experiment is to achieve sufficient understanding of the tropical cloud systems and their interaction both with the underlying ocean and larger scale tropical weather systems to include them in our models and thus produce better long-range forecasts.

This effort—the GARP Atlantic Tropical Experiment, or GATE—is unique in the annals of scientific investigation, not only in terms of its far-reaching scientific goals and comprehensive observational objectives, but also in terms of the close multinational collaboration that has been achieved in its planning stages and will be required in its execution. As lead agency for U.S. participation in the Global Atmospheric Research Program of which GATE is a subprogram, NOAA has been instrumental in assembling an impressive task force that will represent U.S. participation in GATE. For the last three years, NOAA's U.S. GATE Project Office has been engaged in coordinating the combined contributions of many Federal agencies and the scientific community. It has also played a leading role in international conferences to establish scientific objectives for GATE, and to agree upon detailed plans for the execution of the experiment by the many nations involved.

GATE is the culmination of an intensive planning period dating back to 1967, when the World Meteorological Organization and International Council of Scientific Unions agreed to sponsor jointly a program of atmospheric research called the Global Atmospheric Research Program—GARP. At the outset, the investigation of tropical weather systems had been identified as one of the most important studies to be made under GARP. Heretofore, tropical experiments have been the most difficult to mount, chiefly because the demanding observational requirements over a region consisting largely of ocean exceeded the resources of any single nation. Major contributions by thirteen nations— including the United States, Brazil, Canada, Finland, France, the Federal Republic of Germany, the German Democratic Republic, Mexico, the Netherlands, Portugal, Senegal, U.S.S.R., and the United Kingdom— now have circumvented this obstacle. With the commitment of resources that include thirty-five to forty instrumented vessels, approximately twelve research aircraft, polar-orbiting and geostationary satellites, a formidable array of sophisticated tools has been made available to accomplish the requisite field observations. Other countries in Europe, South America, and Africa will participate in GATE by pursuing intensified observational programs from land-based stations.

A Presidential directive following enactment of Senate Concurrent Resolution 67 assigned responsibility to the Secretary of Commerce to coordinate the U.S. contribution to the World Weather Program of which GARP is a part. From this authority, the National Oceanic and Atmospheric Administration was assigned responsibility for the overall data management plan, and for the operational management and implementation of GATE. In addition the U.S. Committee for GARP of the National Academy of Sciences provides scientific advice and recommendations to the Federal Government on programs and activities needed to attain GARP objectives. As a consequence, the U.S. contribution to GATE consists of resources provided by the Departments of Commerce, Defense, Transportation, and State, the National Aeronautics and Space Administration, and the National Science Foundation.

Man's insatiable desire to learn—coupled with a convergent progress in observing technology, computer capability, and physical mathematical modeling—has given form and substance to a large-scale tropical experiment. The acronym for this experiment may be symbolic because its success may literally provide a gate through which man may achieve a better understanding of his environment and in the process form new and lasting bonds of international cooperation among the participating nations.

When the fossil fuels go, how will man survive? One way may be to

Turn on the Sun

By Kurt R. Stehling

One day, the earth's fossil fuels will be exhausted. Then where will man find the energy with which to operate his planet?

Long before such a desperate situation occurs, new sources of energy must be found and a gradual transition from fossil-fuel dependence accomplished. Every alternative must be explored.

One of them may be to turn on the sun. The total solar energy flux received by the earth's surface exceeds by a factor of about *5000 our present, or even our foreseeable, needs. In one sense, the world will receive solar energy "free" forever. Even by the most rigid ecological standards, solar energy conversion is acceptable. Our own deserts, like those of other lands, have sunlight in abundance. In fact, if about 200 square miles of southern Arizona desert were covered with a reasonably efficient conversion installation, all of our Nation's present energy needs—including the boundless appetites of our automobiles—would be met.**

Why, then, are we not busily pouring solar-electric kilowatts into power distribution grids? Why are our new homes not equipped with at least rooftop hot water heaters? Why, for the most part, are solar energy power devices largely laboratory curiosities or, at most, sophisticated and costly spacecraft installations?

Because the case against solar energy seems to many to be as strong as the case for it. Nevertheless, it should be carefully examined.

Solar energy is intermittent, because of the diurnal cycle and cloud or haze obscurations of the sun. It has a low power density, which gets lower with higher latitudes. About 100 watts per square foot fall on the earth's surface in, say, the Southwest, during a cloudless day. In other sections, the average power density is much lower. This means, on the one hand, that expensive power conversion equipment is needed; on the other, that sun-intensive sites are located far from most major users, indicating the necessity for extensive transmission networks.

More formidable than the technological problems associated with solar energy appear to be the expense of putting it to work. Thousands of rooftop heaters were installed in Japan, Israel and Australia, and thousands were abandoned when a gas, oil or electric heater tank delivered the goods less expensively. (The installation cost of a simple system ranges from $300 in Japan to about $2000 here, and the installations involve such complications as flow controls for freezing weather, large insulated storage tanks and maintenance.)

While there is no doubt that solar rooftop installations could eventually save hundreds of millions of kilowatt hours of energy annually, the fact is that home builders and buyers balk at the added $2000 or more required.

Direct conversion of the solar flux, or "photons," into electric energy by photovoltaic means is perhaps the most efficient and elegant of the many schemes touted for solar energy conversion. Unhappily, it is also the most costly. The best-known and most highly developed photovoltaic device is the silicon solar cell, whose prime application has been for spacecraft, where cost is secondary to performance.

While the silicon cell converts about 15 percent of sunlight into direct current other, less efficient (but also less expensive) systems have passed laboratory tests. These systems use cadmium sulphide coatings and improved (and potentially cheaper) silicon cell batteries. They cannot approach the present average commercial utility cost of about $250 per installed kilowatt. For these systems, cost reductions attainable by improved coatings or cheaper crystal manufacture tell only part of the story: the current produced must be converted to the desired voltages, usually to alternating current; the cells of conversion equipment must be ruggedized and made weather- and tamperproof—expensive propositions all.

One must conclude that large-scale applications of solar energy for electric power or hot water production are, at best, long term prospects. A secondary application of major (and more immediate) promise is the production of hydrocarbon gaseous or liquid fuel, from agricultural waste a chemical industry raw material base, if the roles of government, industry, and agriculture can be sorted out. Other, indirect applications, such as tidal, wind, or ocean thermal-energy-difference may always remain trivial adjuncts.

There is, however, another possible application of solar energy which, if it could be accomplished, might literally change the face of the earth, and end the suffering of millions. This is the large-scale production of potable water for irrigation.

No shortage extant is as grim as that of water for agriculture. Its consequence is starvation and death on the heroic scale. The Sahelian region of Africa, its grazing lands blowing away before an encroaching Sahara, has seen thousands starved to death, and perhaps four million persons dispossessed. Drought adds to India's other burdens; U.S. grain deliveries have staved off famine. But a sustained drought in a major U.S. agricultural area would have agonizing global repercussions, and could introduce Americans to European food prices and, not inconceivably, rationing.

Some of our most productive regions are in the Southwest: New Mexico, Arizona and Southern California. There, a good but dry soil, abundant sunshine and a generally mild climate combined with intensive, sophisticated agriculture in river valley areas, have resulted in the highest annual cash crop yields per acre in the world. Lettuce, tomatoes, celery, and other vegetables, fruits, nuts and the like are produced year-round. The area is a veritable greenhouse. But all this has only been achieved by the total and unrelenting exploitation of meager water resources, in a region with an average of about 18 inches of rainfall, contrasted with New York State say, with 40". The Pecos, Rio Grande, Gila and Colorado Rivers service this area of about 200,000 square miles. They have few tributaries; the Colorado is the largest and best known and passes through the most fertile regions. Alleged U.S. diversion of its waters has been discussed between the U.S. and Mexico for a generation. Artesian and other wells help to supply the region, but their increasing proliferation and deeper drilling have drastically lowered the water table, with brackish water now evident here and there.

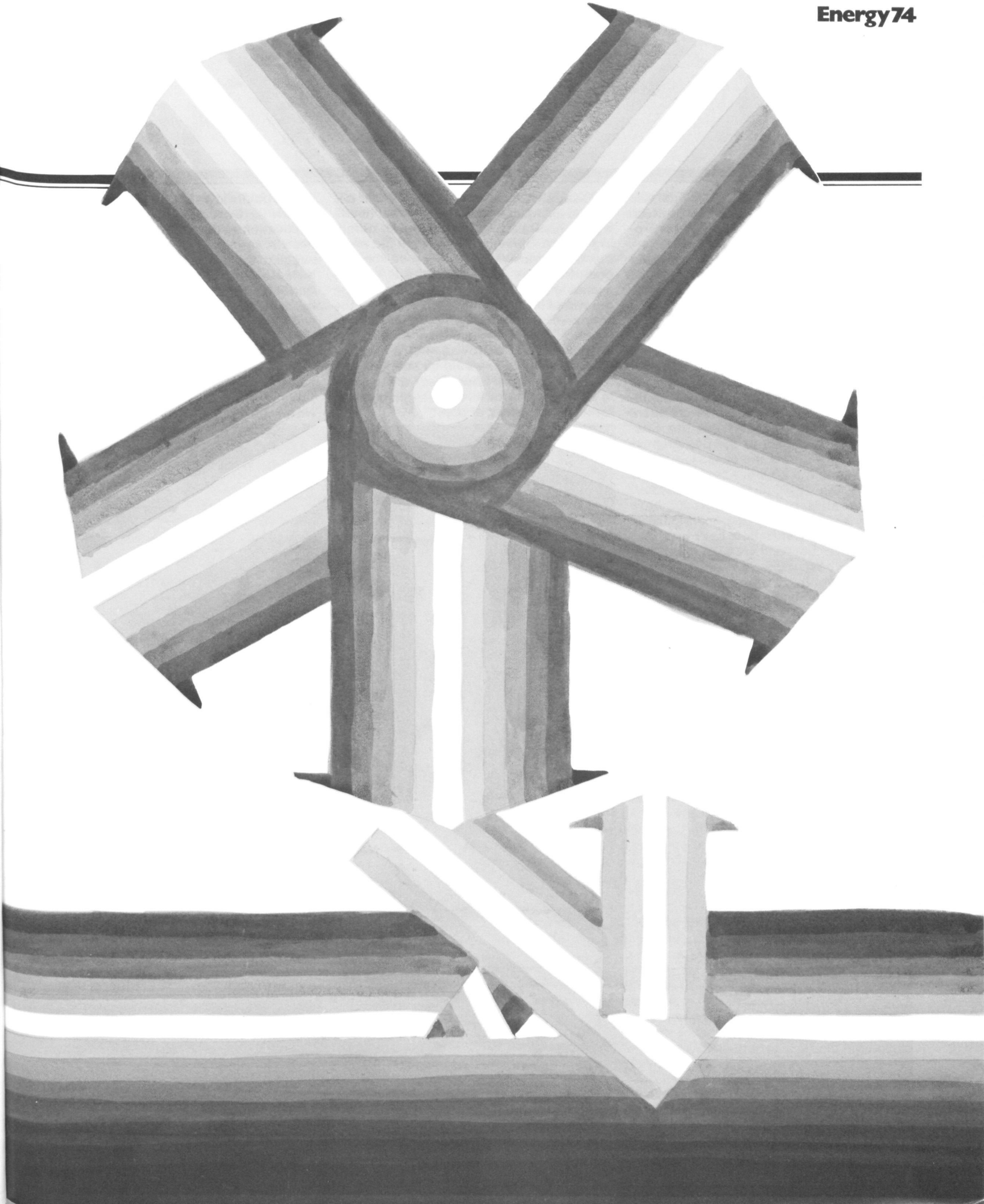
What does all this signify? The prospect that increasing population and agricultural demands are accelerating the depletion of already scarce water resources which no amount of local, regional, cheap power (if there were abundant "cheap" power) can obviate. The answer, barring a climatological miracle, is to bring the water to the regions, by canals or aqueducts.

Where can it come from? The Pacific Ocean!

Such a suggestion sounds jocular. After all mankind has fruitlessly coveted the salty ocean water since agriculture began as an important enterprise in the Euphrates Val-

*We will use energy and power interchangeably. It must be remembered that power results from useful application of energy.

**Cars could all be electric, or hydrogen electrolyzed from sea water would be used.



Energy74

ley and other parts of the Middle East and North Africa where deserts and fertile areas have been contiguous and where prolonged droughts meant catastrophes.

Until recent times, solar-evaporated ocean water falling as rain was nature's own grand scheme, and the only one available, for regularly supplying selected favoured regions. Other regions were cyclically rain-deprived, depending on the whims of the weather. And it is in these regions that the populace must consider the often nearby ocean as a tantalus; the best known U.S. example is that of Southern California. About $1 billion were spent to bring potable water from the Sacramento region down to the Los Angeles basin, which borders the ocean!

Sensitive to the anomaly of such a state of affairs, the U.S. Office of Saline Water, and other state and provate groups have studied the technology and economics of ocean water desalinization, or at least, the restoration of brackish water to fresh. Volumes have been written on techniques for desalting water. However, most of the proposed schemes have foundered on the immovable rocks of economics. The few pilot plants built in the U.S., including a sizeable one near San Diego, have had to be subsidized—and even then the fresh water produced (for human consumption, *not* agriculture) costs several times as much as indigenous or "imported" water. Most pilot plants use gas or oil fuel or electric power to distill, flash-evaporate or freeze the saline water, to extract the chemicals in solution. This is an increasingly costly business, since large amounts of fuel and power are neede. However, if solar energy could be applied, practically, in the technical and economic sense—then we may begin to think of huge solar powered water pumpers and refiners (desalinizer) located near, or "in" the ocean.

Let us describe such a possible installation which would pump and convert enough seawater per day to service 640,000 acres, or 1000 square miles of desert, or otherwise water-deficient fallow land:

—if the test area receives *some* rain—say about 15 inches a year,—then about 5,000,000 pounds of water per minute would still have to be distributed continuously, and very efficiently by shallow depth perforated plastic pipe "infusion" irrigation.

—the test area is assumed an average of 100 feet above sea level. Actually a plastic covered holding basin or reservoir would be needed. Siphoning action could overcome 30-foot high ground obstacles.

To supply 5,000,000 pounds of water per minute against an average 100 foot "head" would require a 20,000 horsepower pumping station. Since the sun sets in the evening, the pumps will stop. Here we come to one of the bugaboos of solar energy. It is available (for the solar concentrators to be described in a moment) only during the sunny—*not* hazy, rainy, foggy, or cloudy—hours! Therefore to allow for this about 50 percent extra power—i.e. a total of 30,000 horsepower would be needed. This assumes about 30 "hopeless" days a year in Southern California and a slight demand for irrigation water at night.

This points to an important consideration which burdens solar energy applications—energy storage during darkness. A variety of energy storage systems suggest themselves: flywheels, batteries, eutectic salts, high pressure steam "chests," hot water, compressed air, hydrogen/oxygen from electrolysed water, and water stored in an elevated reservoir to provide potential energy. Such hydropower systems would probably be the simplest if not the cheapest storage methods in the long run, if no real estate problems exist.

Water storage is included in the solar water pumping system—although the stored reservoir's water will not supply "off-sun" power, it does provide continuity of water flow when the pumps are idle.

Thirty thousand horsepower are equivalent to about 22,000,000 watts. If an average of about 10 watts per square foot of solar flux can be extracted by the concentrations and heat transfer pipes, then about 2,200,000 square feet—or to account for inefficiencies, system pressure drop, changing ambient temperature, and the like, about 3,000,000 square feet would be needed. This could be a patch of real estate of 1000 x 3000 feet.

The installation could be placed on the roof of a suitable building which could serve other purposes, or the assembly could be mounted just off-shore, above the water. This might raise some questions of aesthetics, and environment—because 3,000,000 square feet would be heavily shaded. More of this shortly.

The installation has three purposes:

—to draw water from the ocean;

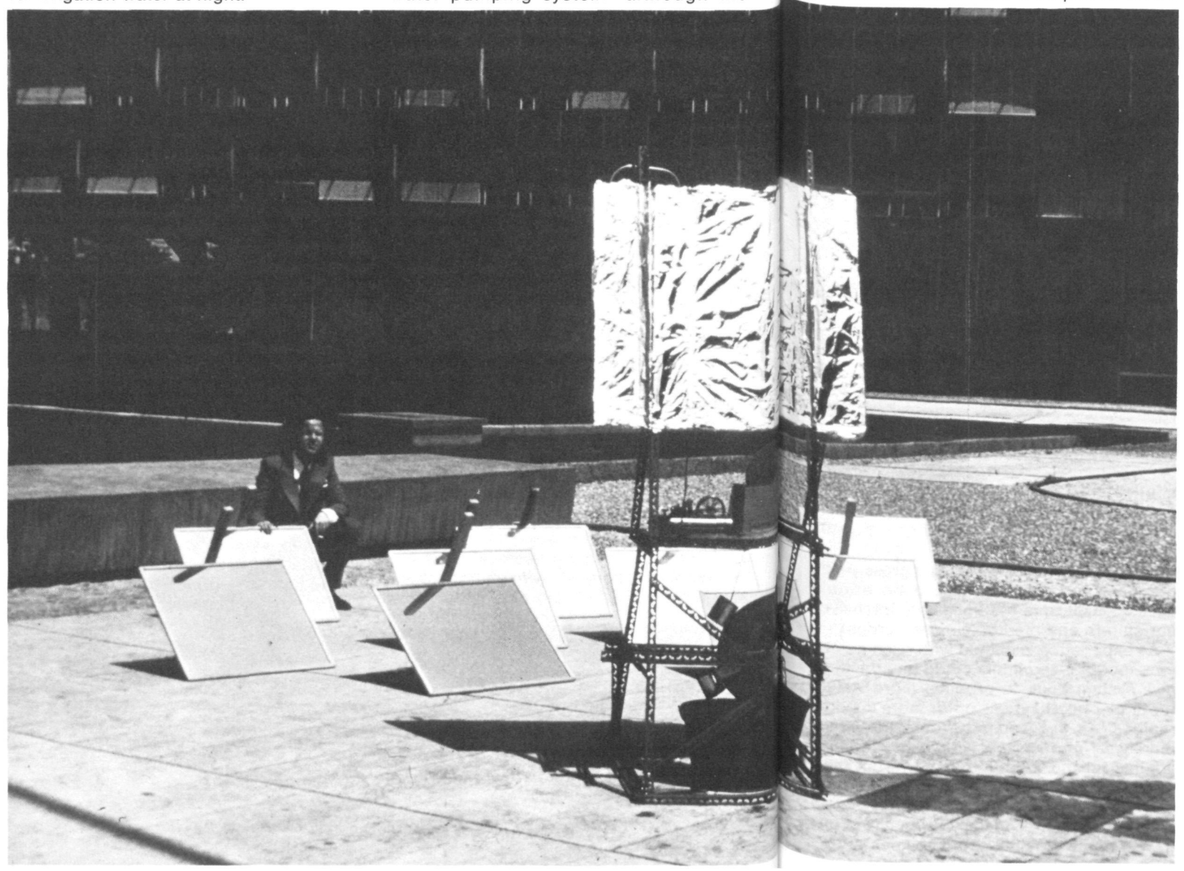
—to extract most of the chemicals;

—to condense the distilled water and pump it inland to the reservoir.

It is proposed to do all this in one integrated system as follows:

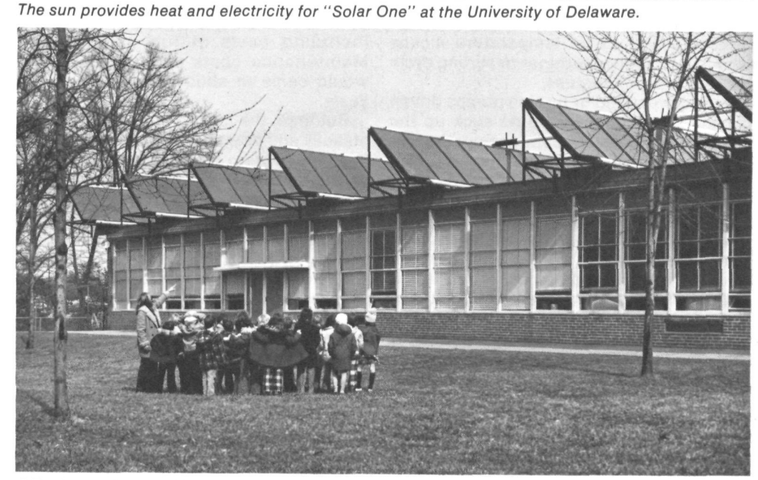
- Ten 3000 horsepower pumps, about 20 feet above the water, suck water up into about 3,000,000 feet of heat transfer pipes;

These pipes are at the focus of cylindrical "fish-eye" fresnel lenses. Such lenses act as an aggregate of total reflecting prisms and lenses. The cylindrical "fish-eye" lens with about 150 degree coverage gets around a main failing of parabolic mirror (or regular lens) concentrations. They must follow the sun across the sky, since they are ineffective when the sun is off the optical axis more than 5 degrees or so (depending on the concentrator). Therefore they must be moved to follow the sun. This is complicated and expensive.



Experimental solar reflector assemblies such as this, help scientists answer the question: "Can man harness the sun's energy practically and economically?"

The sun provides heat and electricity for "Solar One" at the University of Delaware.



A Baltimore County, Maryland, school is the Nation's first to be heated by solar energy.

Energy 74

• The lenses are mass-produced from durable plastic, possibly fluoride coated for stability and resistance to corrosion.

• The entire fixed assemblage is tilted to be approximately normal to the ecliptic.

• The 10 watts per square foot postulated earlier is the *net* power available at the pump after the not inconsiderable thermal inefficiencies within the solar heat transfer, steam vapour and engine systems are subtracted. The water could be flashed to steam, and this made to do work in a steam engine (turbine, probably) and pump, and the steam condensed by cold ocean water, at about 30 percent overall efficiency. Therefore the actual captured solar flux is about 30 watts per square foot, of which 10 watts appears as useful work.

Thirty watts per square foot is a high "capture efficiency," since a maximum of about 100 watts per square foot is evident during about 7 hours per bright day. The solar pumper, by the way, will be most efficient from about 10 a.m. to 4 p.m. and inoperative on cloudy or very hazy days. Solar focusing or concentrating systems create images of the sun and diffuse daylight creates no image.

• Temperatures of about 280°-350° fahrenheit should be attainable—a feat probably impossible with any but the most elaborate and ferociously expensive nonfocusing heat trap systems. Such a temperature is sufficient to create a continuous flow of steam or pressure of about 100 pounds per square inch. The relatively low pressure and steam temperature means specially designed turbines or stirling cycle or Rau (piston) engines.

• Reciprocating or turbine pumps driven by the steam engines would suck up the saline ocean water, condensing the engines' exhaust steam, on the way. The pumps would pump the water into the pipes and also, a tandem pump would pump the condensate inland.

• One important—and possibly serious—item must be noted for the solar pumper. This is the terrific corrosivity of salt water, especially when it's preheated in a steam-water heat exchange before entering the solar pipes. The pipes, which will take the greatest heating would have to be corrosion-proof, possibly via special ceramic linings (which, however, reduce heat transfer). The pipe itself should be a good heat conductor, such as copper, oxide-blackened on one (flat) side at the focus of the fresnel lens. The steam engine is in a fairly safe part of the circuit since the steam would carry along little of the corrosive sodium and other salts.

A scheme would have to be devised to back-flush the heat transfer pipes, perhaps at night to remove the daily accumulation of sea salts. The salt-water pumps would also require special materials and bearings, although these are already widely developed.

• The cost of the water, per gallon, delivered at the reservoir would depend very much on a variety of factors such as amortization, maintenance and research and development costs to be paid off. It could be estimated that such an installation could be constructed just offshore, in areas where aesthetic and environmental restrictions are minimal, for $20,000,000 or about $900/installed kilowatt or $650/installed horsepower.

This is about three to four times the cost of a very good large fossil fuel power plant and about twice that of existing light water nuclear plants.

How, then can our solar pumper compete? In the following fashion:

Assume a 30-year write-off period. During that time, an equivalent oil or gas plant would need about 450 billion British thermal units equivalent to oil or gas costing $10 per million British thermal units on an average for both fuels, or $4.5 million fuel costs for 30 years, assuming a conversion efficiency of about 30 percent. The fuel costs for a nuclear plant, plus maintenance and overhaul are also considerable. Fuel costs are probably $500,000 over 30 years, including costs of fuel replacement. Maintenance costs and refurbishment would come to about $2 million over 30 years.

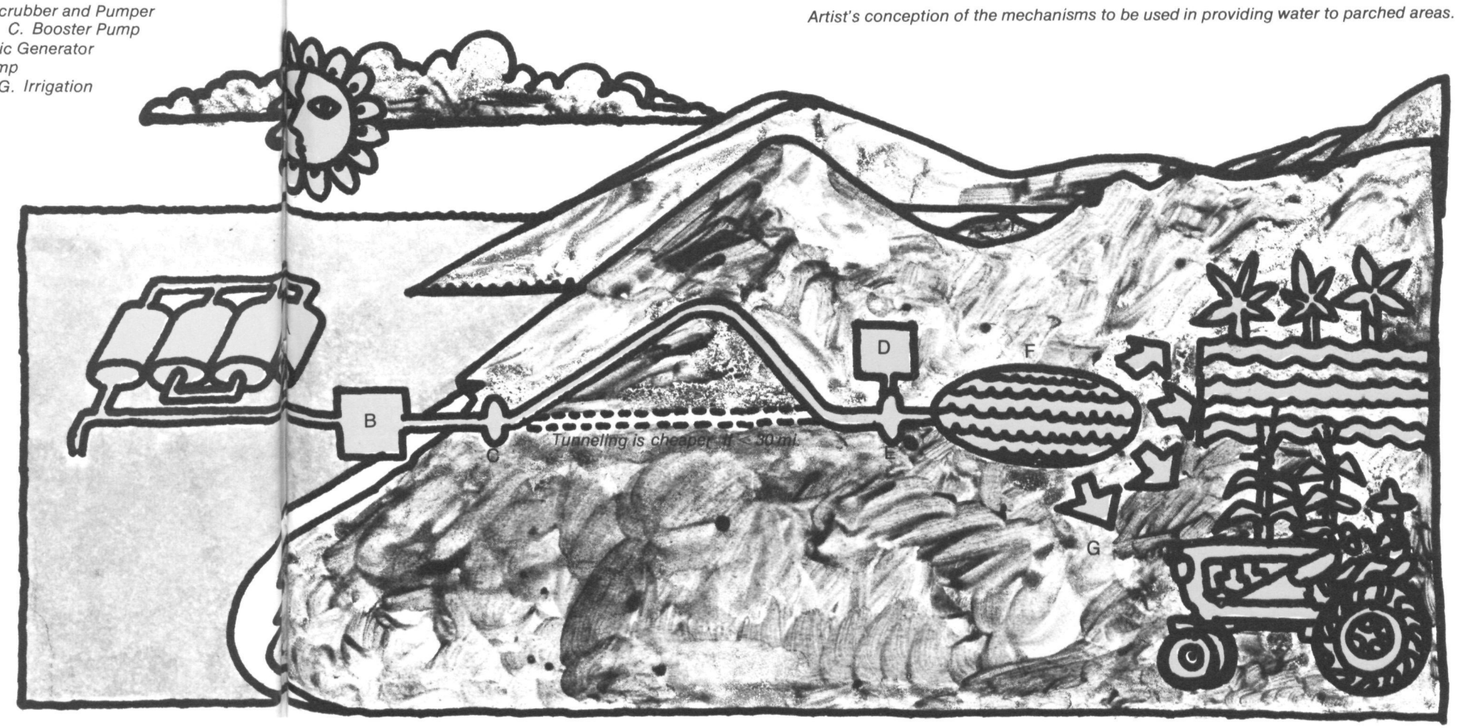
But then, the cost of such fuels is rising steadily and dramatically, leaving aside availability. During that period no fuel costs accrue to the solar pumper. Its main costs would be amortization, maintenance and replacement of elements when needed, costing about $1 million for 30 years.

One further bonus: nuclear and fossil fuel plants inevitably raise environmental and ecological considerations which, while not absent, are negligible for the solar plant.

• Assuming the 30-year amortization rate and reasonable maintenance costs such an installation should be able to deliver potable water to a reservoir for about 10 to 30 cents per 1000 gallons, well within present commercial water costs in Southern California. This cost would include the amortization of a covered aqueduct and covered reservoir, but not that of the irrigation system.

A. Collector, Scrubber and Pumper
B. Condenser C. Booster Pump
D. Solar Electric Generator
E. Booster Pump
F. Reservoir G. Irrigation

Artist's conception of the mechanisms to be used in providing water to parched areas.



• Irrigated land in the Southern California and southwest U.S. areas can produce cash crops worth about $500 to $1000 per acre. Thus for 6,000,000 acres a gross yield per year for produce would be about $300,000,000 (this assumes very intensive agriculture and marketable cash crops).

As experience is gained with such a system, modular segments could be added, a new system built, to produce more water for bigger nearby areas or for more distant regions. As the distance from the ocean increases, more power would have to be applied for the water's transport—but this power requirement would probably not exceed 20 to 30 percent of the total solar pumpers output especially if the elevation or rise of the pipeline could be kept below 1000 feet.

It is possible to visualize a 6 foot diameter cement conduit or pipe extending from the Pacific Ocean through (or over) the hills and mountains, and servicing thousands of square miles of potentially productive land in the lower-lying regions of southern California and Arizona and possibly even New Mexico.

Solar-powered booster pumps could be installed in the pipeline every 40 miles or so, especially in an up-gradient.

An interesting speculation concerns the possibility of "flushing" the Salton Sea of its saline water, as the Dutch have been doing in their Zuider Zee reclamation project. This would be a long-term endeavor—but ultimately a fresh, or slightly brackish Salton Sea would be a ready-made and natural reservoir for its region, acting as a locus for areal irrigation and industry.

Mauritania, a ranking drought sufferer, has steady and abundant sunshine, about 20 percent more per unit area than southern Arizona. A huge solar-powered ocean water pumper could revitalize the dry but nutrient-rich semi-desert soil of the eastern Amechtil region, for example. The region is almost at sea level and is generally flat. A 30,000 to 100,000 horsepower solar pumper could irrigate 1000-4000 square miles producing valuable cash crops far in excess of what the sparsely inhabited region needs. The surplus, perhaps worth $100,000,000 to $200,000,000, could serve as a vegetable and fruit basket for an increasingly urbanized and therefore food-deficient Europe.

The entire Sahelian region would achieve a measurable revitalization from the export funds resulting from an insatiable and steady market. At the same time, the populace would have an assured granary of at least most vegetables, and even certain cereals.

Where would NOAA fit in the development of solar energy? No matter what type of system evolves, intensive local and regional site surveys are vital. Detailed environmental data must be acquired so that tomorrow's solar engineer can design and orient his installation in correct relation to latitude, altitude, solar flux, cloud, fog and haze distribution and frequency, and ambient temperature, for heat transfer calculations. Without doubt, many NOAA disciplines would come into play. Solar power, if it is ever to become a viable, systematic technology, must have the benefit of all the information science and technology can offer it.

The price tag, initially, would be high for a large-scale solar energy project. The possibility of failure would have to be faced.

But, as the headlines remind us every day, the energy stakes are high, and getting higher. It's time to take a long, hard look at the sun—but shade your eyes. □

A NOAA solar energy expert wants to see

More Sunshine in Your Life

By Joan Vandiver Frisch

While Scorpio and Sagittarius, Capricorn and Aquarius seem to influence many a life, a more immediate heavenly force—the sun—has guided the career of Joseph H. Pope, a physicist with the Space Environment Laboratory, one of NOAA's Boulder, Colo.-based Environmental Research Laboratories.

Intrigued by displays of auroras from sun-caused geomagnetic storms, the Salem, Mass., native chose a career in upper atmospheric physics after visiting his father, a Public Health Service dentist in Alaska. Pope subsequently earned a B.S. degree from the University of Alaska with a major in physics and minors in mathematics and electrical engineering. A year later he returned to graduate school and obtained a M.S. degree in physics from Oregon State University at Corvallis. He has been with the Department of Commerce since 1961, first with the Central Radio Propagation Laboratory of the National Bureau of Standards, and more recently with what is now the Space Environment Laboratory.

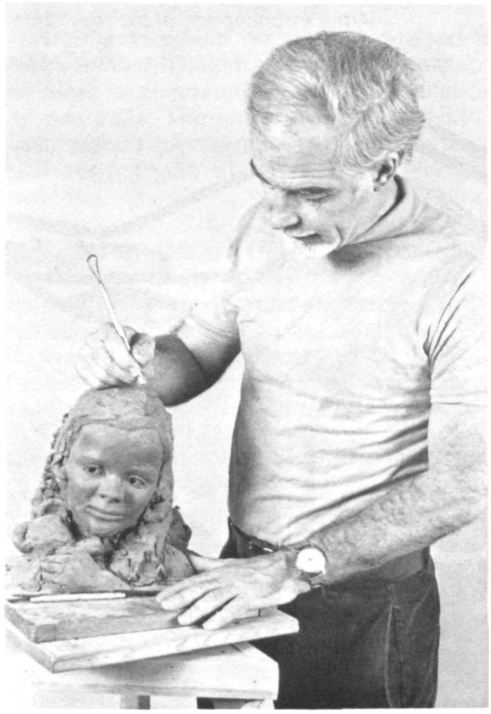
During his recent career Pope has concentrated a great portion of his research on mathematically modeling the ionosphere—the electrically charged portion of the atmosphere—whose makeup is influenced directly by solar forces. Applications of this research involve better predictions concerning communication problems with satellites and with aircraft flying the North Atlantic routes.

Prior to his joining the Department of Commerce, Pope's research at the University of Alaska's Geophysical Institute hinged upon the sun while developing an "all-sky" camera for aurora borealis photography during the International Geophysical Year.

More recently he has become concerned with how the vast radiative energy from our nearest star can be put to work at the earth's surface.

"Solar radiation is the most abundant form of energy available," he says. "But it is subject to day-night cycles, and seasonal and geographic variations, and vulnerable to various weather conditions."

Despite these obstacles the energy crunch has prompted Pope and other solar energy researchers to take the challenge seriously. As a result, the National Science Foundation is awarding contracts to researchers in government and private industry to develop solar-powered heating and air-conditioning equipment which would eventually be used anywhere in the nation with only minor changes for local climate variations. Pope currently has a proposal submitted to the National Science Foundation as part of the research program to develop a solar energy collector that is positioned by a motorized solar tracking device.



Joseph H. Pope, a physicist with NOAA's Environmental Research Laboratories, believes there is a significant relationship between the arts and sciences and can build a solar energy converter or sculpt a bust of his daughter, Josephine, with equal alacrity.

"Any workable system developed will be offered to private industry for mass production," the NOAA scientist explains. "Government installations may be among the first to use the new solar energy equipment for heating military bases and federal buildings."

According to Pope, a number of techniques can be used to implement such systems for converting sunlight to thermal, electrical, chemical, and mechanical forms of energy. All require a "collector"—a device which intercepts sunlight. These include focusing collectors—used for obtaining high temperatures of high power densities—which focus only direct sunlight, and flat-plate or non-focusing, collectors—used when concentration of sunlight is not required—which function in both direct and diffuse solar radiation.

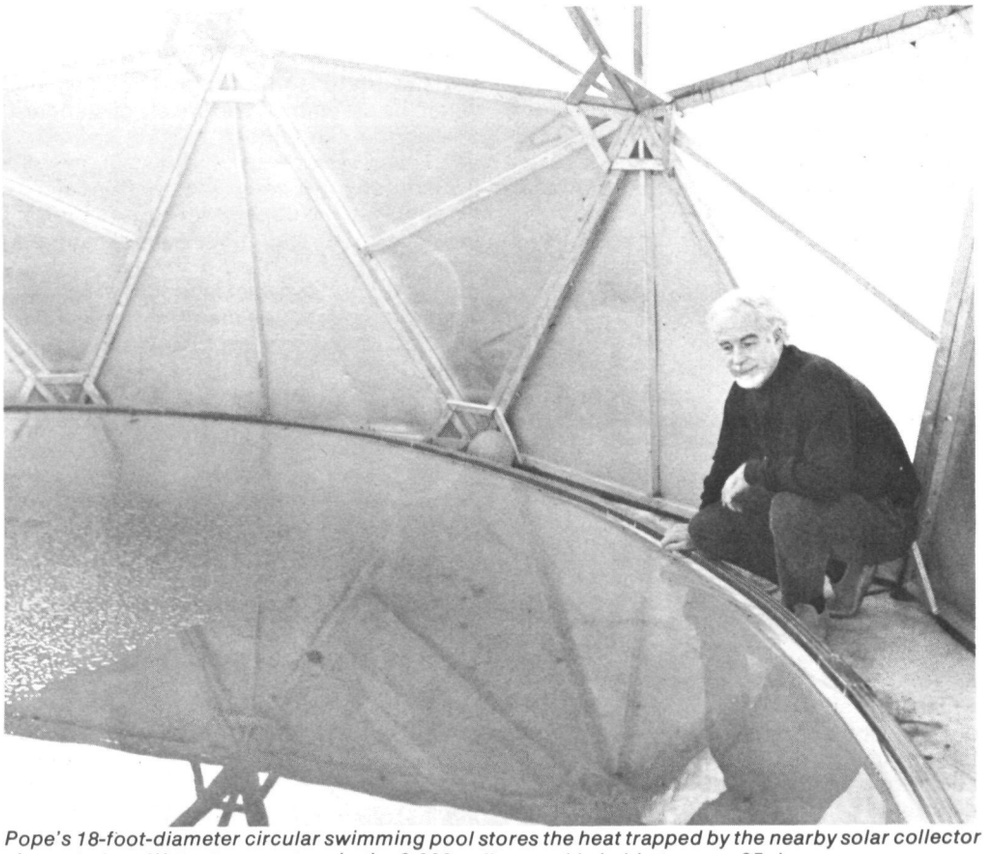
"Cost is the primary reason why more people have not installed solar collectors in their homes," Pope says. "The initial cost of installing a collector and storage tanks for the heat medium—water, rocks or chemicals—is about two and a half times the cost of a furnace. Yet residents in most parts of the United States would still have to invest in a furnace or heat by electric heat to compensate for the 30 to 40 percent of the energy requirements that the sun could not supply. While environmentalists would be opposed to larger consumption of electricity for back-up systems, conversion to solar heating may be worth the additional cost for those living in mountain areas who must rely on dwindling supplies of propane gas as their principal energy source at present."

Before making the decision to convert a home's major heating system to utilize solar energy, the NOAA physicist points out a variety of factors to take into consideration.

"First of all, there are two types of heat transfer media we can use in solar collectors—air and water," he says. "Air, in some cases, may be the more practical medium to use for space heating a home. It's free, always available, and the homeowner does not need to construct a special system of pipes nor worry about leaks. The three essential components for a space heating system consist of a solar energy collecting device, a storage receptacle and a pump or blower."

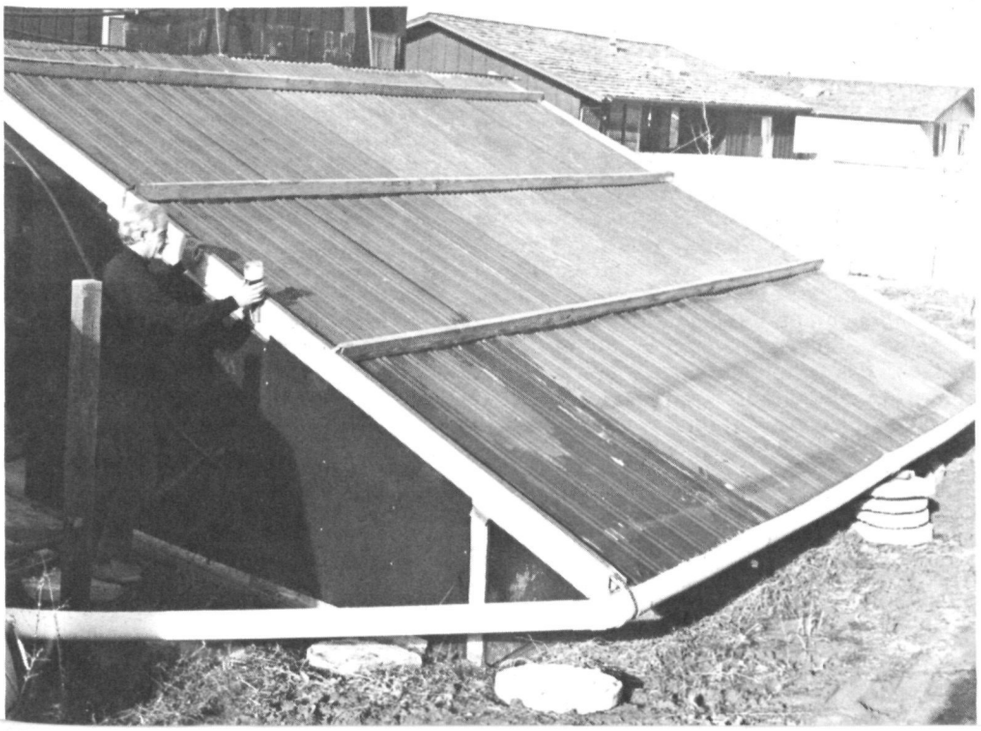
The nonfocusing solar collector used for space heating homes or buildings usually consists of a black metal surface which readily absorbs sunlight, covered with one to three panes of glass to reduce the heat loss. The glass is transparent to the incoming sunlight but is opaque to the longer wavelength radiation emitted by the hot metal. As a result, a "greenhouse" effect is created, increasing the effectiveness of the collector. Air is pumped between the glass surface and the black metal beneath it. From there the air is circulated over rocks, water, or chemicals, which absorb the heat for later use, and then recirculated back through the heating system. "The Denver-Boulder area is a particularly good location for utilizing solar energy," Pope says. "It is situated more than a mile above sea level and as a consequence, we receive about 14 percent more incident radiation than the equivalent amount of sunlight if we were living at sea level. With this contribution sunlight can satisfy approximately 60 to 70 percent of the total energy requirements of our households or buildings."

Editor's Note The Denver area has several working examples of solar space heated buildings. One of the more scientifically designed solar space heating systems in the country is a private residence in Denver. The flat-roof, one-story building,designed by George Lof, a civil engineering professor at Colorado State University in Fort Collins, contains 2,000 square feet of living space and has been functioning for 16 years. The solar collectors, consisting of two 300-square foot panels mounted on the roof, each contain 20 sections, six feet high by 30 inches wide. Each panel consists of shallow boxes in which several layers of transparent glass cover a black-coated pane. Similar to a greenhouse, the clear glass traps most of the sun's heat-bearing waves, and the black surface absorbs them, raising the underlying surface temperature to over 200 degrees Fahrenheit. During the day air flows through the panels to pick up the heat. If needed immediately, the heated air travels through conventional forced-air ducts and returns to the panels. Otherwise the heated air circulates around the base of two insulated, gravel-filled fiber-board cylinders, used normally as concrete forms, which rise from the basement to the roof of the home. The two to three-inch stones, weighing a total of 11 tons, store enough heat to warm the house during the evening hours. During extended periods of cloudiness and overnight, the additional heat is supplied by a gas furnace. Careful records indicate that about $150 a year is saved on the heating bill by using the solar energy collection system, which supplies about 30 percent of the heating required for a typical winter and all the hot water throughout the year.



Pope's 18-foot-diameter circular swimming pool stores the heat trapped by the nearby solar collector shown below. Water temperature in the 8,000 gallon pool is held at a cozy 95 degrees.

Water pumped from the swimming pool runs down the back side of this aluminum sheet, picking up collected heat before returning to the pool. Here, Pope inspects a cloud detector mechanism.



(Another innovative approach for space-heating homes is a solar energy collector, which can be purchased in kit form from a Denver-based firm. Using ordinary materials, the company has designed the kits for the do-it-yourself enthusiast. Using 4 by 4-foot sheets of half-inch plywood, 2 by 4 studs, beer cans, plastic film, glue and black paint, the firm has produced a low-cost collector kit which will employ the same heating system used in a forced-air heated home. The portable kits will not require a major overhaul of the home to allow the system to function. Air feeding into the system is pumped by a small fan at the bottom of the portable unit and emerges

heated on the other side. Since the solar collector is relatively unobtrusive, it can be installed in any wall or roof by the do-it-yourselfer. And the unit is about 60 percent efficient—almost twice the efficiency of a coal-fired power plant.

(Denver Community College's north campus building is now being designed to be heated entirely by solar energy. Plans call for the 320,000 square foot circular structure to be heated by approximately 375,000 gallons of water, which will be stored and circulated through equipment used for air-conditioning systems. In the summer, the system will be used in a conventional manner to extract heat from air and cool the building. In winter, the water will be heated by solar energy, and the heat will be extracted to warm the air.

(Another Denver building—designed for Financial Programs, Inc. by Gershon Meckler, a Wash., D.C. engineering consultant—is especially suited for solar heating and cooling because the peak occupancy is usually during daylight hours. The small office building has been in operation for almost six years. Banks of skylights, which let in sunshine to reduce the need for electric lighting, are also equipped with heat-exchanger louvers containing circulating water that carries away the heat generated by the sun's rays. The movement of the louvers are controlled by photocells which keep them pointed toward the sun. In winter, the hot water circulates through the building's radiators. In summer, the heat exchanger also cuts the building's air-conditioning needs by fifty percent).

Pope has made several cost estimates and suggestions for installing solar energy collectors on private residences.

"If the homeowner wishes to use water as the heat medium, he will need a storage tank or swimming pool which will hold at least 3,000 gallons of water, rocks or chemicals—for a minimum cost for the total system of $1,000 to $3,000," Pope says. "Disadvantages of the water system are that one must be careful not to freeze the water which could damage the pump and the plumbing, and a system of pipes must be installed."

To test the effectiveness of his own specially designed collector, Pope has heated his indoor, 8,000-gallon swimming pool to a cozy 95 degrees Fahrenheit for the past three years, solely by the sun's rays.

The NOAA physicist used a commercially manufactured, circular swimming pool measuring 18 feet in diameter by 4 feet deep for his storage cylinder. To construct the flat-plate collector for heating the water, he assembled two sheets of standard corrugated aluminum roofing material, each measuring 18 by 20 feet. Sandwiched horizontally between the two sheets of aluminum at the uppermost edge of the collector is a one half-inch diameter copper tube with holes drilled at two and a half-inch intervals. As water is pumped from the swimming pool by a one-third horsepower pump, it sprays upward through the perforations in the copper tubing on to the back side of the upper sheet. The sun heats the water as it flows between the aluminum surfaces, the top one of which is painted with flat black enamel, to absorb the sun's rays. As the heated water flows between the sheets of aluminum, it is collected at the bottom and carried by gravity through a 4-inch diameter plastic pipe back to the swimming pool. A cloud detector automatically shuts the pump off when a cloud passes overhead so that no heat loss will occur.

"The pool loses about four degrees at night but gains about ten degrees during the daytime," he says. "Not too much surface evaporation occurs because a green marine fiberglas geodesic dome covers the pool. Overall temperature gain during the daytime depends on the amount of sunshine. On particularly warm days, I turn off the pump when the pool temperature reaches 95 degrees. My solar collector is inclined in a southerly direction at a 20-degree angle and is attached to the south side of our home. The flat-plate peaks out at 30,000 kilowatts—equivalent to three hundred-100-watt light bulbs—during the afternoon sun maximum in summer."

The Boulder scientist has completed calculations to determine the amount of solar insolation for the city's latitude and altitude as a function of the sun's declination angle. His results comparing a one meter square plane positioned horizontal to the earth's surface, positioned perpendicular to the sun at noontime, and positioned perpendicular to the sun at all times by a motorized tracking mechanism suggests that the latter device may be worth the extra cost because of the increase in total energy obtainable.

Pope's scientific knowledge about the effects of the sun has earned him some interesting assignments. Since 1970 he has been a scientific monitor in the Special Foreign Currency program with India, which administers foreign currency obtained by the United States government from the sale of agricultural products, primarily wheat. As a scientific monitor for NOAA-funded projects, the ERL scientist has made two inspection trips to India, including visits and lectures to numerous Indian universities and research organizations.

While studying a group of phenomena known collectively as micropulsations, Pope was involved in collecting data from a widely spaced network of stations. As a result, he has installed micropulsation stations in Kiruna, Sweden; Kingston, Jamaica; and College, Alaska. Later he participated in an expedition to Iceland to obtain very low frequency emission observations simultaneously with high altitude rocket measurements of precipitating charged particles.

Yet Pope also finds time to learn more about his fine arts avocation.

Pursuing an interest in drawing which he's held since high school, the Boulder scientist has taken a number of university courses in drawing, painting, and sculpture during the past 15 years. An accomplished artist, he has cast figures in aluminum, casting stone, and fired clay brick. At present he is completing a bust of his daughter, Josephine. He also participates in an informal drawing group at the University of Colorado.

"Although one may suppose that studies in the arts may have little to do with a scientific career, there is a significant relationship between the two," he explains. "Both require a high degree of creativity and innovation."

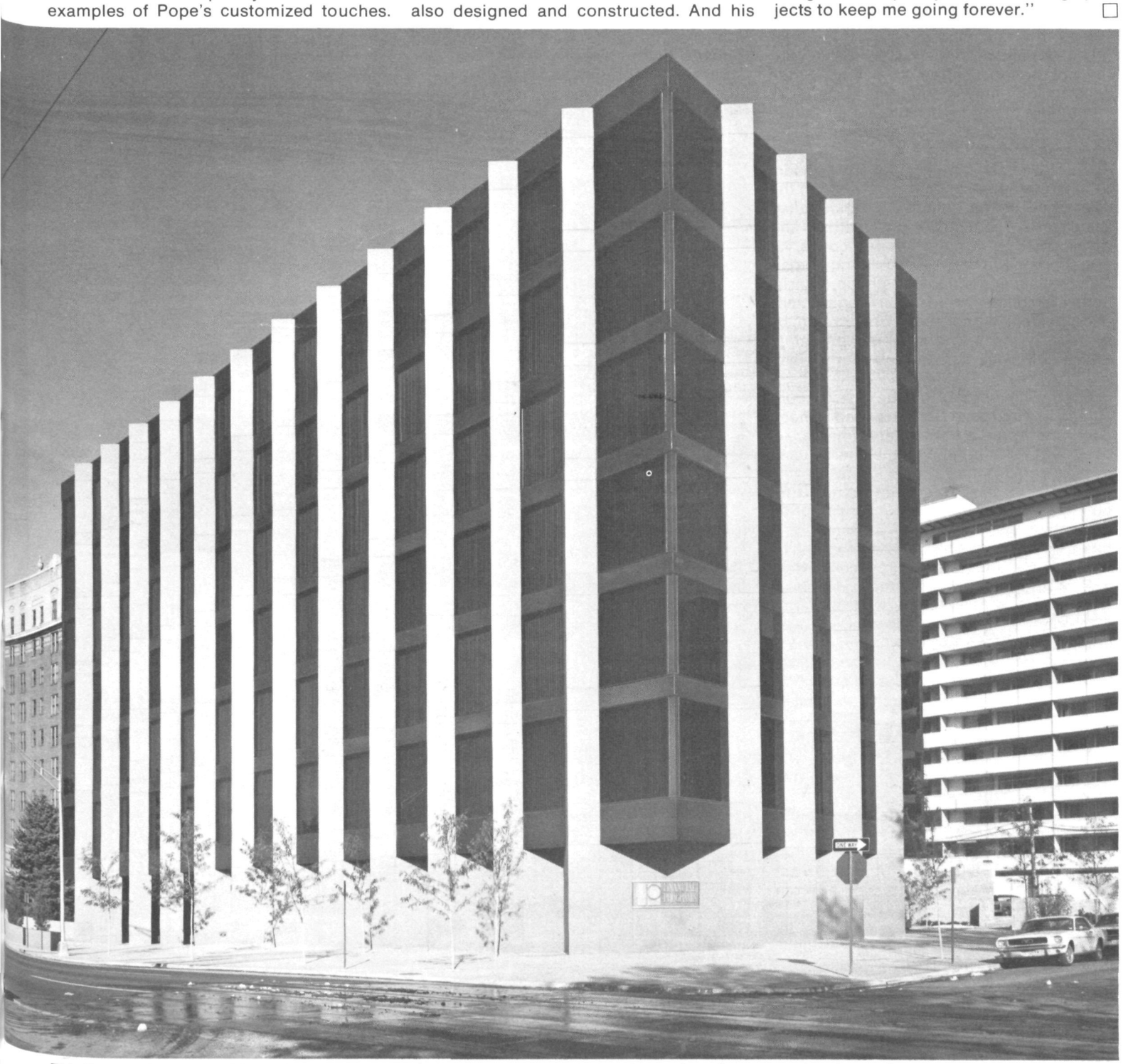
To further illustrate Pope's energetic passion for pursuing new and untried horizons, he is currently reconstructing a harp made during the early part of the nineteenth century. To accomplish the task, the NOAA scientist researched the physics of musical instruments and appropriate literature pertaining to harp design and construction in libraries as far away as the University of California at Berkeley and the Library of Congress in Washington, D. C.

"If I ever get the harp together, my next

project will be to learn to play it," Pope says.

The ERL scientist and his family live near Boulder in a contemporary home filled with examples of Pope's customized touches. Banks of stovepipe lights he designed flood his wife Nancy's kitchen counter and bedroom vanity. His daughter's room contains a customized double walnut dresser he also designed and constructed. And his paintings and sculptures complement the surroundings.

"I'll never lack ideas for tackling something new," Pope says. "I have enough projects to keep me going forever." □



This Denver, Colorado, office building has successfully used a built-in solar heating and cooling system for almost six years.

Building to Save Energy

By Patrick Hughes

According to an article in *House Beautiful back in 1949, Henry Wright, an architect,* reduced summer solar heating in a small house he was designing by 89 percent simply by rotating the floor plan to take advantage of the fact that, contrary to popular belief, in summer the west side of a building, not the south side, is the hot one. Since solar heating may account for as much as 75 percent of the load on home air conditioning systems this is an excellent way to conserve energy.

Unfortunately, Mr. Wright's efforts seem to have been the exception rather than the rule. Most of the buildings in the United States are woefully designed, sited, and constructed in terms of energy conservation. *To date, we have been building primarily* to satisfy economic or esthetic criteria, and have compensated for environmentally poor design, siting, and construction by brute-force heating and air conditioning. We can no longer afford such energy wasting practices.

About *one third* of all the energy consumed in the United States is used to heat, cool, and operate homes, apartments, offices, and other buildings (the energy used in their construction brings the total to 40 percent). It has been estimated that building-associated energy consumption could be cut by up to 40 percent if our buildings were designed, sited, and built by applying climatic data to minimize undesirable environmental effects and to maximize the impact of beneficial environmental elements. The climatic data needed to accomplish this are available from the Environmental Data Service's National Climatic Center in Asheville, N.C., the custodian of U.S. weather records which date back to colonial days.

Our forefathers built to take maximum advantage of the climate. The result was the small-windowed, low-ceilinged cottage of New England; the airy, balconied mansion of the South, and the patioed, adobe ranch house of the Southwest. Unfortunately, we have since tended to substitute modern construction techniques and new building materials for climatic common sense.

A recent national survey, for example, disclosed that over 27 million single-family *homes built before 1950 and still in use* have little or no insulation. In addition, only 2 percent of the surveyed homes built since 1950 have the 6 inches of insulation over the ceiling and 3 inches in the walls considered necessary in the northern United States. The Federal Housing Administration has already upgraded insulation standards for homes it insures, and estimates this change alone will cut home heating losses by 35 percent.

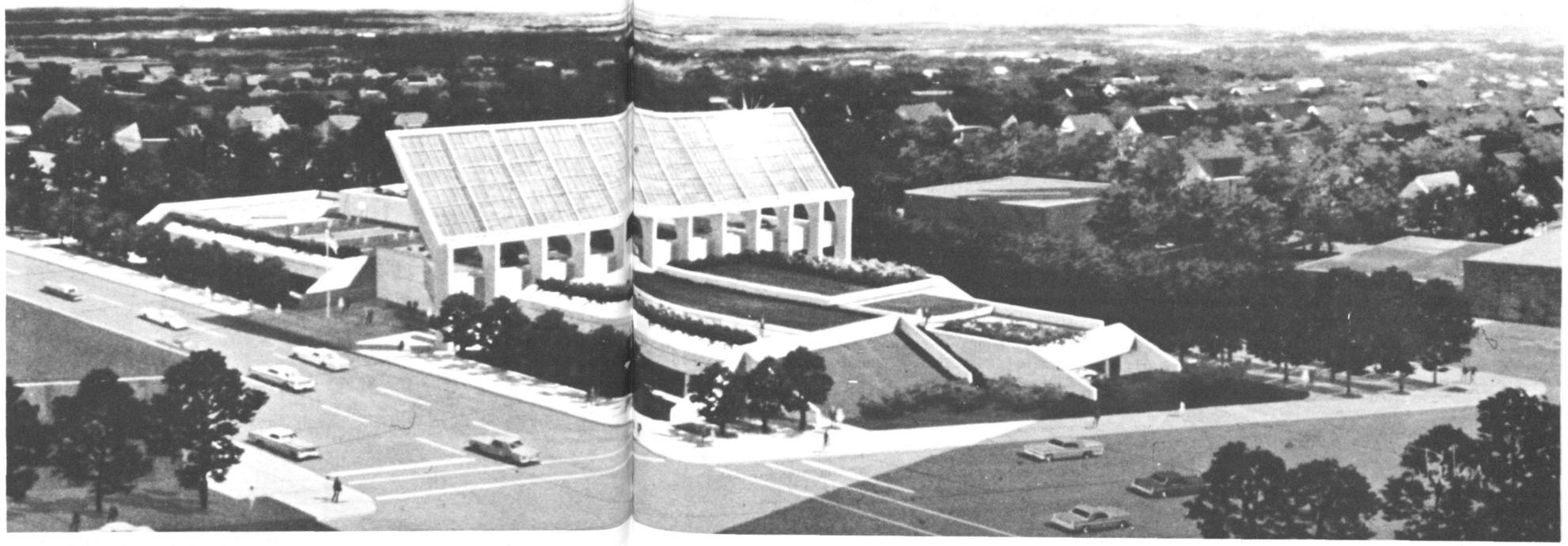
Similarly, too many of our office buildings are, to quote New York architect Richard Stein, "glass-skinned heat percolators." They admit and trap the searing heat of the summer sun and pass manmade heat outdoors in winter. Yet glass walls or windows, properly used, can make a major contribution to energy conservation throughout the year.

The majority of Americans live in sections of the country where the winters are quite cold, and the summers often too hot. As an example, consider the Midwest, where the temperature ranges from about 110 degrees Fahrenheit in summer to about 25 below zero in winter. Eskimos have colder weather and Arabs hotter, but neither have to consider both extremes in their building plans.

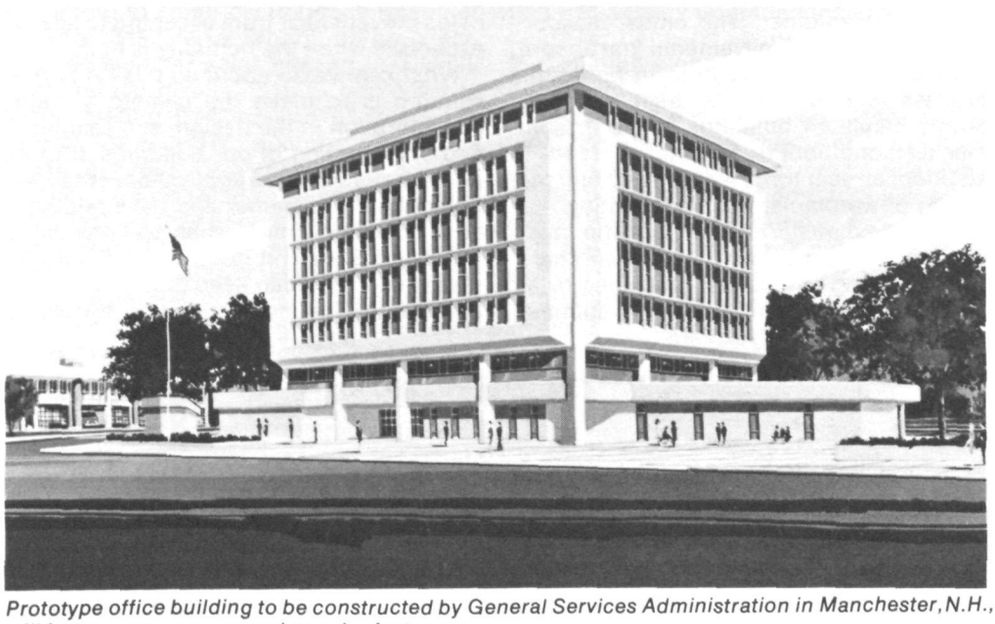
Since most people seem to feel comfortable when the temperature is around 70 *degrees, Midwest buildings must cope with* outside temperatures ranging from 40 degrees too hot to 95 degrees too cold. The fact that high temperatures cause more discomfort than low ones must also be considered—not to mention the humidity; more energy is used to air condition commercial buildings than to heat them.

A related climatic consideration is the fact that our cities are hotter than the surrounding "green" suburbs, day and night, winter and summer. The cities' masonry walls and concrete pavements first absorb, then reradiate the sun's heat. In winter this process is reinforced by heat lost from poorly insulated buildings, while in summer air conditioners add their burden. In addition, *all year long, waste heat from factories*, powerplants, building lighting systems, car exhausts, and myriad other manmade heat sources contribute their share. These heating effects are intensified by air pollution which, particularly in summer, helps prevent heat from escaping to space, especially when the humidity is high.

What can we do about all this? A partial solution is to make the climate a major consideration in the design, site selection, and construction of our buildings. If roofs and exterior walls are light-colored they will reflect heat in summer and have relatively little effect in winter, when well-insulated roofs and walls and double or even triple-glazed windows can keep the cold out and the heat in. The most insulation should be



Proposed Federal Office Building for Saginaw, Mich., still in design stages, would use huge solar collector, otherwise save energy, employ many recycled materials.



Prototype office building to be constructed by General Services Administration in Manchester, N.H., will incorporate energy-saving solar features.

used in the walls that bear the brunt of winter's coldest winds, which usually blow from a northerly direction.

When a "norther" hits Texas, the local expression is that there "ain't nothing but a barbed wire fence between us and the North Pole." Where possible, we must put something between to deflect the wind —trees or a windscreen or outbuildings for a home, older office buildings for a new commercial tower. In addition, buildings should be designed (streamlined) so that they present as little surface as possible to prevailing winter winds.

Buildings should be designed and sited to take maximum advantage of sunshine. In the United States, the noonday sun is 45 degrees lower in the sky in midwinter than in midsummer, thus winter sunlight penetrates much deeper into a room or office, while summer sunlight is relatively easy to cut off with roof overhangs, awnings, or other overhead barriers. Also, there is almost a 60 degree difference in the direction of both the rising and setting sun in summer and winter, and a 120 degree difference in the arc of the sun's travel. In summer the sun rises roughly in the northeast, travels through south, and sets in the northwest. In winter it rises in the southeast quadrant and sets in the southwest. As a result, the only windows which let in much sunshine in winter are those that face south. In summer, however, the late afternoon sun strikes the west window more squarely than the noonday sun hits the south window—and at a time when temperatures are the day's highest.

Strictly from an energy conservation viewpoint, the only good window is a south window, and the colder the winters, the more window areas (multiple-layered) should be concentrated on the south side of a building. Conversely, the hotter the summers, the smaller the west windows should be.

In summer a north window gets several hours of sunshine in the morning and evening, while all day long, even in cloudy weather, it transmits a lot of indirect heat reflected from clouds and haze (sky glare). (In the humid eastern United States every window is a source of heat from sky glare, even when in the shade, and should be shielded from the sky.) In winter, a north window never gets any sun and very little glare. It simply passes heat to the outdoors.

An east window is a little better, since the summer sun comes in only during the morning, but it too is not much help in the winter.

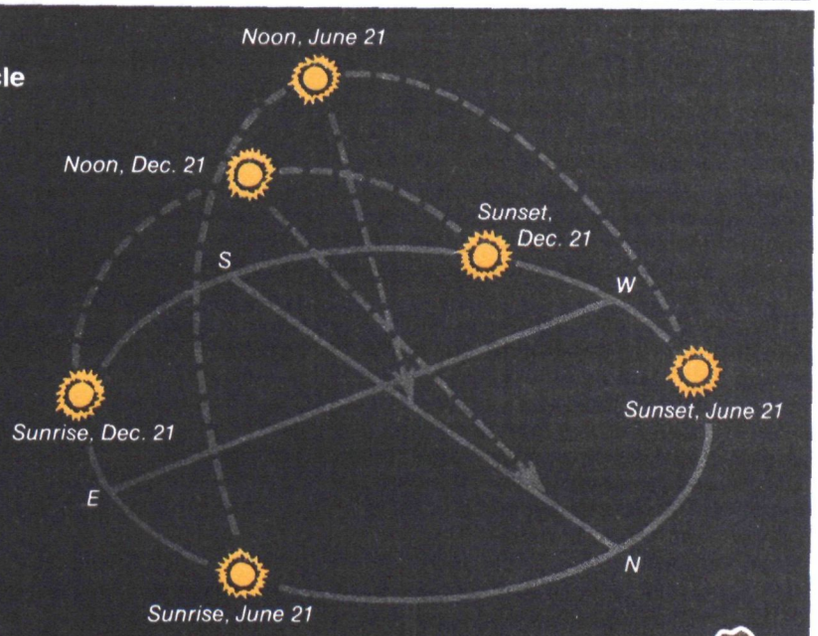
A south window is best. Curtained at night and on cold, cloudy days, it picks up more heat in winter then it loses, saving heating fuel. In summer, it does get direct sunshine at midday, but the sun is high in the sky and sunlight can be kept out of the room by an overhanging roof, awning, porch, or balcony. In all but the coldest, cloudiest sections of the United States, multiple-glass south windows will save fuel.

While large south windows will almost always reduce winter fuel consumption, they do increase the size of the heating plant needed for cold, cloudy weather, when heat escapes through the glass (although this loss can be mitigated by draperies). Also the bigger the south window, the more quick-acting the heating plant should be to most efficiently conserve fuel. Fortunately, in most of the United States extremely cold weather is usually accompanied by clear, sunny skies, and in the long run the added cost of a bigger, quick-response heating plant will be more than compensated for by the extra sunlight admitted.

The U.S. Government, the nation's largest user of office space, is currently designing new Federal buildings to incorporate some of these and other climate-related energy conservation ideas. The General Services Administration will begin work this spring on a 6.5 million dollar prototype office building in Manchester, N.H. The 7-story building will feature double-pane windows covered by fins that let sunlight enter in winter, but exclude it in summer. The north wall will have no windows at all, while a solar collector on the roof will provide the energy for more than 70 percent of the winter heating for three floors and 90 percent of the energy needed to cool them in summer. All-in-all, the building is designed and will be sited to maximize the benefits of the sun and wind conditions prevalent in that part of New England. Overall GSA expects to use 30 to 40 percent less energy in this building than is needed in a similar, conventional office building.

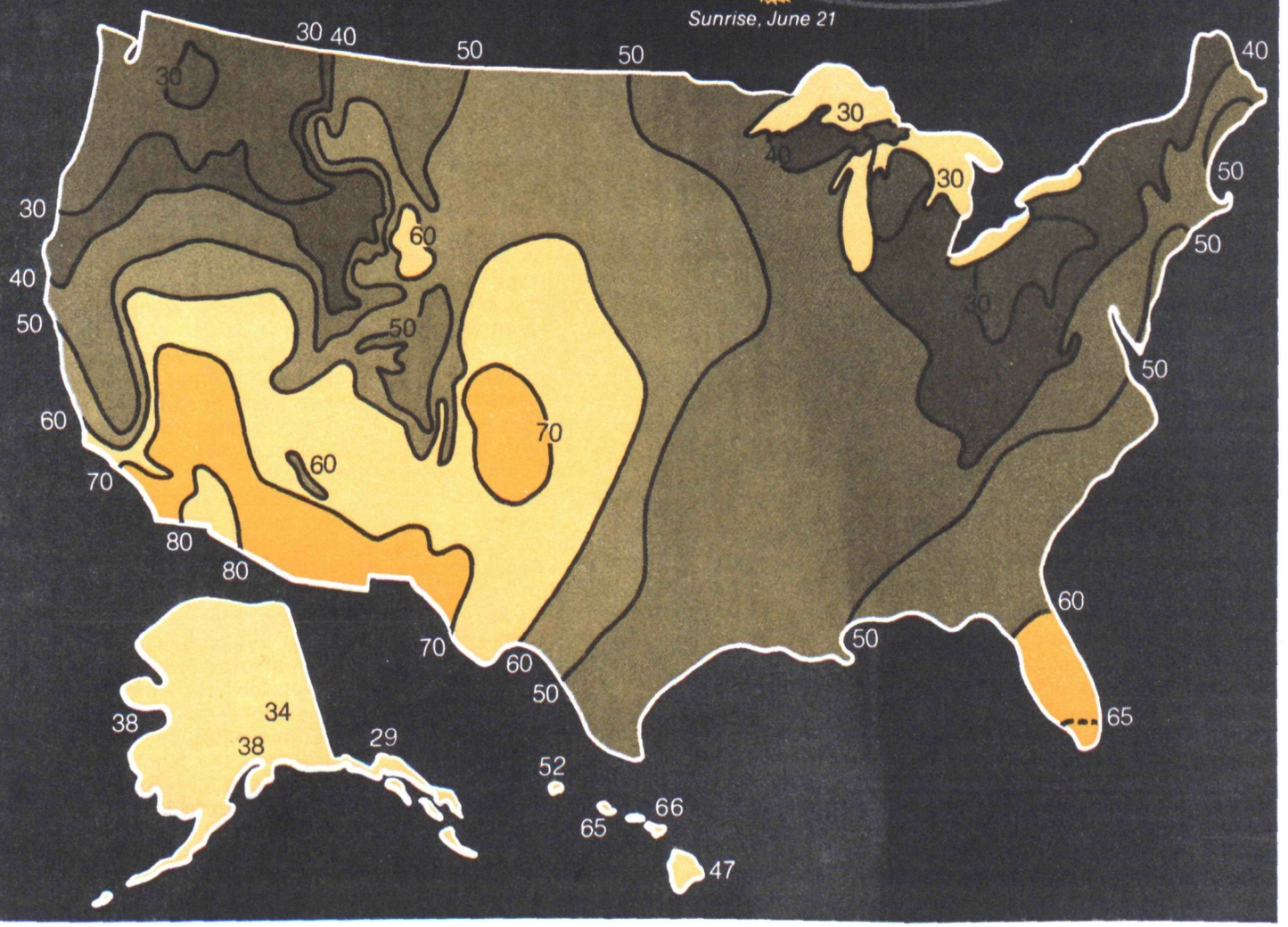
In the home-building field, Richard J. Boushka, president of the Vickers Energy Corp. of Chicago, has predicted that by 1985 solar-powered heating and cooling systems will be standard equipment in one out of every ten new homes built in the United States. Backup, conventional energy sources will be used on cloudy days. The degree to which the homeowner will have to rely on the backup system will depend directly upon the climate of the community in which he lives and how well his home is designed, sited, and constructed to derive the maximum energy benefits from the local environment. □

Seasonal Solar Cycle



Possible Sunshine

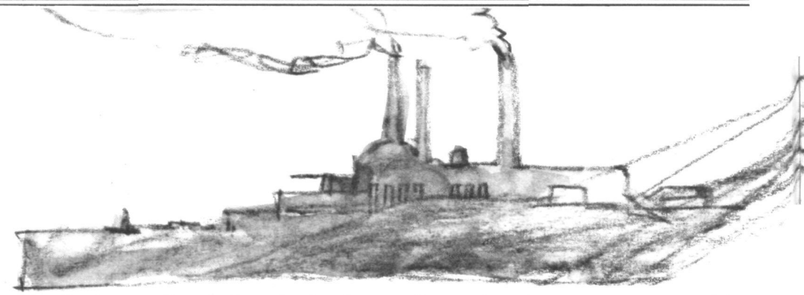
Average percentage of possible sunshine in January. Allowing for such critical considerations as building design, insulation, and materials used, it has been suggested that the sun must shine at least 40 percent of the time in winter for a south window to admit enough sunlight to compensate for the heat lost during cloudy weather.



Using fresh approaches, science is

Helping Power to Be a Good Neighbor

By Ronald Stewart



Along the southern Lake Ontario shoreline there exists a corridor that has become well known for the siting of electricity generating facilities. About 100 miles long, this corridor contains—in operation, under construction, or in the planning stages—power plants with a total generating capacity of 10,000 megawatts of electricity, more than enough to supply the needs of the largest city in the world.

Recognizing the problems that this concentration of generating power might create, individual scientists at several universities, late in the 1960's, undertook individual studies of thermal discharge, lake current characteristics, and related topics.

Today, as a result of a concatenation of concerns about energy, about the environment, and about coastal zone planning, and because of the foresight of NOAA and the New York State Sea Grant staffs, these individual projects and others have been joined into the Lake Ontario Power Plant Siting Team (LOPPST). The goal of this multiuniversity, multidisciplinary effort is to provide information that will permit new power plants to be sited and constructed in ways that will provide the least harm to the environment, the best application of multiple-use concepts, and the optimum possibility for productive use of thermal effluents.

Initially focusing just on the physical characteristics of power plant siting, the New York Sea Grant team has branched out to include biology, law, sociology, economics, political science, and engineering. It has also branched out from its university roots to include among its advisors and cooperating institutions regional power corporations, firms with interests in power plant siting and gasification, and numerous agencies of the State of New York.

Industry cooperation was evident from the beginning when at a Coastal Zone Management Conference one utility offered Sea Grant complete access to all its data. By spring and summer of last year a series of meetings were underway with Rochester Gas & Electric and others, which is leading toward protection of valuable Lake Ontario wetlands near the new Rochester Gas & Electric Sterling site. Although many details remain to be worked out, the firm has been most generous in offering to buy some of these wetlands outright, to permit them to be protected. The firm is also offering unique recreational possibilities to the public on approximately 1200 acres of the Sterling site.

The concept of multiple use of utility-owned lands has been developed in several directions—physical, social, legal—in a LOPPST project of Steven Wilson of Empire State College and Jon T. Scott and the author from SUNY Albany. Physically, the lands that form the buffer zones around an electricity generating facility and transmission lines often involve hundreds of acres. These lands lend themselves to recreational usage with a minimum of development, and small portions of them may be dedicated to intensive use.

Because the present population of New York State generates an estimated 86 million hours of leisure time daily—a figure that may grow to 125 million hours by 1990— use of utility-owned lands for recreational purposes becomes increasingly important.

Saratoga Associates (Saratoga Springs, New York), under contract to the Rochester Gas & Electric Corporation, is developing recreational concepts for a proposed site, and both firms have been cooperative in allowing the Sea Grant staff access to their plans.

Recreational facilities are already associated with pumped storage hydroelectric facilities such as Blenheim-Gilboa (New York) and Northfield Mountain (Massachusetts). Millstone nuclear power station (Connecticut) juts out into Long Island Sound and has a recreation area that includes an information center, picnic facilities, and a swimming area off the beach adjacent to the plant.

Our studies show two separate and frequently conflicting kinds of recreation needs. On the one hand is the backpacker, wilderness camper, naturalist hiker, cross-country skier, snowshoer, and canoeist. On the other is the developed-site camper, water skier, snowmobiler, downhill skier, and off-road vehicle user. With respect to trail related activities, these two camps are not compatible—a multiple trail-use system must separate the cross-country skier from the snowmobiler.

Not only are these two camps often in conflict, but the ORRV user is often in conflict with any non-ORRV user. Many utility rights-of-way are currently being used as trails for hiking, horseback riding, and other outdoor activities, with or without the sanction of the utility concerned. These corridors could be used as trail links in a larger scale trail system, or could be employed for a series of miniparks for other rapidly expanding activities. Golf, for example, is a family sport that may be adapted to fit the land types available. It may also generate considerable profits.

Cross-country skiing is an ideal use of buffer zones and corridors. It is quiet, requires little or no preparation of the landscape and does not use natural resources such as gas and oil.

Turning large areas into tree farms, too, calls for a minimum of disturbance to the land. It also permits joint use of property for picnicking and other family activities.

The public utilities are coming under increasing pressure—on the one hand, to build carefully or not at all, and on the other hand to increase capacity at a rapid rate, using "dirtier" fuels if necessary. In taking the initiative to plan the uses of their lands, they are also showing increasing recognition of the need to cooperate with local communities so as to minimize the deleterious effects of siting.

*Ronald Stewart is Assistant Director at the Atmospheric Sciences Research Center, State University of New York at Albany, and Coordinator of the New York State Sea Grant Lake Ontario Power Plant Siting Team.

As part of its project, therefore, the LOPPST carried out a study of the attitudes of the public and officials toward multiple-use concepts and other power-related ideas. At the same time Rochester Gas & Electric contracted (with Harvey Research Organization) for a survey of resident attitudes near the proposed site.

Within the LOPPST survey, 95 percent of respondents believed that the United States had an energy problem (fall 1973). Americans were almost universally depicted as being wasteful of energy. More than 90 percent believed that the thermal discharge from power plants would be suited to space heating and industrial uses. Two-thirds thought that the thermal discharge should be used to improve recreational possibilities. A strong inclination for careful land use planning developed. Agriculture and non-motorized trail uses were the first choice for transmission corridors.

Having developed ideas for use of these lands, and with evidence that the public was in favor and had some ideas of its own to contribute, New York Sea Grant confronted a legal question: Who is liable?

The investigators found that the legal principles concerning recreational use of utility rights-of-way are nebulous at best. New York State's Office of Parks & Recreation seems to believe that opening utility rights-of-way to recreational use is unlikely to impose any additional liability upon the utilities. On the other hand, the Public Service Commission has doubts and contends that the utilities are not in the business of recreational management. Robert Reis of the University of Buffalo Law Faculty lends support to these doubts, believing that utilities are equally liable as any other corporation for injuries on their property. Therefore, permitting the public to use their land increases their liability since utilities are then inviting them, he believes.

A survey of the eight New York utility companies, conducted by Michael Geiss of the Office of Parks & Recreation,found that liability problems and concerns for adjacent landowners were the major obstacles preventing increased recreational use of rights-of-way. Since the utility companies do not feel that liability to recreational users is one of their public responsibilities, it appears that a firm legal base easing them of the liability risk is needed.

Robert Reis states that a remedy to the liability question is fairly simple—legislation should be introduced exempting property's use for public recreation from current liability standards. Rosemary Nichols of the State University of New York at Albany points out, on the other hand, that a means must remain for courts to award damages, or else the courts might disregard a statutory charge which placed both the utility companies and the park manager within the dimensions of New York's General Obligations Law (which is intended to protect the "passive" landowner who either mildly encourages or does not expressly forbid the use of his land for recreational purposes). At present, plans for recreational uses of transmission corridors, such as those for the "Southern Tier Line," are dealing with this question on a case by case basis.

When the southern coast of Lake Ontario was identified by the New York Public Service Commission and a number of firms as a prime area for the construction of new thermal electric power generation and transmission capacity, conservationists and citizens' groups raised the question of whether this capacity is necessary and, if so, why on Lake Ontario's generally unspoiled shoreline and coastal zone. Proponents pointed out that this shoreline offers the least expensive sites, and abundant cooling water. Power must be available at low prices, they argued, to support New York State's long term economic growth. An economic fact-finding study was therefore incorporated in the LOPPS project by Robert Crow, to help decision-makers determine whether the environmental costs of locating thermal electric power plants in the coastal zone are worth the economic benefits.

Robert Ford and Vaughn Blankenship of SUNY Buffalo undertook an intensive review of the criteria and procedures used for evaluating electric power generating sites. It encompassed New York's Public Service Law, United States Atomic Energy Commission requirements for safety analysis reports and environmental impact statements, proposed site development plans of the New York Atomic & Space Development Authority, of United States Congressional hearings, articles in professional journals, and statements by trade associations and environmental groups. The LOPPST analysts discovered that while a great deal of site evaluation information exists, it is not organized in a way that is likely to lead to an intelligible answer to the basic question of whether a particular area is the best place to put an electric power generating plant.

To remedy this problem, New York Sea Grant is developing a system of "evaluation accounts" whose structure is based on the national income accounting system of the United States government and whose content is based on the literature search conducted thus far. To aid in the economic analysis and demand forecasting, the team began testing models of residential, commercial and industrial demand for electrical energy. Although the precise mathematical forms are still being developed, the major determining variables are expected to be personal income, industrial production, the price of electricity, and prices of substitute sources of energy.

Early in the project, the team discovered that it was extremely difficult to obtain data on the use of electrical energy for areas that coincide with political subdivisions—the basis for all other socio-economic data. Fortunately, the Niagara Mohawk Power Corporation has made available information that is roughly coincident with the Buffalo Standard Metropolitan Statistical Area, a region whose economy has already been studied in some depth. These studies included both electrical energy demand and variations according to different pricing policies, and the impact of pricing policies on the economic growth of the region.

In addition to studying the *effects* of siting, Ford and Blankenship together with Robert Crow, undertook a study of the *process* of siting according to state policy. Because the State Legislature changed these policies in 1972, a before-and-after analysis was made possible.

The work involved extensive interviews with individuals in the Department of Environmental Conservation, New York State Public Service Commission, the Governor's office and Legislature, as well as with representatives of utility companies, various environmental groups and the New York State Power Pool.

Prior to the late 1960's, the team found, state involvement in the location and siting of power plants was minimal. There

was no centralized review process for considering the many factors involved. Decisions were based primarily on the private calculations of utility companies and piecemeal interactions with local and state authorities as the need for specific licenses, permits, zoning allowances, and rulings on rates or issues of bonds arose.

Present studies have delineated: (a) how decisions about power plant siting in the state were made prior to the passage of the power siting bill of 1972; (b) how various state agencies were gradually reorganized in the late 1960's in order to implement emerging, new state and federal requirements in this area; (c) the political, economic and technical considerations surrounding the passage of the new state law; and (d) the emerging linkages between the utility companies, environmental groups and various state agencies. Recent court decisions, such as *Calvert's Cliffs,* indicate a significant role of the judiciary in power plant siting. In recognition of this fact, the team is completing a trend analysis of court decisions as they affect power plant siting. This constitutes the necessary groundwork for an assessment of the effectiveness of new state policies with respect to power plant siting.

Highly important to the team's work, and among the first to be undertaken, have been the physical studies of thermal pollution-discharge-enrichment. Answers were sought to such basically simple questions as how large is the discharge, how is it dissipated, what kinds of biological effects are evident, and how can plants meet New York State thermal criteria? Information is being developed on these questions through infra-red surveys, micro-meteorological measurements and biological sampling.

Ulrich H. Czapski of SUNY-Albany has studied the physics of these plumes. The determining factor in assessing the influence of a given outfall on the atmospheric environment is the total input of heat and water vapor into the atmosphere from the identifiable thermal plume. This plume comprises a limited "hot spot" of some acres of extent in a lake of generally lower temperature. Earlier investigations have shown that the "hot spot" is likely to lose much more heat than a comparative surface of even temperature.

The dominant mode of heat loss of a warm water surface will almost always be by evaporation. Consequently, under the proper atmospheric conditions, fog can form much more readily over or near the thermal plume of a power station if the weather is generally stable. Under unstable conditions, however, where the heat transfer is strongly enhanced over the plume, the moist air formed over the "hot spot" is carried upward much faster. In this case it is reasonable to assume that cloud formation and possibly thunderstorm formation is enhanced by the increased water vapor and heat input, just as it is over cities and natural heat sources of similar extent.

Team member Eugene Chermack of the State University College at Oswego, in a related effort, has taken data for four major power plants over the past several years. His data show a general seasonal variation (winter-summer) of the strengths and areas of effluent pools from the plants, and in general he found that the effluent pool size varied directly with the plant generating capacity. However, in individual cases, he found little or no correlation between power generated or pumping rate, and the resulting pool strengths and sizes. Only minor variations in power generated and pumping rate existed among the plants observed, and the state of the natural cooling media—the lake and the atmosphere—predominated in determining the efficiency of heat dispersal.

In the light of data developed by LOPPST, it may be that the New York State guidelines for effluent pools are overly restrictive. However, the guidelines should be made more explicit in their definition of ambient or natural or undisturbed lake temperature,

Energy74

because there is great difficulty in selecting a single temperature as representing ambient when large gradients exist.

Any criteria must also be based upon potential damage to the biological system. The entrainment of planktonic organisms by once-through power plant cooling systems has been known to result in heavy mortality depending upon plant design. Yet there are indications that some compensating effects are also present which tend to restore the plankton productivity, perhaps even to enhance it under some conditions. Given these general observations, it should be possible to alter plant design to change the net effect on plankton— to increase plankton production where desired, or to decrease it where this is for some reason preferred.

Previous Sea Grant results indicate that when two plants are located sufficiently close together that their effluent plumes overlap, the depression of plankton productivity is less than what would occur if they were more widely separated. Clustering of power plants thus reduces this kind of environmental degradation, if the information is correct. This is a matter of sufficient importance in plant siting to require further study. When the Fitzpatrick power plant commences operation its plume will overlap that of the currently operating Nine Mile Point plant, thus providing an opportunity for validating the cluster theory.

A mathematical model has been developed by Donald McNaught and Madelyn Glase of SUNY Albany to simulate the mortalities of plankton due to condenser passage, as well as the stimulation of growth of plankton in thermal plumes of nuclear power plants. Initial results suggest that biological effects from condenser passage are measurable within 10 miles of a plant situated on the shores of a large lake. The model suggests that once waters that have passed through a condenser have traveled more than 10 miles, natural biological processes have accounted for the return of entrained animals to a "normal" biological community.

But if thermal discharge is a problem in some ways, it may also offer an opportunity, with its energy being channeled into usable processes. Ronald Stewart has been carrying out research in this area for several years and now Donald Price of Cornell University, part of the Sea Grant team, is looking into such uses.

As early as the fall of 1972, the need for heating fuels became critical in some areas, partly due to fuel shortages and partly due to delivery systems. This was emphasized when the first major cold wave of the season swept through the midwest. In Iowa, 500 elevators (out of 1200 operating elevators) were shut down due to a lack of fuel for drying. Tens of millions of bushels of corn filled bins and overflowed into the street as the drying process ground to a halt. The economic problem was compounded by the greater than normal moisture content in the corn and the fact that much of the corn could not be harvested due to wet fields. For elevators which switched to propane the fuel costs rose 2½ to 3 times the normal drying cost. If thermal discharges were available for drying, less fuel would be required.

Several other drying alternatives include: dehydration of vegetables and fruits; seed drying; freeze drying with its many applications to various foods; tobacco drying; and kiln drying lumber. All of these processes involve warm air drying at temperatures obtainable using heat exchange with either the condenser unit or directly from the turbine.

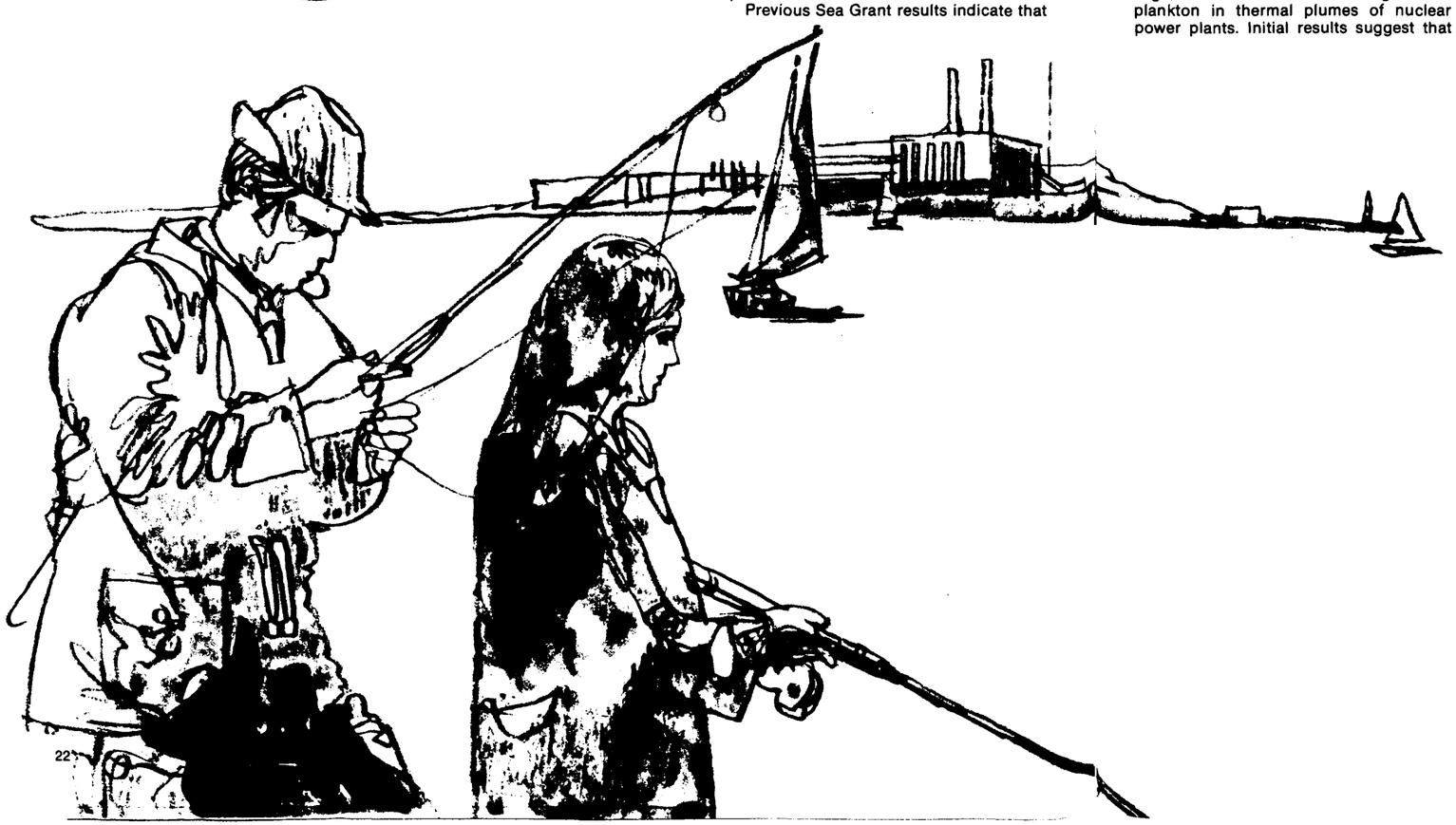
Seed drying is a process involving somewhat lower temperatures than vegetable and fruit dehydration. Grain used for feed may be dried with temperatures up to 200°F, but grain used for seed is not dried at temperatures exceeding 110°F. Seeds with an initial moisture content of from 18 to 30 percent should be dried at temperatures less than 90°F. With lower initial moisture levels, maximum drying temperatures approach 110°F. These temperatures are sustained with an airflow rate in commercial dryers of from 20 to 40 cfm/bu (cubic feet per minute per bushel). The airflow rate will remove 1.2 to 2.4 percent of moisture per hour.

Wood drying is particularly important in New York, with its many small kiln operations. Most kilns have a capacity of from 10,000 to 100,000 board feet. For example, one small kiln drying operation has six separate kilns. There are three 55,000 board feet capacity kilns and three 30,000 board feet kilns. One 300 hp boiler generates steam for all six kilns. In this operation maple, beech, and birch are dried most frequently.

The drying process itself utilizes hot air at 120° to 170°F blown through the stacked wood for a period of about 2 weeks and involving three separate temperature stages. With respect to moisture evaporation, the average initial moisture of the wood is 60 percent and the final dried product should be at 6 to 8 percent. A representative sample finds 1000 board feet of green hard maple at an initial moisture of 75 percent is reduced to 8 percent moisture with an evaporative loss of 1951 pounds.

One other aspect of "drying" has been noted at the 120 MWe dry cooling tower in Rugeley, England. The area inside the tower represents approximately two acres of dry, protected, usable space. At present the Central Electricity Generating Board uses the space for dry storage and maintenance. Should a similar facility be erected in the United States, this space would be most useful for drying purposes. It would obviate the need for an extra building, decrease total land use, and eliminate fuel bills.As dry cooling tower technology improves in Europe and the pressure increases in the United States for remote siting, dry cooling may become a necessary way of life for siting. Proper use of the heat released should be planned on at the design stage, not by retrofitting.

One of the more exciting long-term studies involves the creation of lakes using secondary effluent from sewage facilities. Jon T. Scott has been studying the possibility of siting power plants on such lakes. Near Muskegon, Michigan, 10,000 acres have been set aside for effluent lakes which will provide the irrigation waters for crops. In this way the "living filter" concept recycles wastes into a productive commodity. As biological activity is dependent upon temperature it may be possible to enhance the purification process of these waste waters by cooling the power plants and thus raising the temperature of the water. Then the issue of thermal pollution could be laid to rest as it provides a service to man. □



An assortment of helpful hints about saving energy and

Keeping Your Cool

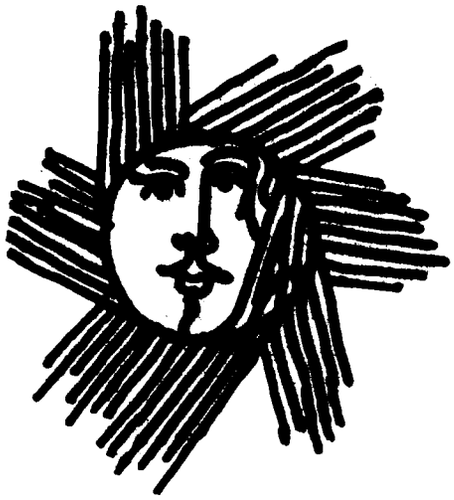
Summer sister of the familiar heating degree day, the cooling degree day statistic issued by NOAA's Environmental Data Service serves as a measure of air-conditioning requirements during the year's warmer months.

According to experts, the need for air conditioning begins to be felt when the daily maximum temperature climbs 10 or 15 degrees Fahrenheit above a daily mean temperature of 65 degrees. The cooling degree day is therefore a kind of mirror image of the heating degree day. After obtaining the daily mean by adding together the day's high and low temperatures and dividing the total by two, the base 65 is subtracted from the resulting figure to calculate the cooling degree day accumulation. For example, on a day with a maximum temperature of 82 degrees and a minimum of 60, six cooling degree days would accumulate during the 24-hour period (82 plus 60=142; 142 divided by 2=71; 71−65=6).

The greater the cooling degree day accumulation, the more energy is required to maintain indoor temperatures at a comfortable level. However, the correlation between cooling degree days and energy use is less direct than that between heating degree days and fuel consumption. In fact, there is considerable controversy among meteorologists, as well as air-conditioning engineers, as to what meteorological variables are most closely related to energy consumption by air-conditioning systems. Many experts argue that because high humidity levels make people feel more uncomfortable as temperatures rise, some measure of moisture should be included in calculating energy needs for air conditioning. Effective Temperature and the Temperature-Humidity Index have been suggested as alternative bases for calculating cooling degree days.

Effective Temperature—a concept developed in 1923 by the American Society of Heating, Refrigeration and Air Conditioning Engineers—is an index of the degree of warmth experienced by the body on exposure to different combinations of temperature, humidity, and air movement.

The Temperature-Humidity Index is a modification of Effective Temperature that takes into account temperature and dew-point (or relative humidity). In summer, relatively few people will be uncomfortable because of heat and humidity while the Temperature-Humidity Index is 70 or below, about half of the population will be



uncomfortable when the index reaches 75, and almost everyone will be uncomfortable when it reaches 80.

In addition to moisture, solar radiation and wind speed are other factors that some experts feel should be included in computations of energy needs for air conditioning.

But all agree that there is a need for a unit of measurement of the effect of weather variables on air-conditioning loads, a unit proportional to the input normally needed to operate air-conditioning systems.

Until a definitive study of the problem is conducted, NOAA's Environmental Data Service is continuing to use and publish statistics based on the simple cooling degree day calculation, employing air temperatures measured at National Weather Service and cooperating stations throughout the country. Records for the years 1941-1970 show that mean annual total cooling degree days in the United States (excluding Alaska and Hawaii) range from 4000 in extreme southeastern California, southwestern Arizona, southwest Texas, and southern Florida, to zero along the northwestern coastline.

One application of the EDS statistics is that of the Federal government's General Services Administration, which permits air conditioning in government vehicles in regions where cooling degree day accumulations average 700 or more during the year's four warmest months.

Wherever air conditioning is used, there are a number of steps—recommended by the National Bureau of Standards' Center for Building Technology—that can reduce consumption of scarce energy during the coming summer season.

Set air-conditioner thermostats higher. Raising thermostat settings from 75 degrees to 80 degrees, for example, will reduce the air-conditioning load by 15 percent or more.

Prevent excessive entry of outdoor air:

—Weatherstrip windows and doors at movable joints, and caulk cracks and openings at their frames; seal all cracks and openings in exterior walls.

—Keep windows and doors shut, and keep storm windows and doors in place during the air-conditioning season. However, a few windows should be easy to open for ventilation.

—If there is a fireplace, tightly close its damper.

—Close and seal all passages or openings between the air-conditioned space and the attic, including cracks around attic doors.

—If there is a large generation of water vapor or heat due to cooking, bathing, or washing, operate kitchen or bathroom exhaust fans, but only as long as needed. In cooking, use covered pots and low fires when possible.

Shade windows, especially from direct sun:

—Blinds and draperies reduce heat gain through windows by as much as 50 percent. Their effectiveness depends on how well they reflect solar radiation back through the window. They should be light in color and opaque. And they should be drawn when sunlight enters the rooms, especially rooms not in use at the time.

—Heat-absorbing and reflecting window glass can reduce solar heat gain through windows by 40 to 70 percent.

—External awnings, overhangs, sun screens, and trees are by far the most effective ways to reduce solar heat gain, cutting it by as much as 80 percent if properly designed. Awnings and overhangs should be designed not to trap hot air in window areas.

Insulate ceilings, walls, and ducts:

—Six inches of insulation in the top-floor ceiling will reduce heat flow downward from the sun-heated attic, just as it reduces cold air flow in winter. Increasing insulation thickness from three or four inches to six inches pays for itself in three or four years by the combined winter-summer savings.

—Outside walls should have three or four inches of good thermal insulation, but in existing houses expert technical advice is needed to avoid problems of moisture

condensation within the walls.

—Air-conditioning ducts that pass through non-cooled spaces should have at least 1½ inches of good insulation.

Limit the use of electricity, gas, and other fuels (every kilowatt of electrical energy used for illumination and appliances is converted to heat, and adds to the load on the air-conditioning system):

—Turn off lights when not in use.

—Turn off television sets, radios, and phonographs, when they are not being used. Use electric irons, hair dryers, and other appliances as briefly as possible.

—Make sure refrigerator or freezer door seals are airtight and that their condenser coils are clear for good airflow. Avoid unnecessary or prolonged door openings.

—Avoid using the cleaning feature of self-cleaning ovens at times when air-conditioning loads are heavy.

—Try to schedule electrical energy-using activities, such as washing, drying, or ironing, for early morning or late evening when heavy demands are not being made upon electrical distribution systems.

—Try to confine heavy use of cooking ranges and shower facilities to the cooler morning or evening hours. These activities set up a chain reaction of energy consumption for hot water heating and space cooling.

Cooling units

—Select the proper size, and keep the system clean and in good operating condition.

—Check filters every 30 to 60 days, and clean or change them when dirt accumulates.

—Keep condensers clean.

—Lubricate bearings and maintain the proper tension on the fan belt.

Shade the house from the sun. Trees can shield large areas of a house, keeping some solar radiation from the roof and walls. Other methods of shading include wide overhangs, porches, balconies, and other horizontal projections, and sun screens positioned according to solar angles.

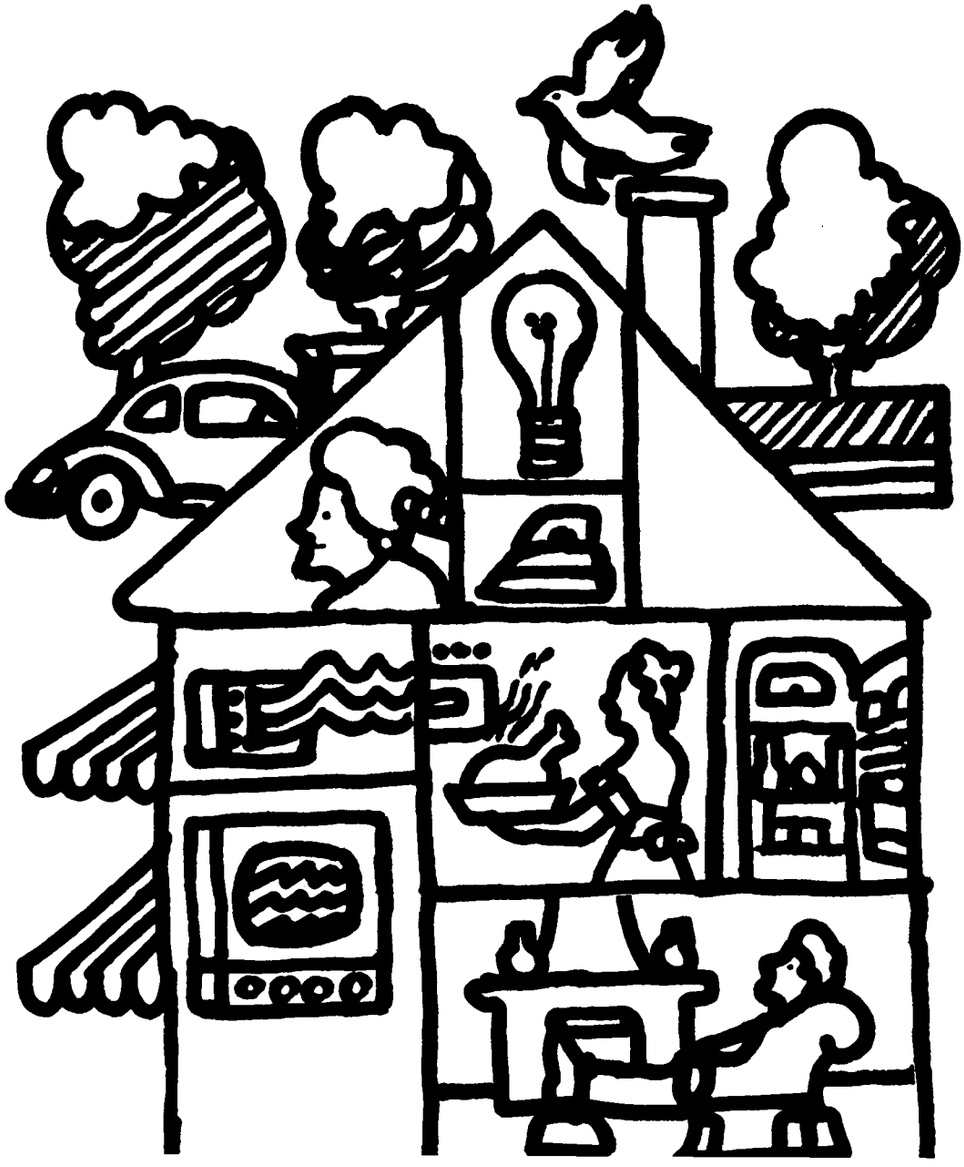
Use light-colored paints and roofing materials. The whiter and smoother a surface is, the less solar radiation energy it absorbs. A dark-colored surface can become as much as 60 degrees hotter than the air temperature. That same surface, if painted white, would heat up to only about 20 degrees above the air temperature.

Those who live in houses without air conditioning can work hand in hand with nature's daily temperature cycle to keep indoor temperatures comfortable. The daily range of outdoor temperature is between 15 and 35 degrees, with lowest air temperatures usually occurring from midnight to just before dawn.

Button up the house during the day, closing doors and windows, drawing blinds and draperies, and reducing heat generated indoors.

At night, invite the cooler air inside. Use a ventilator fan to draw in air from the coolest side of the house. Expel warm air from the upper parts of the house, either into the attic or through windows, preferably near their tops. A ventilator fan can be installed in the upper ceiling to pull air through the house and push it into the attic. Or it can be situated in the attic to ventilate that space while pulling air through an opening into the attic.

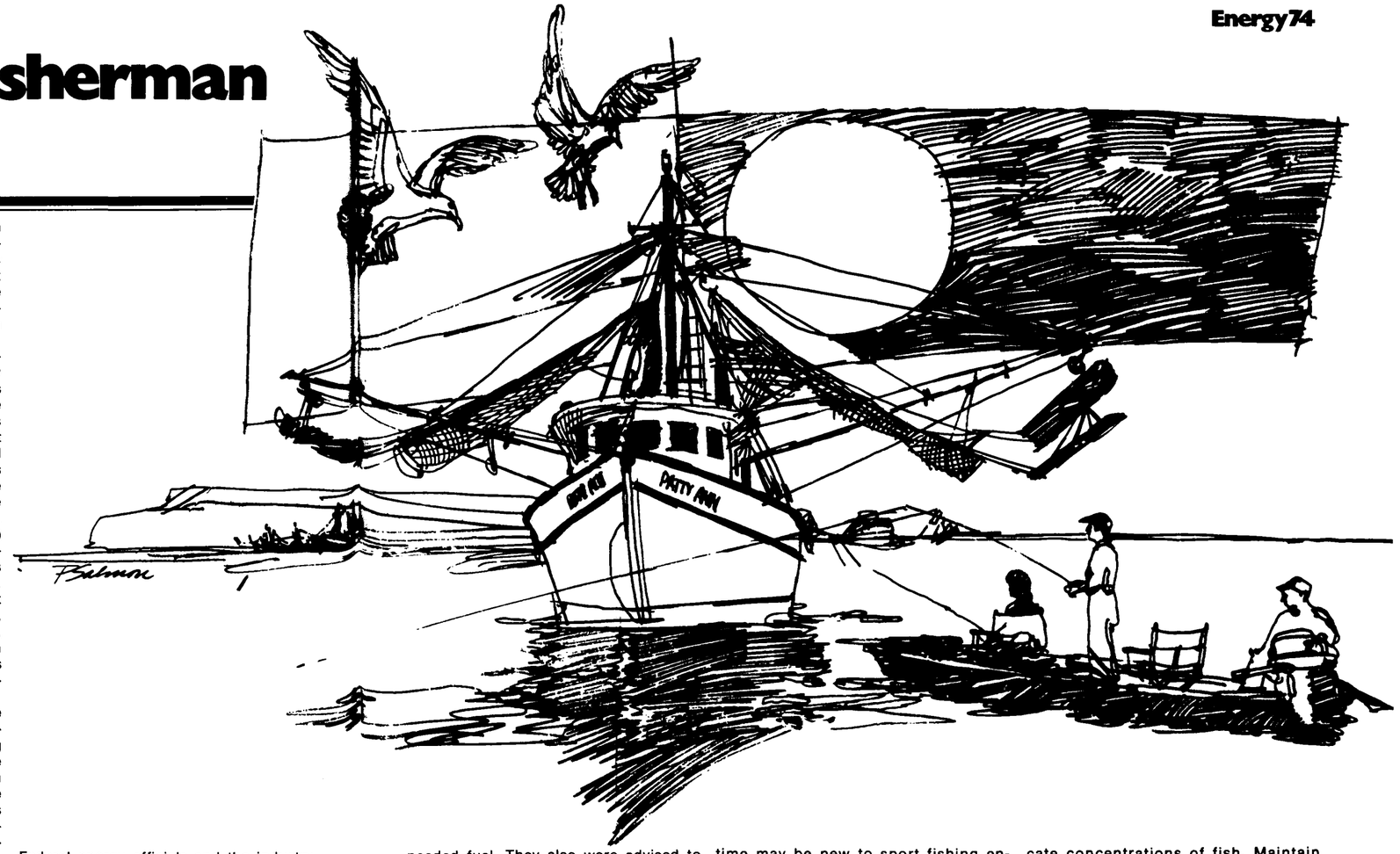
More detailed information on these summer energy-conservation measures is included in the National Bureau of Standards publication "11 Ways to Reduce Energy Consumption and Increase Comfort in Household Cooling," available from the Superintendent of Documents for 40 cents postpaid or in GPO Bookstores for 30 cents a copy. □



What's in store?

Energy and the U.S. Fisherman

By Joseph Pileggi* and John A. Guinan



Although most Americans awoke one day to find themselves suddenly faced with an energy shortage, some groups, including commercial fishermen, had been concerned with the possibility much earlier. NOAA's National Marine Fisheries Service had a specialist working on the energy situation as early as May of last year.

Not all segments of the fishing industry felt the effect of the fuel shortage as early as May. During the spring and summer of 1973, however, fuel shortages began to appear, principally in the South Atlantic and Gulf areas. Even before the voluntary petroleum allocation program came into being, fishing vessel operators were reporting that they were limited by their suppliers to the amount of fuel purchased in a given month the previous year. In many cases this caused a hardship because the amount allocated was considerably less than needed to operate under normal fishing conditions. For example, in some instances fishing in 1972 had been curtailed due to adverse weather conditions such as Hurricane Agnes which had such an impact on Chesapeake Bay fishing. Later in 1973, reports began to filter in that the West Coast tuna fishing vessels were encountering difficulties in buying fuel at California and Central American ports. In the meantime, fuel prices were rising steadily throughout this country and others, adding to the mounting costs of operating fishing vessels.

Since May 1973 there have been several Federal allocation programs for fuel. In the early versions of the program the commercial fishing industry was not accorded the same priority as agriculture, despite the fact that fishery products make an important contribution to the Nation's protein supply. In November, NMFS, working with fishing industry leaders, obtained a priority rating for commercial fisheries similar to that for agriculture. This meant that fishing vessel operators would be able to buy the fuel they needed in order to continue normal activities. This, of course, did not guarantee them fuel, and in the early stages of this phase of the program the priority was not always clear to the fuel supplier.

On November 27, 1973, President Nixon signed the Emergency Petroleum Allocation Act which gives him specific, temporary authority to alleviate shortages of fuel and all refined petroleum products in, or imported by, or refined in the United States.

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Prior to the Act, the petroleum allocation program was under jurisdiction of the Office of Oil and Gas in the United States Department of the Interior. When the Act became effective the Federal Energy Office (FEO) was created to administer the petroleum allocation program and certain other provisions of the Act.

On December 14, 1973, the newly established FEO formed seven citizen advisory committees to represent specific segments of the economy. One of the seven is the Agriculture Committee. At first, no fisheries representatives were appointed to that group, but at the behest of NOAA and NMFS, the fishing industry, and members of the Congress concerned with the fisheries, four fisheries members were named to the committee. They are: Jacob J. Dykstra, President, Point Judith (R.I.) Fishermen's Cooperative; Joseph J. Colson, Executive Secretarry, Gulf States Marine Fisheries Commission; Theodore J. Bugas, Director, Public and Government Relations, Bumble Bee Seafoods (Astoria, Ore.); and J. Steele Culbertson, Director, National Fishmeal and Oil Association (Washington, D.C.). These appointments represent a good cross-section, both geographically and by fisheries.

Toward the end of 1973 the committee held its first meeting and the fishing industry members, along with those representing agriculture, presented their views on the proposed mandatory petroleum allocation regulations scheduled to become effective early in 1974. Their principal objection was that as proposed, the regulations for middle distillates including diesel fuel, provided for 110 percent of the fuel used during s specified base period in 1972. Because agriculture and fisheries operations are highly seasonal the committee claimed that the proposed allocations would cause undue hardship to these industries.

The new mandatory regulations were issued on January 15, 1974. A priority rating was accorded to both agriculture and fisheries. For middle distillates, the agriculture committee's views prevailed and agriculture and fisheries were accorded 100 percent of current requirements instead of 110 percent of a 1972 base period. For gasoline, propane, butane, aviation gasoline for fishing spotter-planes, agriculture and fisheries are also allocated 100 percent of current requirements. The only proviso is that each end-user is required to certify that he has an energy conservation program in effect.

NOAA has maintained close contact with Federal energy officials and the industry during the entire period, and continues that liaison on a daily basis. NMFS Regional offices have assisted many vessel owners in completing the paperwork and in explaining the regulations where necessary.

NOAA issued a national news release last September offering several timely tips to commercial fishermen on how to continue to provide seafood to Americans, while at the same time conserving fuel. Operators were advised to emphasize to fuel suppliers that commercial fishing along with farming and dairying, among other industries, qualify for priority fuel allocations. The fishermen were urged to make contractual arrangements where possible rather than buying fuel on an intermittent basis, and were advised that—because much fishing is seasonal—it might benefit vessel owners to compute annual fuel consumption for the past 3 years, as a basis for obtaining needed fuel. They also were advised to consider building, renting, or buying shoreside fuel storage facilities on a cooperative basis with other owners.

At that time, NMFS pointed out that a fishing vessel powered by a diesel engine with approximately 340 horsepower may consume about 15 gallons of fuel per hour of operation or some 63,000 gallons per year if operated an average of 20 hours per day for 210 days of the year. At an average cost of about 23 cents a gallon (the prevailing price in September), fuel costs would be about $14,500 for the year. If the vessel operator could reduce fuel consumption by seven percent, he could realize a saving of about $1,000 a year. At current prices, the savings resulting from a seven percent reduction in fuel used would be considerably higher.

Some common practices that have been in use by commercial fishermen for some time may be new to sport fishing enthusiasts who face severe curtailment of fuel:

1. Keep engine in top condition.
   A. Tune regularly.
   B. Check filters and change as often as necessary.
   C. Inspect and properly maintain power systems.
2. "Haul out" vessel periodically to inspect propellar and clean the hull.
3. Avoid unnecessary running of engine.
4. Increase vessel speed gradually instead of suddenly.
5. Operate vessel at most efficient speed.
6. Improve navigation—Remember, the shortest distance between two points is a straight line.

Commercial fishermen were offered ways to improve fishing techniques and vessel management:

1. Cooperate with other fishermen to locate concentrations of fish. Maintain "open" radio; listen for reported catches—avoid "seek and find" when possible.
2. Take more ice or make longer trips to maximize fishing time.
3. Insulate ice bunkers and fish holds of older vessels. This may reduce the melting rate of ice up to 30% resulting in direct savings and a better quality product.
4. Organize efforts to have "buy boats" strategically located for collection and transportation of catches from a number of individual vessels to port.
5. Consider the economics of marginal fishing (especially at beginning and ending of season). Such trips may not be profitable.

These, plus additional tips on saving fuel have been widely disseminated by local Sea Grant elements of NOAA's Maine Advisory Service, in addition to NMFS. The tips went

to newspapers, trade magazines, radio and television stations, and national and regional newsletters. They were given wide dissemination especially in coastal areas.

Over the next decade, it is expected that the fishing industry, along with others, will be confronted with continuing fuel shortages. It appears that increases in petroleum prices are inevitable, as has become increasingly evident in the past six months. The fishing and allied industries have an opportunity in the coming decade to be among the leaders in conserving the Nation's energy resources, and at the same time continuing to contribute to its food supply.

The problems faced by commercial fishermen regarding fuel are as different as the numerous fisheries. For example, the fuel requirement of distant water fisheries such as the west coast tuna fleet fishing in the eastern tropical Pacific differ greatly from vessels of the coastal fisheries that make only short trips of one or two days duration. A large tuna purse seiner uses about 200,000 gallons of diesel fuel per trip and generally speaking they must fuel up to capacity before leaving its home port. These trips can last up to three months and cover thousands of miles. In the case of coastal fisheries there are a number of transient vessels that operate from different ports due to the seasonal nature of the fisheries. Because of the transient nature of their fishing efforts these vessels had no single supplier from whom they could purchase fuel.

A few specific examples of what NOAA/NMFS has been able to do for the fishing industry:

1. Obtain a blanket fuel exemption in December, 1973 and before final regulations went into effect, for the first trips by tuna vessels in 1974.
2. Obtained fuel in Puerto Rico for 5 tuna vessels where some California based vessels unload their catches.
3. Obtained an increase in gasoline supply for Maryland oystermen.
4. Started action for obtaining fuel for tuna vessels operating out of American Samoa for U.S. tuna canneries.
5. After developing the facts turned over to FEO compliance division data regarding alleged illegal refueling of foreign fishing vessels in New England.
6. Initiated action with Military Sea Lift Command to look into possibility of using their tankers to refuel tuna fleet in eastern tropical Pacific beginning first week in March. The Federal Energy Office has announced that the key goals of the mandatory petroleum regulations are to:

1. Keep food on the table
2. Keep people at work
3. Maintain the economic and physical health of the nation.

Assigning a priority to agriculture, including fishing, is a major step toward achieving these goals.

The Federal Energy Administrator, William E. Simon, says: "The allocation program is not rationing, but rather a system to ensure equitable distribution at the wholesale level."

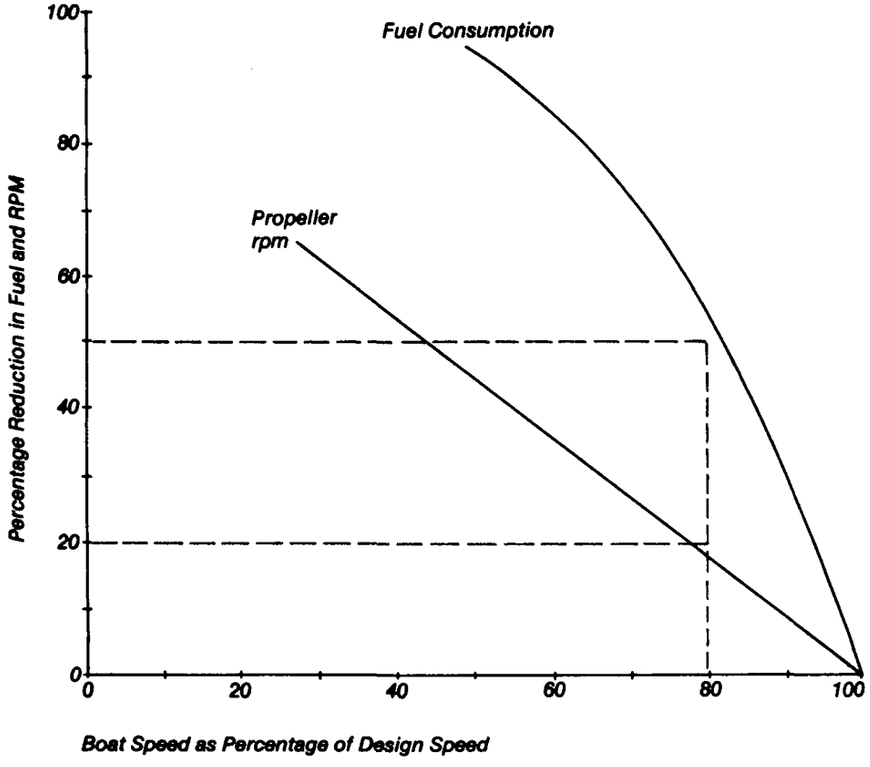
For sport fishermen, party boat operators, and pleasure boat owners the fuel shortage may become even more critical since commercial fishermen have priority to the available fuel. Sport fishermen face a real challenge. However, it has been recognized that sport fishing and boating are important segments of our economy because of the expenditures such activities generate. The Federal Energy Office has pointed out that the value of sport fishing and boating to the economy is highly visible and that every effort will be made to assure that they will receive an equitable share of available fuel. Sport fishermen may soon turn to "pooling" and use one boat rather than operating individually. This pooling effort can easily save fuel in exactly the same way car pooling is effective, and fishermen can still enjoy their hobby even if in a less private manner.

Party boat fishing, sometimes known as commercial passenger fishing fleets, sport fishing, and outdoor recreational activities in general will also face cutbacks because the fuel shortage will hamper these activities.

The Federal Government and the various State fisheries agencies are also having difficulties in obtaining fuel in the necessary quantities to conduct their fisheries research programs.

Neither NOAA nor NMFS has any authority in the allocation of fuel. Rather, it is the intent of the Fisheries Service to assist commercial fishermen by keeping them in-

Dramatic Fuel Savings Possible for Diesel Boats



This graph shows dramatic fuel savings that are possible by reducing diesel boat speeds.

formed of the latest developments in what must be regarded as a long term fuel shortage.

Experts predict that prices for petroleum products in 1974 will average about 50 percent above those of last summer. With reduced supplies in 1974 this price increase would not by itself be enough to match supply and demand. Therefore, one must assume that the gap will be closed by:

A. Voluntary restraint, economizing on petroleum use, air flight cutbacks, and a slower economic pace, and

B. by cutbacks in recreational use of gasoline and other fuels through semi-voluntary or compulsory rationing.

An "energy audit" appears to be needed, to determine how much is used, where it is used, and how it can be conserved. We should also seek new procedures or processes that will reduce our extravagant use of energy. While fisheries consumption of fuel does not approach what agriculture uses, it is significant. NMFS has collected some preliminary data on the diesel fuel consumption by the U.S. commercial fisheries. In 1972, the latest year for which figures are available, the industry used some 287.8 million gallons for fishing alone. Of that amount the New England States used 27.3 million gallons, the mid-Atlantic States 8.4 million, the Chesapeake Bay area 38.6 million, the South Atlantic including the east coast of Florida 18 million, the Gulf of Mexico 131 million, the Southwest 40.6 million, the Northwest and Alaska 21.6 million, and the Great Lakes 2.3 million. At this writing we have not been able to get an accurate figure on the gasoline used in commercial fishing.

Although the outlook is not rosy for the immediate future for fuel for fisheries or other industries, the long run supplies of energy should be adequate after we have a time and experience to adjust concerning equality of distribution and allocation. Prompt and proper action by all segments of American industry and government can assure at least adequate domestic supplies for many years to come. □

NMAS lends a hand

Local units of the NOAA Marine Advisory Service have been quick to respond to the energy shortage, getting information directly to watermen and others about ways to lessen their fuel problems.

The Sea Grant Advisory Service of the Virginia Institute of Marine Science, for example, issued a special report on fuel allocation in December, using information from NMFS. *Fuel Shortage and the Fisherman: What Can Be Done,* explained the Mandatory Allocation Program for Middle Distillate Fuels, told fishermen how to obtain fuel allotments, and gave names, addresses, and phone numbers to contact in cases of emergency or hardship. The VIMS bulletin is widely distributed directly to Virginia fishermen.

Sea Grant Advisory Services in South Carolina did much the same thing, and updated the information in a later issue of their bulletin *Fathom Line*—again, information distributed directly to the boatmen concerned.

At the Massachusetts Institute of Technology, a Marine Advisory Service technical release consisted of a simple graph showing how reduced boat speed can make possible dramatic fuel savings for diesel boats. With the brief accompanying explanation, a fishermen would discover from the graph that, for example, a boat designed to make 10 knots top speed would save 50 percent in fuel if it ran at eight knots and 20 percent lower rpm.

The New York State Sea Grant Advisory Service has worked with NMFS in obtaining emergency fuel allocation for commercial fishermen, and has also addressed itself to the problems of recreational boaters. Upon a request by NMFS, the New York advisory staff coordinated emergency fuel allocation for Long Island fishermen and seafood processors, and distributed the report on "Assistance in Solving Fishing Vessel Fuel Allocation Problems." This material was further publicized through the state advisory bulletin *Coastlines,* as was the problem to be faced by the pleasure boating industry. Suggestions for marina operators were made, and a recreational industry data sheet developed by the National Association of Engine and Boat Manufactuters was distributed widely.

California Cooperative Extension instituted a newsletter on energy conservation and fuel supplies in relation to agriculture, and the University of California Marine Advisory Program has submitted items on the needs of the state's commercial fishing industry and partyboat fleet. California maintains a 5,000 boat commercial fishing fleet, noted the marine advisory service, and the almost 500 boats in the partyboat fleet carried an estimated 720,000 fishermen.

Also in California, the Marine Advisory-Extension Service of California State University at Humboldt, acting on a request from NMFS, collected information on diesel fuel consumption at several fishing ports, and represented fishermen in meetings devoted to ensuring that the fishing industry would continue to receive adequate diesel fuel supplies.

The Oregon State University Cooperative Extension Service arranged for TV and newspaper coverage of fishing vessels in Astoria that could not get fuel in November, and helped organize follow-up TV interviews with fishing industry representatives and local fuel dealers. A meeting was arranged with the state energy office and the local fishing industry, which was attended by more than 200 fishermen and fish processors. The meeting developed suggestions for a new fuel program which the Service forwarded to state legislators; it also resulted in the formation of a local industry advisory committee to work on the fuel problem. Subsequently NMFS took the lead in working with the Region X Federal Energy Office, and the Oregon State Marine Extension agent was named to the industry advisory committee to the FEO.

And so it went around the country, Marine Advisory and NMFS working together on the energy problem—

- The University of Washington Sea Grant program arranged a series of five town hall meeting at fishing ports, to discuss fuel allocations and other topics—discussion leaders at each meeting included representatives of the state Department of Fisheries, NMFS, the Coast Guard, FEO, and Washington Sea Grant.
- The Florida Cooperative Extension Service provided a bulletin to commercial fishermen on their gasoline tax exemptions and fuel allocation procedures, and contacted every county extension director to inform them of changes in fuel allocation procedures, provide them with the necessary documents, and show how they could provide assistance.
- The University of Rhode Island assisted NMFS in gathering local data on industry fuel use, and provided a forum for marina owners and operators to discuss their fuel problems.

ERL's contribution to gasoline saving

Carpooling by Computer

". . . I'd like to join a carpool. I live at 501 Mapleton Avenue here in Boulder and work at the Interstate Truffle Refinery, 5100 Marine Street. My hours are eight to five, and my home telephone is 443-5011."

"One moment please . . ."

(And NOAA's time-share computer in a fractional second's aside:

"Let's see. She lives *here,* and wants to go *here.* Anyone in her grid? Hmm? No. Let's try a larger grid. Hmm? Not there. Let's try a larger grid around her destination. No. Okay, back to her home with a three-quarter-mile grid. Work? Nope. Okay, the one-mile grid. Better, much better. Here you go.")

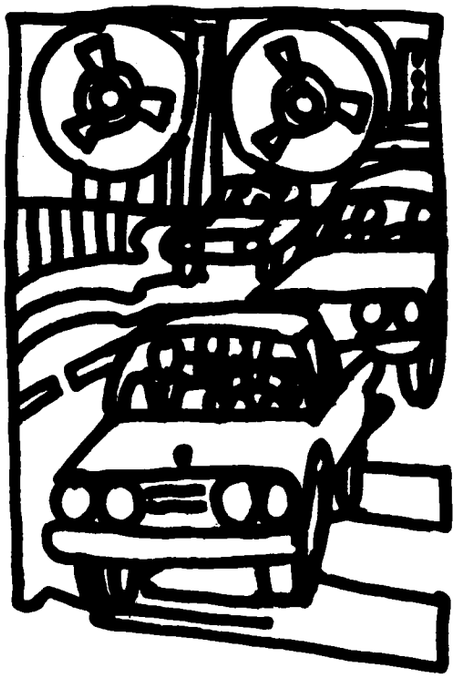
". . . Good. We have five people from your general neighborhood who're interested in carpooling. They are . . ."

And there follows a list of names, addresses, and telephone numbers. The caller has contributed something under three minutes and a dime to helping work out the difficult problem of an affluent nation's petroleum consumption—the ways in which automobiles are used. The investment brings some side benefits as well: no longer the grim ride to work; no longer a car with the mechanical lifespan of a fruitfly; the quality of life inches up a notch.

The idea of using NOAA's time-share computer in a cooperative carpooling effort with the city of Boulder came from Jack Kemper, director of the Environmental Research Laboratories' Research Support Services. The computer program was designed by a team headed by Dr. Ralph Slutz of the ERL director's office, whose computer skills have formerly been given to simulating the complex physical systems of the space environment.

According to Kemper, the NOAA contribution makes the system easy to use, and that factor may make carpooling acceptable to Boulder's individualistic society. "We think the beauty of this carpool system is that it's just a telephone call away from the prospective carpooler. There are no forms to fill out, nothing to pay, and it takes very little of a person's time. We hope that, by making it easy to use, we've opened it up to wide usage in this area."

The community car pool system for the Boulder area went into operation this month, with the City of Boulder handling the administration of the system, and the contacts with the public, and ERL providing technical support and computer operatiions.



"Although this system should help the people of Boulder ride out this spring's energy crisis, we want it to go farther than that," says Boulder city manager Archie Twitchell. "Carpools are an excellent energy-saving device and we hope to start something here that will foster more of a carpool mentality in this area. We are able to offer this service at relatively little cost to the city budget, and we hope to provide a model for communities around the nation."

Here is how the Boulder carpool system operates. Boulder city and county maps in the computer's memory are gridded in squares ranging from one-quarter mile on a side in the densely populated city on out to as much as a mile in rural areas. (The Denver, Colo. portion of the program is based on zip codes.) Input to the computer consists of "to," "from," "when," and other information from the aspiring carpooler.

When a prospective participant dials the Boulder city municipal building number, he asks for the carpool clerk and proceeds to give his name, home address, telephone, and work address, and the time of day he must arrive and leave work. The carpool clerk punches this information into a console connected to ERL's XDS 940 time-share computer. The computer automatically begins the search, taking only a fraction of a second to make its various comparisons.

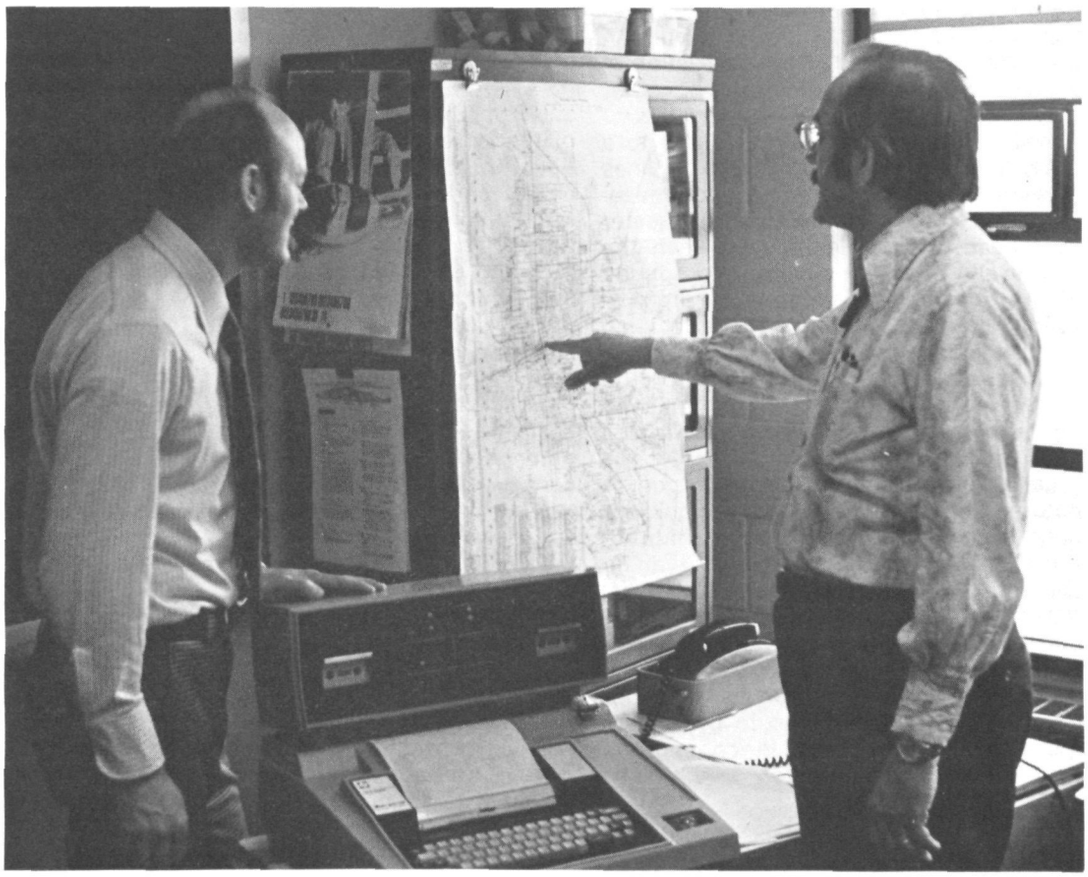
"If the computer is successful the first time, it will automatically print out five names, addresses, and telephone numbers of possible participants within the caller's grid area," Slutz explains. "If unsuccessful, the computer goes on to the half-mile by half-mile grid, and tries again, first on the 'from' location, then on the 'to' location. And the 940 continues this pattern until it finds five names."

However, if all efforts are unsuccessful to within a mile square grid, the computer will automatically relax one of the requirements. For example, if the participant wants a ride to accommodate an eight to five work schedule, the computer initially maintained those times within 15 minutes. Now the XDS 940 relaxes the time criterion slightly, to see if people can be located with a 30-minute difference in time. And so on.

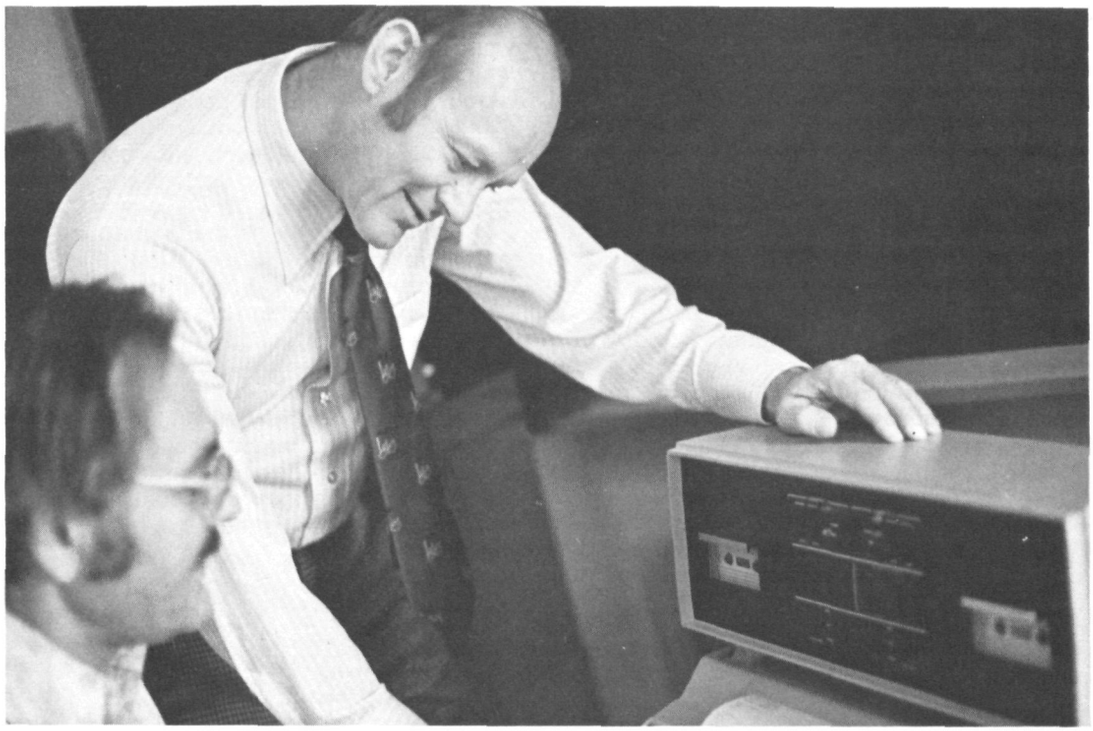
Probable advantages of such a carpool system for the individual citizen and for the community as a whole include reduced costs for automobile operation and maintenance, decreases in traffic and highway or street maintenance, and easing of rush-hour congestion and associated tensions. Carpools may also help reduce accidents, hazards and losses, and bring about a decrease in smog and noise pollution.

Citizens wishing to participate in a carpool inquire either by telephone or in writing by submitting a form to the city manager's office. The computer terminal or teletypewriter installed in the city manager's office gives immediate responses to both telephone and written inquiries. All participants receive a written answer to their inquiries regardless of whether they also received a reply on the telephone.

"We hope that the Boulder carpool system can be made so successful that it will provide a model for other systems, and that additional achievement can result," Kemper says. "For example, the system might eventually be expanded to enhance local bus services and their use. It may also provide carpools for recreational purposes, shopping or special events, supplementary transportation for employers, and interlinkage with other pools or public transit." □



Dr. Ralph Slutz, who designed the car-pool computer program, points out one of the many machine-produced pooling combinations to Jack Kemper, originator of the idea.



At a computer terminal, Slutz and Kemper watch as ERL's XDS 940 matches names, places, and times to help Boulder-area commuters get together for gas-saving carpools.

High water, low water:

An Energy Balance Sheet

By John Hanna

High water levels on the Great Lakes have cost millions of dollars in erosion and flood damages, and in the construction of protective works. Paradoxically, however, they have helped ease the energy crisis.

Water flowing from a higher level to a lower level when passed through turbines provides the cleanest, most economical way of producing electricity. The greater the "head" (the difference between the two levels) the more electricity produced at lower cost. Today's high levels are providing more than enough water to keep the turbines spinning at top speed. Electrical needs for a good portion of the northeastern United States are furnished by the hydroelectric plants on the Niagara and St. Lawrence Rivers.

Lake level fluctuations are of course natural phenomena. Man can no more control lake levels particularly during abnormal high or low supply periods than he can control earthquakes or hurricanes. NOAA's Lake Survey Center with its extensive water level gaging network furnishes data of value not only to the National Weather Service, for its lakeshore warning program, but also to hydroelectric power plants. They, in cooperation with international regulatory bodies, use Lake Survey data to determine precisely how much water they can take while recognizing the needs of commercial shipping and riparian interests.

The outflows from three of the five Great Lakes are used, in part, for hydroelectric power production. The outflows from two of the three lakes, Lake Superior and Lake Ontario, are controlled, thus providing some means of limited regulation of the levels of those lakes during normal supply conditions.

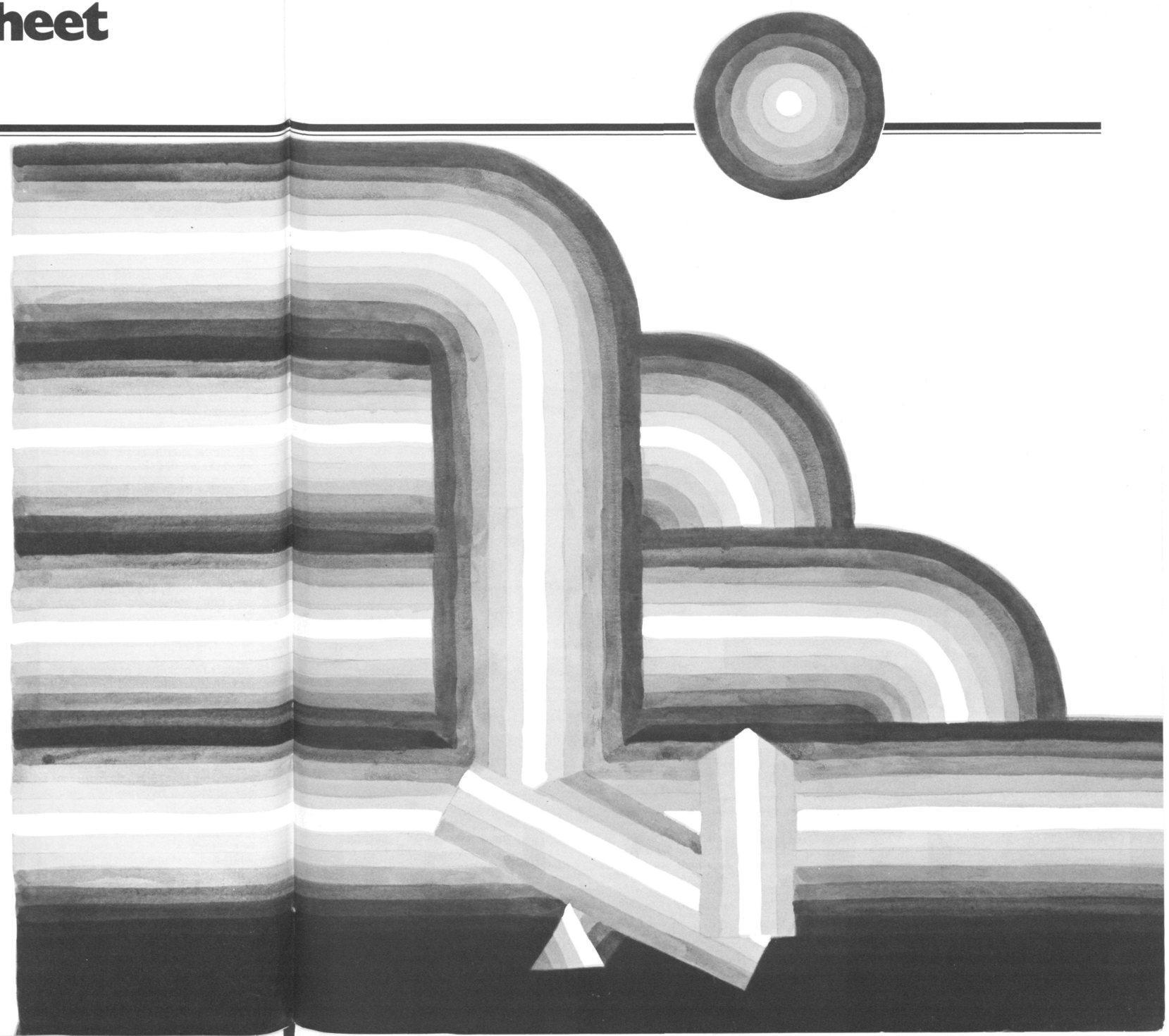
The outflow from Lake Erie is at Niagara Falls, and consequently is not controlled. United States and Canadian power companies divert water from the Niagara River but are required by international agreement to maintain a prescribed flow over the Falls during certain periods for aesthetic purposes.

Flows out of Superior and Ontario are strictly controlled by the International Lake Superior Board of Control and the International St. Lawrence River Board of Control, respectively. These Boards are units under the International Joint Commission, and each is made up of high-ranking American and Canadian experts. In the case of Lake Ontario, water releases are determined weekly in cooperation with the Power Authority, State of New York and the Hydroelectric Power Commission of Ontario. Essential data from two Lake Survey Center water level gauges on the U.S. side of Lake Ontario and from four gages on the Canadian side of the Lake are used in such determinations. In addition to power requirements, equal consideration is also given to riparian interests and the needs of navigation.

During a period of low water levels, like that which occurred in 1963-64-65, the power companies are forced to turn to alternate methods to meet the demand. These include burning coal and oil. Periods of high production permit the furnishing of extra power generated to other areas, thereby allowing them to conserve fuel. When production falls because of lower lake levels, other methods have to be used or electricity has to be purchased from conventional producers who use coal or oil.

Engineering News-Record in its edition of August 20, 1964 stated, "Power production on the lake outlets fell off considerably from a 20 percent drop in flow in 1962 and 1963 and low production still continues. For example, output last year at the New York State Power Authority's Niagara generating plant totalled only 10.8 billion kwh instead of the 13 billion expected normally. The money loss this year will run to $5 million or more." If that situation existed today the impact on the energy crisis would be far greater.

By way of comparison, peak flows in 1973 were 350,000 cubic feet per second (cfs) at the Moses-Saunders power structure on the St. Lawrence River, and just under 200,000 cfs in 1964. Not all the 350,000 cfs last year went through the turbines—25,000 to 30,000 cfs (depending on head) were released via Long Sault Dam which caused Lake Ontario to be lowered by a foot, according to Robert D. Conner, Resident Manager, Power Authority—State of New York. He also commented that the Power Authority lost about 1½ million dollars by not being able to use that water. Extra power generated there is sold to other power producers who usually shut down their own coal or oil fired generators at such times. □



Monster of the Year: This huge tornado was one of the most powerful ever recorded and also had the longest track of the year—158 miles. Here it is approaching Salina, Kansas, where it flattened a 44-unit mobile-home court. Eighty residents, well warned, escaped harm in an underground shelter.

The Salina tornado took on many forms—all of them deadly—as it roared down on a mobile-home court on the southeast outskirts of town.

Dirt and debris spurt from base of the twister which killed three as it spun across Kansas and Nebraska.

Photos: Fritz Mendell, Chief Photographer of the Salina "Journal"

"The outstanding performance by those involved . . . should be written in letters a foot high."

George P. Cressman

Success Story in Kansas

BY EDWIN P. WEIGEL

"RECORD TOTAL OF TWISTERS IN '73" . . . "TORNADOES HIT NEW ALL-TIME HIGHS IN 11 STATES" . . . "SOUTH BLITZED BY TWISTERS AGAIN."

These and similar headlines were commonplace in 1973, as the U.S. was raked by the greatest number of tornadoes weathermen ever recorded for a single year. When the 1973 tally was completed in January, the year's total was 1107, compared with the previous record for a single year of 929, set in 1967.

Accompanying damage, too, was high—amounting to more than half a billion dollars.

Yet the death toll was low, proportionately. There were 87 tornado fatalities in 1973, compared with a 21-year annual average of 113.

Allen Pearson, Director of the National Severe Storms Forecast Center in Kansas City, said:

"The conclusion I draw from this is that a great many lives were saved by the Weather Service's program of tornado watches and warnings and by excellent community preparedness on the part of local officials."

Weather Service Director Dr. George P. Cressman agreed. He said:

"It used to be that for every reported tornado there were, on the average, 1½ lives lost. On that basis, almost 1,700 lives should have been lost to tornadoes in 1973, with perhaps five times as many people injured. Yet fewer than 100 lives actually were lost. It would appear, then, the warning system as a whole saved 1,600 lives. The National Severe Storms Forecast Center deserves a large share of the credit for this, along with local Weather Service offices, public-safety agencies, and radio and TV stations which delivered the tornado watches and warnings to the public.

"The people got the word, and they knew what to do."

On several occasions during 1973, the Weather Service paid tribute to its field units and to local people for their part in preventing tornado deaths. One such occasion was a ceremony last June in Sumner, Miss., honoring persons who helped to safeguard the lives of 800 schoolchildren from a tornado which demolished classrooms. Teachers had herded the children into interior hallways minutes before the tornado struck. There were injuries but no deaths. This episode was described in detail in the July NOAA Magazine. A key element was a cooperative arrangement between the Jackson, Miss., Weather Service Forecast Office and the Mississippi Power and Light Company in which the power company provided forecasters with precise times of power-line breaks in an area for which tornado watches had been issued. Correlating this information with what they could see on radar, weathermen were able to issue timely warnings even before they had spotters' confirmation of the twister bearing down on the school.

Another standout performance took place in September—this one during a record outbreak of tornadoes in Kansas. This, too, was a textbook example of how to cope with twisters. Instead of a potential death toll of hundreds, there were three. For life-saving warnings during this outbreak, the Concordia, Kansas, Weather Service Office was awarded a unit citation. For equally significant performance as tornado spotters and for their long-range community preparedness, more than a score of Kansas agencies and individuals were given Public Service Awards—the Weather Service's highest honor—at ceremonies in November.

The Kansas episode—like the one in Mississippi—is worth examining in detail for the tips it may offer to other communities on dealing with tornadoes. To set the stage, here is a summary of what happened, based on a report by Harold E. Lowman and his staff. Lowman is Official in Charge of the Concordia Weather Service Office.

The family of tornadoes which hit north-central Kansas on September 25 was the worst outbreak since the Weather Service has had an office in that area—a period of more than 50 years. More than a dozen separate twisters spun downward out of the sky that afternoon and evening—more tornadoes on a single day than ever before recorded for the entire month of September in Kansas. Several of these were on the ground simultaneously.

Most of the damage during that period, however, was caused by two long-track tornadoes—potential mass killers. These struck intermittently along parallel paths separated by only a few miles and a little more than 90 minutes. They averaged 25 to 30 miles per hour in forward speed and had rotational speeds of more than 200 miles per hour.

The first and lesser of these long-track twisters was first reported at 5:20 p.m. about 10 miles north of Salina, Kansas. It traveled 72 miles northeast to a point near the Nebraska border, striking, successively, Bennington, Longford, Oak Hill, Garfield Center, Palmer and Linn. At Linn it caused 1.5 million dollars in damage. Warnings preceded this tornado along most of its path. There were injuries but no deaths.

The second of these two long-track tornadoes was by far the greater potential killer. It did cost the lives of three persons. First sighted near Little River, Kansas, at 5:05 p.m., it traveled 40 miles northeast to the southeast edge of Salina where at 6:15 it reduced a 44-unit mobile-home court—the Sundowner East—to scrap. A timely watch and warning had allowed 80 people to escape death or injury in an underground storm shelter which had been provided by the owners, Mr. and Mrs. Frank Norton.

Photos: Darras Delamaide, Salina "Journal"

There were no deaths. Four persons outside the storm shelter were injured.

From Salina, this vicious twister—intermittently funneling down, gouging the countryside, receding, and then reforming—skipped northeast to New Cambria, and thence to Niles, where it killed a woman by dropping a 40-foot grain bin on her home. In addition it injured two persons and caused $150,000 in damage. From Niles, the storm continued northeast to Longford at 7:10 p.m., and was next reported 5 miles south of Clay Center at 7:51. From here, veering almost straight north, it roared into Clay Center at 8 p.m., causing 20 injuries in that area and 2½ million dollars' damage, a substantial part of this to the county hospital. It was next reported one mile east of Garfield Center at 8:15, from whence it proceeded to Greenleaf, at 8:52, causing two deaths, six injuries and three million dollars' damage in a hamlet of only 500 people. Deaths in Greenleaf were two children in a family of five in a frame home which had no basement. From Greenleaf, the storm continued across the border into Nebraska, where it was last reported near Blue Springs at 10:35 p.m.

This tornado had the longest track of the year, covering 158 miles—138 of them in Kansas and 20 in Nebraska. Lowman estimated it was on the ground about 70 percent of the time during a 5½-hour period, and that its predecessor was on the ground 60 percent of the time during two hours and 20 minutes. He said their paths were identifiable in unpopulated areas by tree and crop damage.

State, county and local officials, when interviewed later by Weather Service investigators, said they were uniformly pleased with the storm warning and with emergency actions throughout the crisis. They added they were confident many lives had been saved. When pieced together from many sources later, here is how it went.

Many Kansans were first aware of possible storms on the way as a result of the 7 a.m. convective outlook issued by the National Severe Storms Forecast Center in Kansas City. This is the basis for the SKYWARN report seen routinely on early-morning television. In Kansas it is transmitted by the NOAA Weather Wire Service to all local Weather Service offices and to key Civil Defense units.

Police Chief John Woody of Salina, Kansas, recalled that at about 10 a.m. that day he was aware there was a strong chance of tornadoes, and that the Saline County spotter network, reporting to Civil Defense chief Don Rectenwald, might be called upon to radio in warnings from 18 strategic spots around the county. So the Emergency Operations Center in the basement of the

At the Sundowner East mobile-home court near Salina (far left) the steel I-beam frame of a mobile home was wrapped around a tree. (Above) dazed survivors emerge to find their homes reduced to scrap. (Left) the tornado wiped out most belongings of this couple. (Below) in this sturdy shelter, 80 people escaped unharmed when the tornado hit. The structure above, a clubhouse, simply exploded.

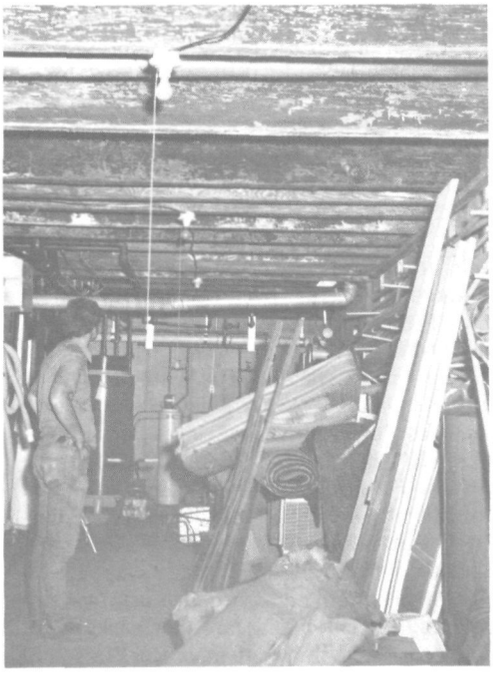


Photo: Edwin P. Weigel

Salina police station was manned and ready.

When a tornado watch was issued at 4 p.m. by the Severe Storms Center for an area to the south of Salina, public-safety officials in north-central Kansas knew it was only a matter of time. Their vigil sharpened. At 5 p.m., Kansas City issued another tornado watch. This one included Salina. The watch went to radio and television stations throughout Kansas, the state highway patrol, all Civil Defense units, and to many local police and fire departments. Severe-storm forecasters were telling residents in a box-shaped part of Kansas: Now is the time to watch for threatening clouds. Conditions are right for tornadoes to form. A few minutes later, tornadoes indeed were sighted within the watch area. The airwaves crackled with excited reports from spotters.

Meanwhile, weathermen at Concordia were comparing spotters' reports with what they saw on radar. At 5:15 p.m., they issued their first tornado warning of the day—based on the sighting of a funnel cloud at 5:10 by the Kansas Highway Patrol just north of Salina. This tornado was moving north-northeast, Concordia warned, at about 25 to 30 miles an hour. It was to become the first of the day's two long-track tornadoes.

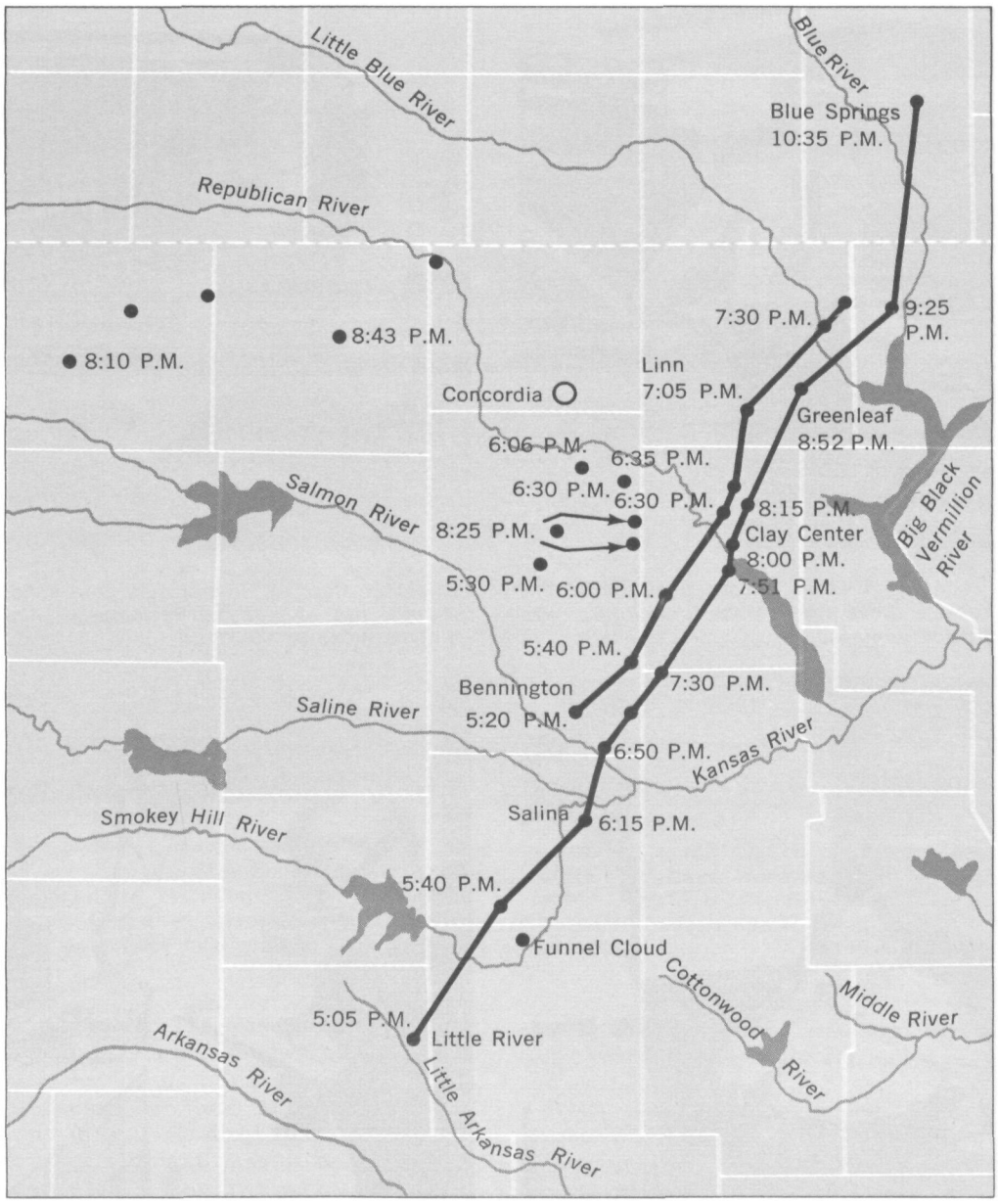
At 5:47 p.m. Concordia issued another tornado warning. This one was based on a sighting of a tornado 2 miles north of Marquette, Kansas, 20 miles southwest of Salina. This turned out to be the second long-track tornado of the day—the killer that demolished the mobile-home court at Salina and spread a path of destruction 158 miles long. Concordia's warning correctly covered the Kansas counties in its path.

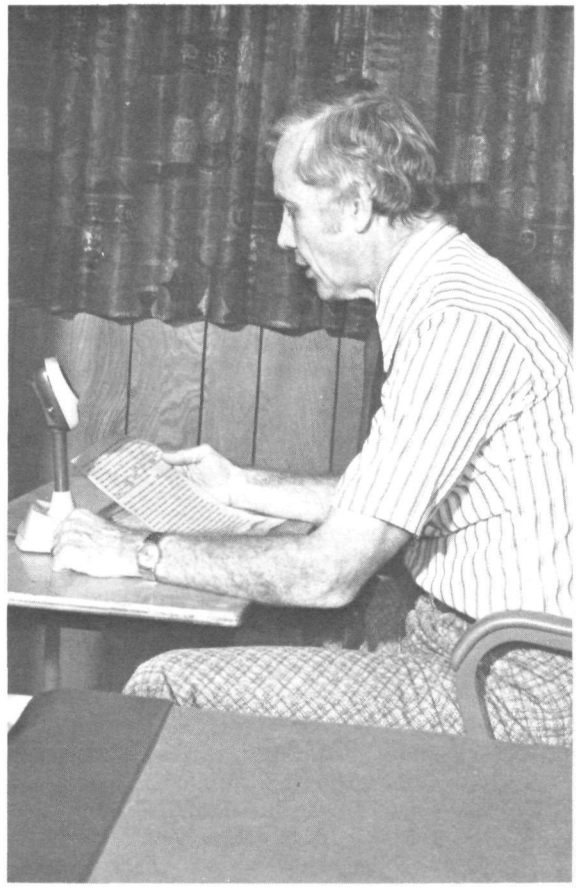
As the seconds ticked by, Salina's and Saline County's spotters hardly lost sight of this monster tornado for a moment as it bore down on the city. It was observed from many different angles and at many successive instants. It was photographed in black and white, in color, and on color movie film. Salina Police Chief Woody himself was in one of the patrol cars monitoring the skies southwest of the city. "When debris began falling around me," he said, "I knew it was time to activate our network of 14 sirens in Salina, even though the tornado was still some distance away and I couldn't see it."

At 5:50 p.m. the sirens began to wail their unmistakable warning.

Arriving at the evening news hour in Salina, the tornado was covered by television during the peak viewing period, but not by visual means. The cable-television system in Salina allows a voice override to broadcast emergency messages on all 12 channels regardless of the images on the screens. TV and radio announcers delivered their warnings directly from the city's Emergency Operations Center, giving minute-by-minute coverage of the tornado's approach. Also, a program of recorded music was interrupted, so shoppers in supermarkets got the word. Law-enforcement officers in squad

Photos: Clay Center "Dispatch"





(Far left) The tower of Clay County courthouse rears above the wreckage left after a tornado ripped through the heart of Clay Center. (Left) A tornado map shows where a dozen twisters blitzed north-central Kansas on September 25. The two longtrack tornadoes—covering 72 and 158 miles—did the most damage. (Above) Harold Lowman, Official in Charge of the Concordia, Kans., Weather Service Office, made numerous live broadcasts of tornado warnings as a dozen storms raked his area.

cars threaded through roads and streets blaring the message to pedestrians and motorists: "This is no drill. Take cover in the nearest shelter." Said Chief Woody: "Salina was almost like a ghost town, with cars left where they'd been stopped, everybody out of sight."

When the tornado veered and unleashed its fury on the mobile-home court, at 6:15, the rest of the town was spared. Although it had been a near thing for this town of 38,000 people, Salina was as ready as it ever could be.

Before it hit the mobile-home court, residents of the Sundowner East at the southeast edge of Salina had been watching the giant tornado for some time. Galen Crum, an employee of the court, said they had heard the tornado watch over KSAL radio. "And we could see it when it was about six miles away. It was huge and black. For a while it looked like it was going to hit the big Westinghouse plant south of town. Shortly after that, it veered and we all crowded into the storm shelter beneath the clubhouse."

This shelter, which did double duty as a workshop, had been built by the owners of the Sundowner East, Mr. and Mrs. Frank Norton, because they were well aware of the extreme vulnerability of mobile homes to strong winds. The Nortons had also required that all mobile homes in the park be anchored to the ground with over-the-top straps or cables. But they knew these alone were not enough protection. So, even though Kansas law didn't require it, they had provided a sturdy shelter big enough —about 12 by 60 feet—to hold all the court residents.

"It was simply the right thing to do," said Norton.

The Nortons and their employees hadn't been sure how such a shelter should be built, so they had made it extra strong. Walls were of reinforced concrete. Overhead were 4 × 12-inch beams set into the concrete and overlain, first, with 2 × 6-inch tongue-in-grove subflooring, and then with three-fourths-inch plywood.

When the tornado hit the park, mobile homes were reduced to knee-high junk, frames wrapped around tress. Debris was scattered more than half a mile to the northeast. The clubhouse—a renovated 100-year-old railroad station built of extremely solid timbers—"simply exploded." Said Crum:

"Amidst all that roaring noise we could hear the nails ripping loose. The wind blew the door open even though three men were trying to hold it shut. In a few moments it was all over. Soon we could see sunlight shining through cracks over our heads.

"When we came out we were amazed at the damage. Everything was gone. The first thing we did was to shut off gas lines and start looking for people. Sheriff's officers and police were on hand almost immediately. We found the injured right away."

Even as the dazed survivors at Sundowner East were emerging into the sunlight, the

tornado was striking farmsteads and towns to the northeast. When it got to the vicinity of Clay Center 45 miles and 90 minutes later, it was about to impose its next major test. Already, another skillful corps of spotters was on the job, having tracked a predecessor tornado—the first of the two long-track storms—just to the west.

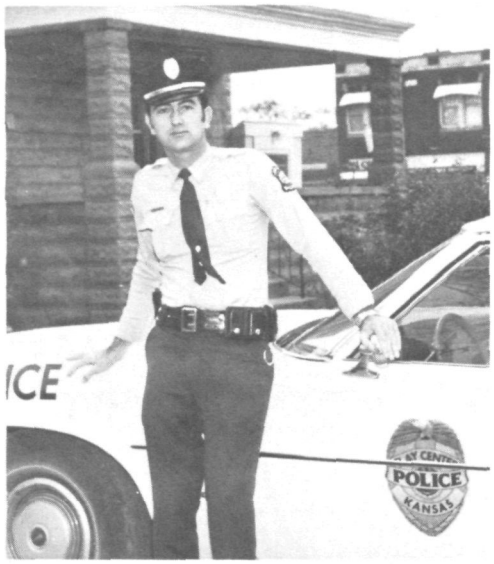
When the second tornado was spotted five miles south of Clay Center, Police Chief Lorin Kasper, Jr., was among those who drove out to meet and track it. His patrol car was buffeted and damaged, windshield broken. "It was enormous," he said. To another observer "it looked like a white tornado," lit by flashes of lightning.

As it headed straight toward the town, Carolyn Proctor, dispatcher for the town's Law Enforcement Center, was using a voice override system to broadcast warnings of its position and direction over the Clay Center 12-channel cable-TV system, which is similar to Salina's. Said Kasper: "She was getting reports from two phones, one in each hand, and was controlling the radio mike with her elbow." Kasper said the step-by-step reports from the weather office at Concordia had been a tremendous help throughout. During these final moments, one Clay Center resident—James Cramer—had the presence of mind to leave a tape recorder going before he took cover. He now has the memento of a lifetime, the roar of a tornado growing louder and louder until the power went off.

The tornado tore right through the heart of Clay Center, damaging or destroying hundreds of structures. The city's power, lights and phone system all were knocked out. For a time, the only means of communication with the outside world was by patrol-car radio.

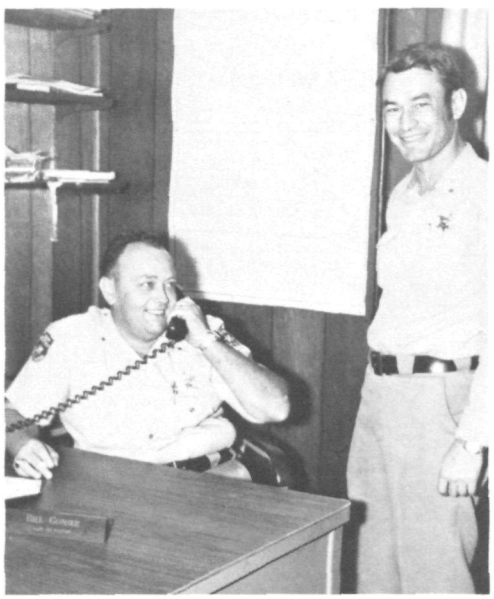
Just how many lives were saved by warnings in Clay Center that night can never be known for certain, but Chief Kasper says there were several hundred people in the path of destruction. He believes many would have been killed or maimed had they not taken cover.

The staff at the Clay County Hospital, at the north edge of town, adds an emphatic affirmative. Administrator Charles Gray and Assistant Head Nurse Alice Specht said they began to put their storm-emergency plan into effect when a tornado-siren on an adjacent water tower began to wail at 6:30 p.m., in response to the sighting of the first long-track tornado a few miles distant. Although this tornado missed Clay Center, it gave the hospital 1½ hours to put its tornado-emergency plan into effect and move ambulatory patients to the basement and those bedfast to interior corridors, protected by pillows and blankets. When the killer tornado arrived at 8:06, it ripped off the roof of the hospital's east wing, showered rooms with broken window glass, and almost demolished a nearby clinic. Loyde Hager, a hospital attendant, had his right arm almost severed just below the elbow by a slamming door as he was attempting to make a last-second move of an endan-



Police Chief Lorin Kasper of Clay Center, Kansas, drove out to track tornado. Car was hit and damaged.

Dispatcher Carolyn Proctor had her hands full with two phones and a radio, sending warnings by cable TV.



Sheriff Bill Gonser and Undersheriff Clayton Wright miraculously escaped death while trying to issue warnings.

Administrator Charles Gray and Nurse Alice Specht were on duty when tornado hit Clay County Hospital.

Photo: Clay Center "Dispatch"

Sheriff's car was rolled over and over by tornado. Wright was thrown clear. Gonser rode it out, crouched on floor, face pressed tight to seat.

Bergman Studio

Staff of the Concordia Weather Service Office was awarded a unit citation for the September 25 warnings. They are (from left, kneeling) William P. Matthes, Willie Ray Sanders, Roy F. Freiburger, (standing) Wilson Floe, Keith E. Adams, Marvin D. Petersen, and, holding plaque, Official in Charge Harold E. Lowman. At Lowman's side is Karl R. Johannessen of Weather Service headquarters who made the presentation.

gered patient. The patient received face cuts. Hager's arm was sewn back on later by a team of surgeons at nearby Fort Riley.

Administrator Gray said there were so many tornado warnings through the night he kept patients in interior corridors until dawn. He was sure lives were saved in his hospital. "I wouldn't change a single word of our emergency plan," he said.

Three patients in Clay County Hospital had the novel experience of living through two tornadoes in one night. One was a woman injured by an earlier tornado northeast of town. She had a fractured pelvis and was hospitalized in time to be on hand for the 8:06 twister. The other two were Clay County Sheriff William Gonser and Undersheriff Clayton Wright. They had been patrolling southwest of Clay Center near Oak Hill when the first of the two long-track tornadoes passed through. Gonser had radioed the Law Enforcement Center in the police station that a tornado was on the ground. Then, according to a write-up by the Clay Center "Dispatch," he and Wright headed south toward Oak Hill to sound an alarm, but they didn't make it.

"As Gonser and Wright reached the top of a hill north of Oak Hill they met the tornado head on. It struck the car broadside, slinging it first to the west side of the road and around a circle to the east side, 150 yards into a nearby pasture. Wright was thrown from the car and Gonser got down on his knees on the floor . . . and, burying his head in the seat, held tightly to the seat belts . . . as the car turned over and over and over. . . ."

When the car came to rest, Gonser, "seriously injured . . . pulled himself from the crumpled wreckage . . . as Wright made his way to a nearby farmhouse for help." An ambulance arrived shortly thereafter and transferred them to the hospital, where they were being treated when tornado No. 2 made the second attempt on their lives that night. This time, they escaped further injury.

Other excerpts from the write-up by the Clay Center "Dispatch" provide a graphic description of what happens when a town of 5,100 people is hit by a large tornado:

"From a distance the town appeared to explode in giant, eerie green flames. The tornado raged down Sixth Street at about second-story level, dipping down to demolish businesses. . . . It ripped buildings for two blocks on either side of its path. . . . Tress were uprooted. St. Paul's Episcopal Church at Sixth and Clarke was reduced to a pile of rubble. . . . The tornado continued its course up Sixth, striking final blows to the east wing of the hospital and totally demolishing the Medical Arts Building. . . .

"The strike took only a few minutes. A deafening silence followed. Communications between the Law Enforcement Center and the world outside the city limits were cut off as the water-tower antenna was ripped down. Within minutes, cleanup and rescue operations began . . . as authorities scrambled to set up communications and begin . . . clearing streets of fallen trees and chunks of homes and buildings. . . . Within two hours, the Law Enforcement Center was filled with volunteers with chain saws, ham radio operators, officials from surrounding towns, and local citizens looking for assignments. . . . The hospital continued emergency operation on the hospital generator. . . . Assistance from surrounding law-enforcement agencies, hospitals, and utility and telephone crews began pouring in. . . . Thirty members of . . . the National Guard reported for duty at the borrowed police car serving as a temporary command post . . . amidst rain, confusion, and the roar of gasoline generators.

"Fourteen ambulances arrived from as far away as Mankato and Horton, Kansas, and five Army helicopters landed near Clay County Hospital. . . .

"Rumors came and went, but no one was to have any idea of the scope of the destruction until dawn."

With dawn came the revelation. As described by John Marshall of the Salina "Journal":

"The streets of Clay Center were littered with rubbish, much of it once parts of family rooms, kitchens, bedrooms, dining rooms. Big pieces of roofs and walls were ripped by the wind, scattered like slivers into the streets. Huge trees had been fractured and twisted and tossed. Limbs and branches were everywhere.

"Electric cables were strewn like spaghetti in yards and alleys and streets. They sizzled and popped until the city shut off all electric power to the downed lines. Natural gas lines were ripped, jagged and hissing. Cars and trucks lay bent, wrinkled, crushed, as though a giant had stepped on his toys."

The "Dispatch" reported the Red Cross tallied 500 Clay Center homes damaged and about 80 destroyed, while in the business district at least 80 offices, shops and stores were hit.

Yet despite the widespread destruction, not a single person died in Clay Center that night.

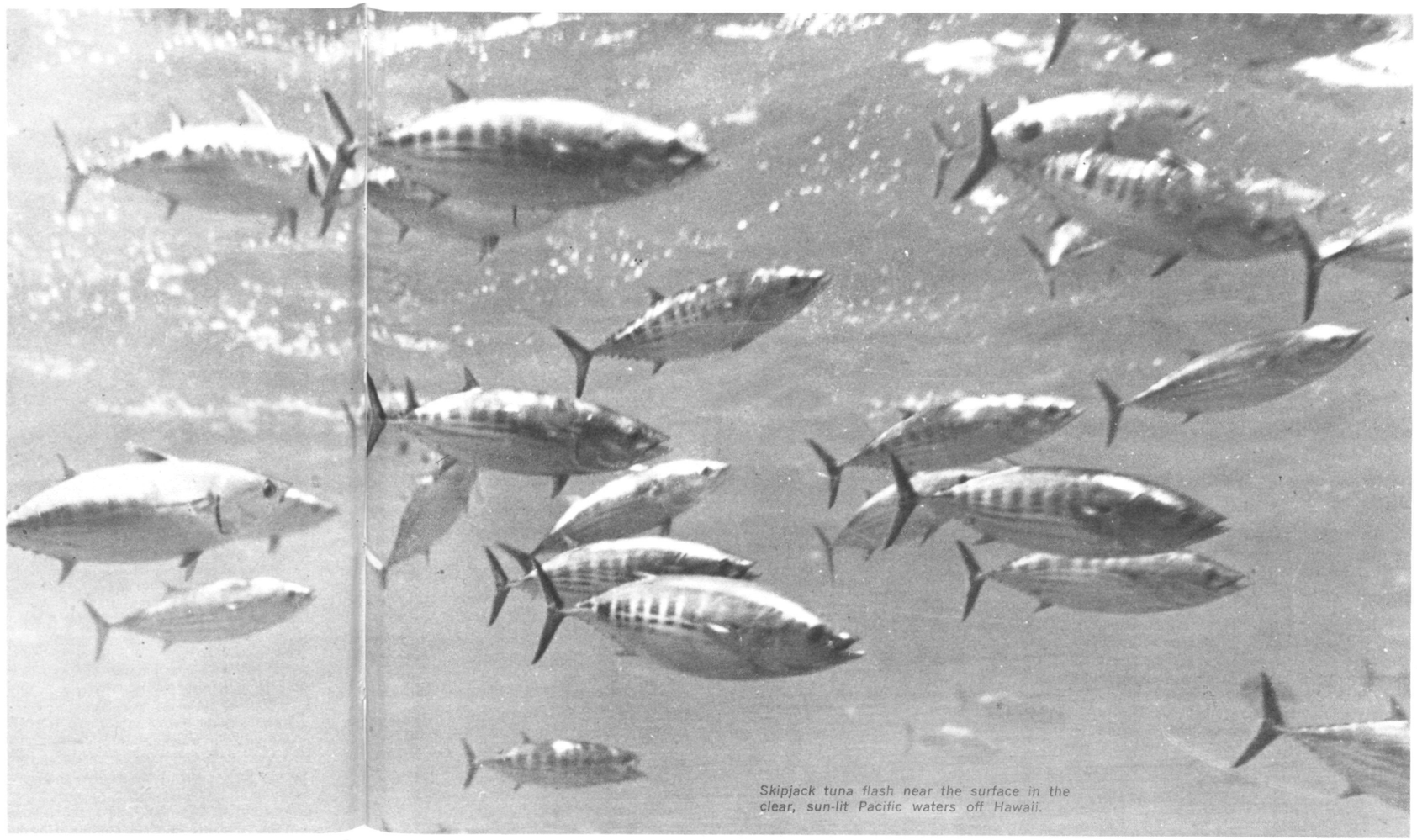
Reviewing the violence of these Kansas tornadoes and the amount of damage they inflicted in comparison with the low number of deaths, Weather Service Director George Cressman said:

"A few decades ago, I'm sure a tornado outbreak of this magnitude would have been followed by headlines mourning scores or perhaps hundreds of fatalities. The advancements since then in storm forecasting, communications, and public awareness of how to meet the tornado threat have resulted in an increasing number of disasters that didn't happen—like this one—and these undoubtedly don't receive the attention they deserve. I believe the outstanding performance by those involved in lifesaving warnings and emergency action in this episode should have been written in letters a foot high." □

TUNAS

Something For Almost Everybody

BY ANN WEEKS



Skipjack tuna flash near the surface in the clear, sun-lit Pacific waters off Hawaii.

Tuna fish, perhaps the most taken-for-granted seafood available in the United States today, during 1972 and 1973 became the runner-up to shrimp, consistently the country's most valuable ocean catch. For the past several years, the second-place tuna (sometimes called the "hamburger" of seafood) has been caught at the rate of more than 350 million pounds per year and sold at steadily rising prices now nearing $100 million per year to the U.S. fishermen. The tuna catch means $500 million to the total economy. Previously salmon was the second most valuable catch.

All portents suggest that tuna prices will increase substantially during 1974 and 1975, inasmuch as fishermen made their point when they refused to begin fishing out of West Coast ports in 1974 until they had gained the agreement of U.S. canners to pay a higher price for the tuna catch. In 1974 canners will pay $75 more per ton for yellowfin tuna and $45 more per ton for large skipjack when catches are delivered to port about mid-year. The canned product reaches grocery shelves several months thereafter or during the following year.

If retail tuna prices continue the upward spiral of the past few years—from about 38 cents per 6½-ounce can as recently as 1970, to 47 cents in 1972, to 65 cents in 1973, to 75 cents or higher in 1974—the commonplace market item may achieve the kind of glamor status that causes food editors to star the fish in new concoctions bearing exotic names such as "filet of tuna Veronique" or "tuna en papillote."

Though a long-established favorite with the school lunch bunch, with business people who either brown-bag their lunch or go out to eat, and with busy home-makers, the tuna as a natural phenomenon seems not to excite much curiosity or interest on the part of its millions of consumers. Most Americans—who consume an average of almost three pounds (about seven cans) per person per year—tend to think of the tuna only in terms of the contents of a can or as part of a salad, a sandwich, or a blandly flavored casserole. Children of the TV generation probably picture the animal as the somewhat disreputable, definitely suicidal "Charlie the Tuna" of television cartoon commercials, which apparently spends most of its time trying to get caught and canned.

In the natural state tunas are among the ocean's most splendid and fascinating creatures, a triumph of nature's ability to produce a biological machine capable of surviving not only a harsh environment, but a long history of predation by man. Archeological evidence indicates that tunas were used as food in early human civilizations thousands of years before herring, cod, and salmon were eaten; Greek objets d'art dating to the Sixth Century B.C. depict the butchering of tunas for human consumption. By and large, U.S. citizens have traditionally confined their tuna consumption to the canned form since the product was introduced in 1903, but in other countries the fish is cooked in a variety of ways or eaten raw. ("Sashimi," a favorite dish of the Japanese, consists of fresh raw tuna, sliced thin and eaten with a spicy sauce.)

The world catch of tuna for commercial usage amounts to some 3½ billion pounds, worth about half a billion dollars, and shared among 40 countries on an extremely unequal basis: the United States and Japan take and use about 70 percent of the world catch, and 38 other countries utilize the remaining 30 percent. The percentage gap exists for a number of reasons, not the least of which is that the price of tuna—still regarded as reasonable in this country—puts it in the luxury class in other countries.

The 12 or more different species of tuna so far identified by science are found throughout the world in all but the coldest marine waters, and their migratory routes take them through the Atlantic, Pacific, and Indian Oceans. Tunas are classified scientifically as within the scombroid family (mackerel or mackerel-like fish) and—though their size varies from the few pounds of the small bonitos to the 1,120-pound record giant bluefin—all share certain biological characteristics. Forced by their physiology to swim without respite, the tunas have high metabolic rates and high oxygen requirements, heavily muscled bodies that move speedily over vast distances, a tendency to rapid growth, and a spawning pattern which deposits young over tremendous stretches of ocean. Almost all the tunas considered of major consequence to commercial fisheries—yellowfin, skipjack, albacore, bluefin, and bigeye (which make up 90 percent of the world commercial catch)—also are caught in sport fisheries around the world. Others, such as the geographically limited blackfin tuna (habitat is the Caribbean and the southern Gulf of Mexico), and the strongly flavored little tunny (its meat is extremely dark and its market limited), also are caught by commercial and sport fishermen.

Three methods are used for commercial tuna catches, with the choice dictated by the type of tuna available, the area of the fishery, and national preference. The longline method, used extensively by Oriental nations, consists of long strings of hooks set out from single vessels over as much as 75 miles of ocean, with as many as 2,000 hooks reaching as deep as 100 fathoms. The longline remains undisturbed for a specific period—usually most of a day—then the accrued catch is brought aboard the fishing vessel. The livebait method, used widely for surface schooling fish by Europeans and in the South Atlantic and Caribbean, involves chumming waters with live bait and fishing for the feeding tuna by individual pole-and-line from a platform off the side of the boat. Purse-seine fishing, which came into heavy usage worldwide in the 1960's and in ensuing years replaced a large part of the fishing effort made by the other two types of fisheries, is the predominant method used by the U.S. tuna fleet. The technique relies on the capture of tremendous quantities of surface schools of tuna in each "set" of the enormous nets, which close around the catch in purse-string fashion.

Purse-seining for tuna unexpectedly provided behavioral scientists with knowledge of an odd, and so far unexplained, affinity of tunas for porpoises (or vice versa), a trait that was to cause serious repercussions for the U.S. tuna fleet in the 1970's. Because tuna (particularly yellowfin tuna) school in gigantic numbers beneath close-to-the-surface porpoise schools, seine fishermen soon learned to use porpoises as a means of locating tuna. When the purse-seine nets closed around the yellowfins, they also closed around porpoises, entrapping both species. The result sometimes was the unintentional drowning of some of the trapped marine mammals despite the most strenuous efforts on the part of the tuna fishermen to release the porpoises. What was a problem of inconvenience, conscience, and individual compassion during the Sixties became a matter of law in 1972, when the Marine Mammals Protection Act was signed into law by President Nixon. The U.S. fishing fleet was allowed two years from the effective date of the legislation (October 20, 1972) to fish without a permit to take marine mammals. However, during that period the fishermen were required to adhere to any regulations promulgated by NMFS that were designed to reduce the incidental taking of porpoises. Failure to adhere to such regulations would subject the fishermen to severe penalties. The need for action has given impetus to expanded biological investigation of Pacific porpoises by the National Marine Fisheries Service and a stepped-up gear research and development effort by the industry and the Fisheries Service to enable the tuna men to meet the deadline of October 1974. The built-in prohibitions of the marine mammals legislation also apply to imports—after October 1974, methods of catching must conform to U.S.-set standards, regardless

of country of origin, or catch cannot be accepted in the United States.

Historically the most abundant world and U.S. tuna catches consist of yellowfin, with skipjack and albacore placing second and third, and bigeye and bluefish running fourth and fifth. The major portion of the U.S. tuna catch is taken from the eastern Pacific Ocean; about 10 to 15 percent of the total comes from the Atlantic, including the tropical Atlantic off the west coast of Africa. The five major species are geographically categorized as tropical or temperate. Albacore, the only species that can be marketed as "white meat" tuna, is the most valuable tuna on a price-per-pound basis in this country; yellowfin, skipjack, and others are canned as "light meat." Because the Japanese place a higher value on bluefin tuna than on others, and an increase in U.S. catches of bluefin coincided with a decrease in Japanese catches during the past three years, the recent price paid to American fishermen for bluefin has risen considerably. The high price paid by the Japanese for bluefin (said to be up to $1.65 per pound in certain areas) is causing serious concern on the part of fisheries scientists, conservationists, and sport fishermen who fear that the double pressure of intensified commercial and sport fishing on the species is reducing its numbers to dangerous lows.

Most of the tuna species seem to share another, somewhat striking characteristic, which is an uncanny annual punctuality. The fish seem to respond to some inner timetable of tremendous efficiency during long and short migrations. Sport fishermen, for instance, have for years known precisely when schools of giant bluefin tunas will appear around the Bahamas Islands and in the Florida Straits in the springtime, and eastern Pacific commercial tuna men can set their fishing calendar a year in advance for yellowfin and albacore migrations. Scientific investigations of short-term migrations have revealed similar tight schedules—in a series of experiments with skipjack tunas near a small feeding center close to Hawaii, for instance, NMFS biologists repeatedly observed that schools would move several to 20 miles away into the open ocean overnight, but would compulsively rush to be at the feeding grounds by sun-up (presumably breakfast time) the following day. In view of the long transoceanic and inter-continental migrations undertaken by some of the tunas, the factors that control migratory movements and patterns are of extreme interest to students of natural behavior of animals.

Marine scientists, fisheries managers, and experts in the legalities of high-seas resources throughout the tuna fishing world have exhibited an intense and abiding interest in the ecology, the physical attributes, and the geographic distribution of tuna populations since the tuna industry began to burgeon in the 1940's.

World tuna catches for the five major species advanced most dramatically after

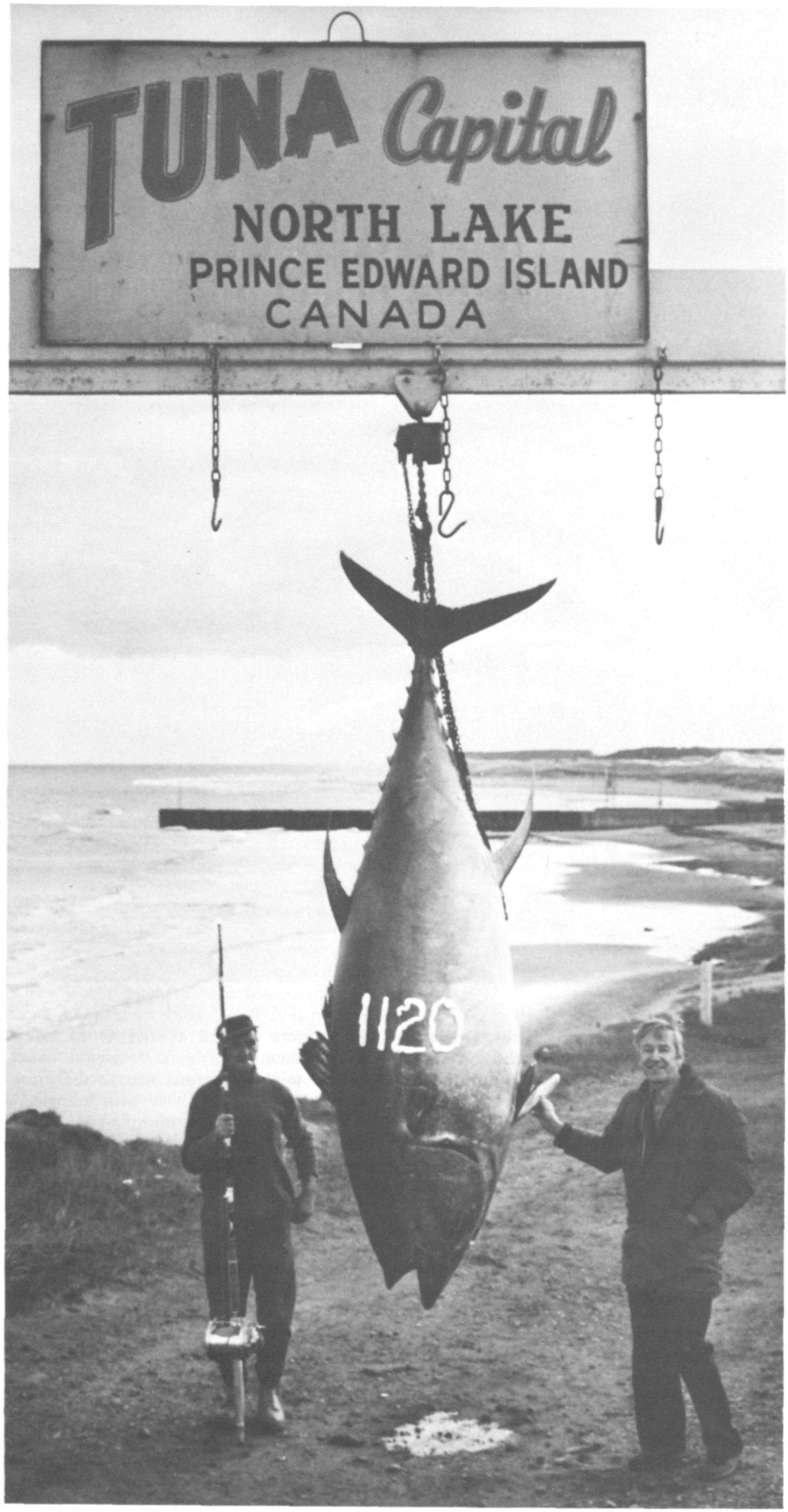


Photo: Prince Edward Island Department of Environment and Tourism

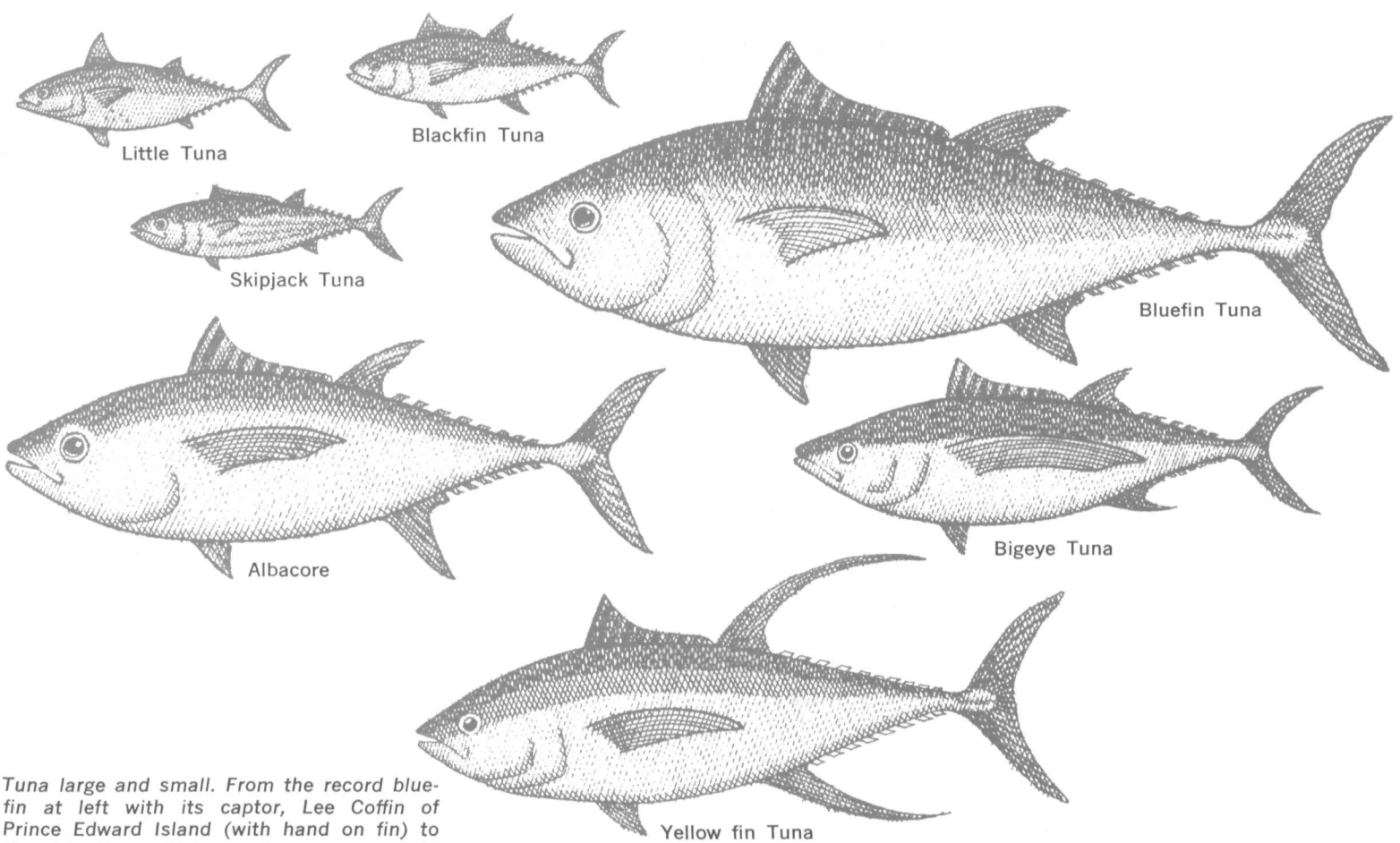
World War II—from about 700 million pounds in the late 1930's to more than 1 billion pounds in 1952, reaching a plateau of slightly over 2 billion pounds which held 1961 to 1965. The catch increased slightly from year to year thereafter until it reached the current 3.5 billion pound figure. In the United States, consumption of tuna has nearly doubled every decade over the past 50 years, and the end is not in sight. Obviously the tuna and its continuing wellbeing are of major importance to a long list of individuals, including commercial and sport fishermen, vessels and gear suppliers, canners and processors, restaurateurs, grocers, and housewives.

U.S. involvement in international consideration of the management and protection of the valuable tuna resource has been extensive for a quarter of a century. NOAA's National Marine Fisheries Service and its predecessor, the Bureau of Commercial Fisheries, long have been committed to major roles in the creation and implementation of the national philosophy and policy toward the management of tuna fisheries. Federal fisheries scientists have been in the vanguard of the national tuna research effort.

The United States is associated with two international organizations that exist for the sole purpose of studying and managing the high migratory tuna resources, and providing the necessary guidance for the establishment of necessary controls on fisheries for the tunas. The first, the Inter-American Tropical Tuna Commission (commonly called IATTC), was established in 1949 by convention between Costa Rica and the U.S.A. The region under consideration by IATTC is that part of the eastern Pacific Ocean from 40° N. to 30° S. and as far as about 2,500 nautical miles off the North and South American shores, and the species of primary responsibility are yellowfin and skipjack tunas. IATTC, whose members presently are Canada, Costa Rica, France, Japan, Mexico, Nicaragua, Panama, and the U.S.A., strives to conserve and manage the tuna and tuna-like fish resources in the area under its control by international regulation. Since 1966, the organization has established an annual quota and an open and closed season for yellowfin tuna, the only species under regulation. The fishing season begins January 1, and although the closure date was once as late as September (the year the conservation program began), in recent years—primarily because of the tremendous growth of the international fleet, the season has ended as early as March. In recent years, the quota has been 165,000 tons.

One serious issue facing the IATTC in 1974 is the question of effective enforcement of regulatory provisions by all countries participating in the fishery. Lively discussions also are expected at the next several meetings of the organization concerning the international implementation of measures demanded by the provisions of the U.S. Marine Mammal Protection Act of 1972. The United States has asked tuna-fishing nations to cooperate in reducing the incidental catch of porpoises in purse-seine catches of tuna, citing the language of the U.S. law, which prohibits the importation of fish or fish products resulting from commercial capture methods that cause an incidental kill or serious injury to the marine mammals. The United States, as required by the Act, has asked the IATTC's Director of Investigations to recommend to all Commission members those types of fishing gear and methods tested and found effective in preventing harm to porpoises.

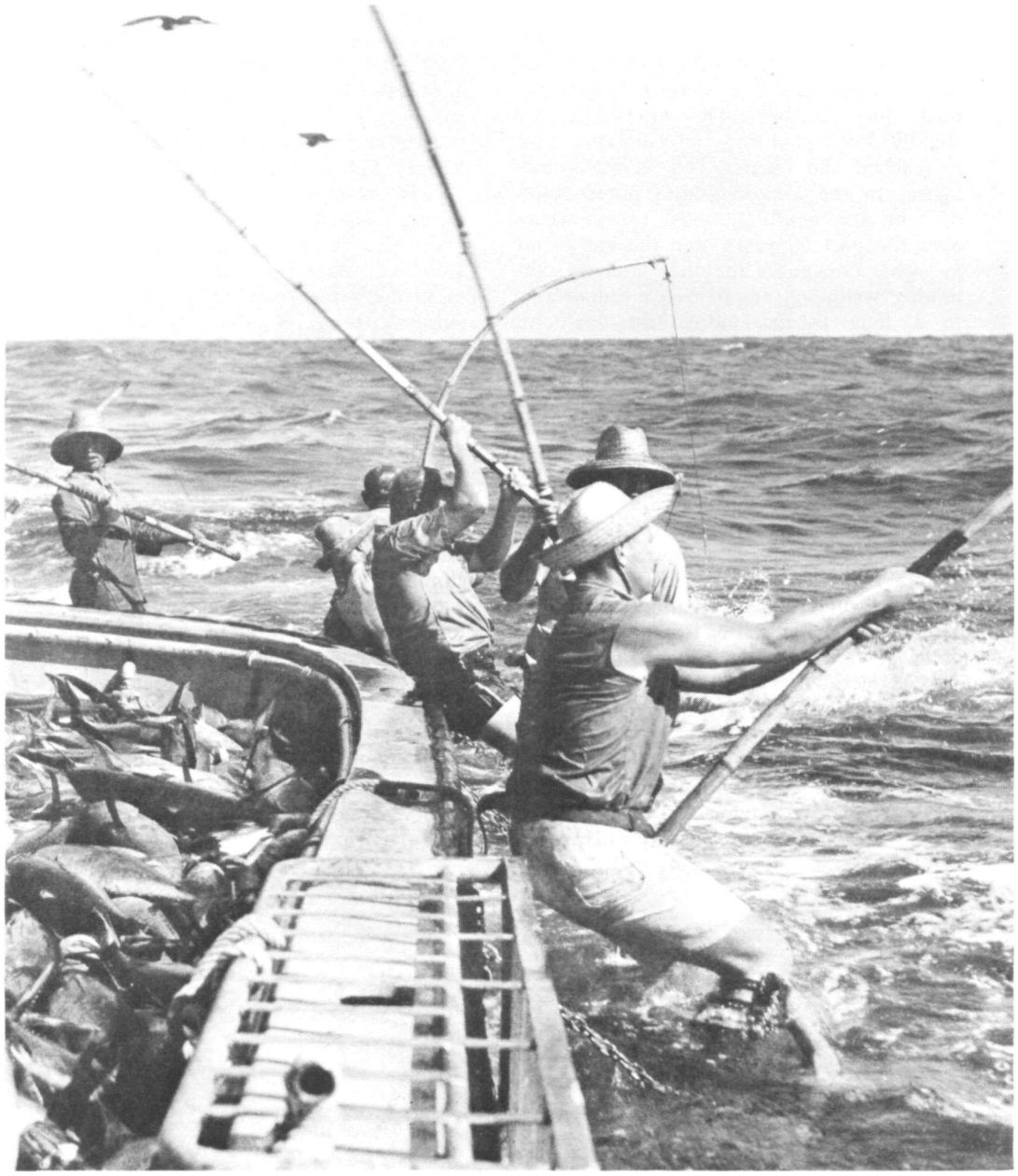
The second such regulatory body is the International Commission for the Conservation of Atlantic Tunas, established in 1969. ICCAT has responsibility for obtaining and collating the information necessary for maintaining tuna populations in all Atlantic waters, including adjacent seas. ICCAT has established four panels with primary responsibility for developing regulatory proposals for species and areas, as follows: tropical tunas—yellowfin and skipjack, temperate tunas (north)—bluefin and albacore in the northern hemisphere; temperate tunas (south)—bluefin and albacore in the south-



Tuna large and small. From the record bluefin at left with its captor, Lee Coffin of Prince Edward Island (with hand on fin) to the blackfin, which rarely runs over 10 pounds, they're all caught for food or sport.

Photo: Dade W. Thornton

Porpoises skip joyfully away after release from a tuna purse seine (top). A school of 400–500-pound bluefin in the Atlantic (above). Yellowfin are taken by pole and line from the racks on the Hugh M. Smith after chumming with livebait.



ern hemisphere; and other species—including bigeye, bonito, and billfish.

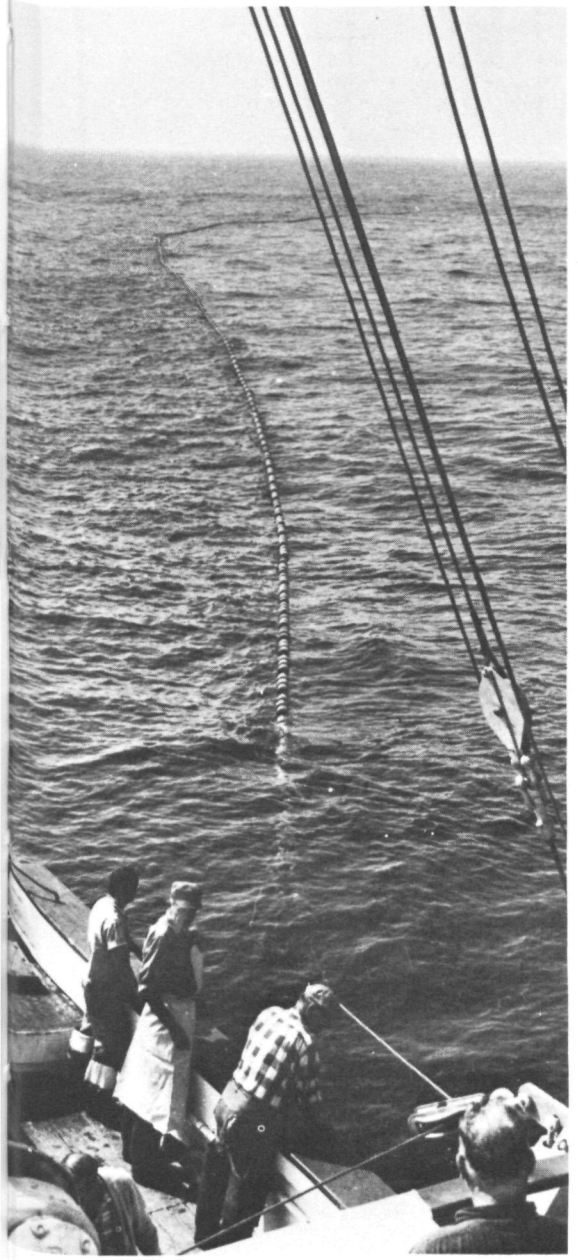
Dr. Brian J. Rothschild, Director of NOAA's NMFS Southern Fisheries Center (La Jolla, Calif.), was elected Chairman of the ICCAT Standing Committee for Research and Statistics at the November-December 1973 annual meeting. Dr. Rothschild is the second scientist and the first American to occupy the post since ICCAT's formation. Within NOAA, he has the responsibility for coordinating national biological research on tuna, and for the conduct of research on tuna fisheries in the Atlantic, Pacific, and Indian Oceans.

Members of the ICCAT consist of Brazil, Canada, France, Ghana, Ivory Coast, Japan, Korea, Morocco, Portugal, Senegal, South Africa, Spain, and the United States. At the most recent ICCAT meeting, the United States formally expressed its concern for the possibly precarious status of the Atlantic bluefin tuna stocks, in view of indications of possible decreases in abundance. The U.S. attitude was supported by the evidence of 20 years of scientific investigation by Federal and private marine researchers and tag returns from an extensive bluefin tuna tagging operation which has been under the direction of the Woods Hole Oceanographic Institution since 1954.

Full-scale programs of investigation of the Atlantic tunas by Federal scientists began in 1962, under the aegis of the old Bureau of Commercial Fisheries. The fisheries agency acted as international coordinator and a participant in the International Cooperative Investigations of the Tropical Atlantic—an organization that carried out intensive studies of the biology and oceanography of the tropical Atlantic. ICITA, sponsored by the Intergovernmental Oceanographic Commission of UNESCO, was responsible for numerous cruises by 14 research vessels from eight nations, during 1963 and 1964. These "Equalant Expeditions" (=Equatorial Atlantic) provided what amounted to two seasonal "photographs" of the horizontal and vertical distribution of the physical, chemical, and biological properties of the tropical Atlantic waters from the Tropic of Cancer south to the Tropic of Capricorn.

Atlantic tuna investigation was carried out from 1965 to 1970 from the Fisheries Service's Tropical Atlantic Biological Laboratory, Miami, Fla. (now renamed the NMFS Southern Fisheries Center). Numerous research cruises ranged out as far as the west coast of Africa in pursuit of tuna information, and several laboratory programs collected and processed great volumes of scientific and fisheries data. Much of the material thus collected formed the groundwork for the ICCAT when the organization was in formative stages.

Most tuna research performed by Federal scientists was centralized and relocated, in 1970, at the Southwest Fisheries Center at



Purse seine methods (left) are most popular with U.S. tunafishermen. At the top, skipjack tuna to be used as research samples are lined up for inspection. Above, a 500-pound bucket of yellowfin tuna is swung from ship to shore.

La Jolla, Calif., whose mission had long encompassed wide-range studies of various tuna species. The NMFS Miami facility was to continue its studies of Atlantic tunas, but in terms of the sport catch, with particular attention to albacore and bluefin migrations through Atlantic waters as evidenced by tags taken from recaptured fish. NMFS expanded its participation in tagging studies last February when it formally joined with the Woods Hole Oceanographic Institution and became a partner in the Game Fish Tagging Program. (The pioneering tagging program began in the Atlantic in 1954; to date more than 39,000 fish have been tagged—primarily tunas and billfish—and some 3000 tags have been recovered. Over the years, the program has received partial support from the Sport Fisheries Institute, the National Science Foundation, the NMFS, and the Office of Sea Grant.) Tagging activities are now a part of the Southeast Fisheries Center's Oceanic Game-fish Investigation.

Since 1970, fishery biologists, oceanographers, population dynamicists, and physiologists at the NMFS laboratories in La Jolla and Honolulu (part of the Southwest Fisheries Center) have carried out a greatly expanded series of tuna-related activities—from providing scientific and technical advice in support of the U.S. positions taken on international fisheries commissions such as the IATTC and the ICCAT, to studies of porpoise-tuna interactions.

The basic mission of the Honolulu laboratory is to provide U.S. commercial fisheries, recreational fisheries, and the general public with information and advice on the management and conduct of the fishery resources of U.S. concern in the Pacific region, particularly the development of the skipjack fishery. (Fisheries experts tend to agree that the skipjack tuna is not fully utilized commercially, perhaps to the detriment of other tuna populations that show evidence of overexploitation.) The laboratory also stresses assessment studies of commercial and game-fish stocks (chiefly the tunas), and studies of the relation of fish to tropical oceanic and island environments.

The La Jolla laboratory places emphasis on the acquisition of information designed to form the basis of analyses pertaining to tuna fishery management systems, and the provision of technical advice to delegates representing the United States at various international meetings. Laboratory personnel carry out environmental and biological studies leading to improved tuna fishing systems, including laboratory and field studies designed to reveal scientific information about life cycles and migratory patterns of tunas.

The NMFS Northwest Fisheries Center (Seattle, Wash.) makes an important contribution to fishing gear research and development. Since the passage of the Marine Mammals Act of 1972, the Center has been conducting extensive experiments with nets and gear to mitigate the adverse effects of tuna fishing methods on porpoise populations.

The two Pacific Ocean laboratories work closely with sister research laboratories, fishermen's organizations, state fisheries departments, foreign nations, and West Coast academic institutions in a number of cooperative projects related to tuna populations and habits. The study and development of various kinds of tuna gear and equipment, always of major importance, became of paramount importance in the early 1970's as pressure on the Pacific tuna fleet mounted in anticipation of the October 1974 prohibition against fishing methods that endanger porpoises. NMFS gear specialists and fishermen worked side-by-side in a series of west coast projects intended to solve the problems presented by the tuna-porpoise association on the high seas, while NMFS biologists bore down on the study of porpoise populations and life cycles.

The much expanded NOAA-NMFS tuna investigation got underway not a moment too soon. A number of factors combined, in the first half of the 1970-80 decade to underscore the emergency nature of the national need for an expanded fisheries program to both develop and conserve to the utmost our marine food resources. The nation was faced with food shortages and sky-high prices especially for protein foods; diminished marine food catches because of natural fluctuations and intense fishing competition from foreign nations; the fuel shortage, which threatened to still furthur reduce food supplies delivered to the market; the threat inherent in the Marine Mammal Protection Act of 1972, of another reduction in the national supply of fish (tuna), including imported supplies.

The continued viability of the world tuna resources, the maintenance of a rich tuna harvest, and a stable and prosperous tuna industry now more than ever are necessities of the highest priority. □

A refreshing, $3.7 million Inflation Age paradox is reported by the National Ocean Survey

SALES UP, PRICES DOWN

BY RAYMOND WILCOVE

Photos: Harold M. Goodman, NOAA

(Left) Karen Kaiser waits on customers purchasing charts at the National Ocean Survey's public sales counter in Riverdale, Md.

(Above) Morris Jones (seated) and Spellman Diez, Chief and Assistant Chief of the Distribution Division, examine a new chart.

NOAA is the home of one of the federal government's oldest and largest distribution facilities, from which more than 50 million pieces of mail are sent out each year. During the past 135 years, approximately one billion publications have been issued.

Known as the Distribution Division, this multi-million dollar facility is part of the National Ocean Survey's Office of Aeronautical Charting and Cartography. It is located in Riverdale, Md., a community of 6000 in the Washington, D.C., metropolitan area.

Here in a renovated World War II aircraft plant the Division handles publications essential to the nation's economy and to the safety and wellbeing of millions of persons. The diverse publications it distributes are sent the length and breadth of the United States and to the far corners of the earth. They range from navigational charts to maps of the sea bottom and copies of L'Enfant's original manuscript plan of 1791 for the City of Washington.

The facility's main product is the multicolored navigational chart, both aeronautical and nautical. During the past year, it distributed approximately 35 million copies. Without them, much of the nation's commerce could not function efficiently.

The earliest known records of chart distribution by the Coast and Geodetic Survey, predecessor of the National Ocean Survey, show that approximately 1700 were issued in 1851. Small numbers of charts were issued annually, prior to that after formation of the agency in 1807.

According to the available records, the one billionth navigational chart will be issued in 1976.

A staff of 93 headed by Morris R. Jones keeps these vital publications moving to the nation's aircraft and sea pilots, millions of recreational boaters, and thousands of others in related activities.

While the Distribution Division handles a tremendous amount of mail, the speed with which it is issued is Jones' primary concern.

"Some of our publications, primarily aeronautical charts, must be furnished to pilots as quickly as possible because changes, many of them critical, are occurring constantly," he pointed out. "It is important that pilots obtain up-to-date charts as they are published. To insure that only the latest charts are used, regularly revised lists are published for aeronautical charts."

The receiving, processing and mailing of orders for aeronautical charts may seem like a humdrum, cut-and-dried operation, but it is far from that, as some of the letters received from customers attest. For Jones and his staff are in the "hot seat" when it comes to handling aeronautical charts because of the important role they play in aviation.

That Jones and his staff have been successful in their task is attested by the honors they have received. Jones was the recipient last year of NOAA's Public Service Award for his "untiring efforts, outstanding leadership and managerial ability in directing the complex chart distribution activity for the National Ocean Survey." The award consisted of a plaque and $1000 and was accompanied by the congratulations of Dr. Robert M. White, NOAA Administrator, for Jones' "fine accomplishments."

During nearly four years as Chief of the Distribution Division, Jones has introduced various innovations in the issuance of the publications. He developed new processes and procedures to expedite ordering, packaging and delivery and to reduce the cost of charts to the user. He also installed an after-hours telephone recording service so that chart orders can be placed at any time of the day or night. Jones, a graduate engineer, served as an Army topographic engineer in World War II and as a topographic engineer and distribution officer with the Geological Survey until he joined the National Ocean Survey in 1970 to head the Distribution Division.

The Distribution Division's Assistant Chief, Spellman Diez, has also been honored for developing major improvements in the chart distribution system. Diez has received the Department of Commerce Silver Medal, the agency's second highest award. He has been with the Commerce Department for almost 33 years, including 19 years with geodetic field parties in 48 states. He was previously assigned for eight years in the San Francisco office where he last served as Chief of Operations.

But Jones, Diez and staff have their problems. No matter how efficient an operation may be, the human equation cannot be ignored and when some 75,000 orders have to be filled each year, some mistakes and honest misunderstandings are bound to occur. When aeronautical charts are not delivered on time, whether it be the fault of the agency or anyone else, the seats in which they sit get overly warm and they hear from John Q. Public, especially if he is an aircraft pilot.

Most aeronautical charts go to civilian pilots, including some commercial pilots, and those with foreign airlines and other government agencies. One series of aeronautical charts is subject to weekly revisions. Available on a subscription basis, these Instrument Approach Procedure Charts contain 1800 charts in a complete file, with from 80 to 100 of them being revised each week.

Maintenance of the Distribution Division's subscriptions is being phased into computer assistance in the areas of producing mailing labels and subscriber renewal notices. The computer also provides a big assist in stock control and management and the billing of monthly agent accounts.

Time is of the essence in their delivery and when some charts do not arrive on time the complaints come hard and fast, although few are as pungent as this one received from an air service.

"I can only conclude that your Washington office doesn't know what they are doing, doesn't care what they are doing, doesn't care about their dealers, doesn't care about the pilot, doesn't have the least idea of running a business, doesn't have any training in filling orders, doesn't have any kind of supervision by anyone that's on their toes, and doesn't have any bosses that know how to act like a boss and GET THINGS ACCOMPLISHED!"

But this unfavorable comment is offset by the kudos received from most satisfied customers, such as the aeronautical chart agent

(Above) Ralfe Speiser of the Records and Statistical Branch enters chart distribution data on a magnetic tape as part of the stock control and automatic billing program.
(Upper Right) Marlene Menick of the Subscription Section works at account maintenance.

(Right) Pauline Poston, Franklin Britton, Edna Jolly and others in the Instrument Aeronautical Chart Section of the Chart Supply Branch, pull Aeronautical Instrument Approach Procedure Charts neatly stored in pigeon-hole racks.

in Ohio who informed Jones: "If all the people in government were as efficient as you people, our taxes would be cut in half. You really do a fine job."

Or this communication from another customer: "You must have an efficient organization with dedicated people."

From still another, "If all governmental departments had the esprit de corps that the National Ocean Survey has with their employees, what a fine government we would have."

More effective than this unsolicited comment is the action taken by the National Ocean Survey to cut the cost of some of the charts issued by the Distribution Division. In a period of constantly rising prices, the Survey has been able to reduce the price of 25 aeronautical chart items this year.

The reduced prices were made possible by economies in distribution, including centralization of activities at Riverdale and a reduction in personnel from 124 in 1969 to the present staff of 93. While some charts are sold from government offices in San Francisco, Anchorage, Alaska, Detroit and Rockville, Md., the great bulk of the mailings is handled at Riverdale, much of it to authorized commercial agents, who sell direct to the chart users.

Economies were also effected in the processing and compilation of data by the Office of Marine Surveys and Maps, headed by Captain Robert C. Munson, and in the printing of charts by the Office of Aeronautical Charting and Cartography, directed by Col. Frederick O. Diercks.

Some price reductions are substantial. The cost per year of Instrument Approach Procedure Chart Substcriptions for the conterminous United States has been cut almost 13 percent, from $132 to $115, and the subscription for regional charts has been reduced from $29.95 to $25.50. Reductions in subscriptions for Radio Facility Charts range from 25 cents to $3, while a Standard Instrument Departure Chart subscription for Alaska was cut more than 41 percent, from $12 to $7. While most reductions are in the cost of aeronautical charts, the price of bathymetric maps, previously $4 each, was slashed in half. Some prices have also been increased, but this does not alter the fact that the prices on as many as 25 chart items have been reduced.

Navigational charts—almost 1000 nautical and 3300 aeronautical—make up the bulk of publications issued by the Distribution Division and of these the great majority are aeronautical charts. These charts depict communication facilities, navigational aids, airport landing patterns, safe operating procedures and air traffic rules.

A new-issued Sectional Aeronautical Chart is sent on its way by Essix Daniel and other chart distribution specialists. These men are part of a team at the National Ocean Survey Distribution Division which sends out more than 50 million pieces of mail each year.

They are used by air navigators and pilots, air traffic controllers, airports and airlines.

About 80 percent of the 33 million aeronautical charts distributed annually are Instrument Aeronautical Charts. Some 27 million were distributed last year. Approximately 2.2 million nautical charts are also issued annually.

While most charts go to the private sector, the military forces are also major customers. Approximately 850,000 aeronautical charts, primarily Visual Aeronautical Charts, are furnished annually to the Air Force and some 700,000 nautical charts to the Navy.

The Distribution Division also acts as an Air Force agent in the sale and distribution to civil aviation of Air Force charts covering airspace outside the United States. About 150,000 Air Force charts are sold each year. Approximately 15,000 navigational charts are furnished also to Members of Congress without cost, largely for constitutents, with each member entitled by law to 100 charts a year.

One of the innovations instituted at the distribution facility is a self-service office where customers can select their own charts and then pay for them at the sales counter. Approximately 2400 charts are sold there monthly.

Most charts, however, are mailed to almost 1500 aeronautical chart sales agents and more than 1000 nautical chart agents, including outlets in 12 foreign countries. These account for 90 percent of visual aeronautical and nautical chart sales. The aeronautical chart agents are generally base operators at airports and aeronautical supply outlets, while the nautical chart agents are, in general, marine equipment outlets, marinas and harbor facilities.

The Distribution Division also furnishes navigational charts to 85 colleges and public libraries in the United States and seven in Canada which maintain up to date collections of National Ocean Survey charts for reference.

In addition to navigational charts, the division distributes various miscellaneous publications, some among the most interesting available to the public. These include such varied publications as: territorial sea maps outlining the three and 12-mile limits along American shores; historical charts of the Wilkes Expedition of 1838–42 in the Pacific Northwest; outline maps for construction of a model of the world; publications on such subjects as hurricanes, tornadoes, aviation weather services, marine game fish and the VHF radio weather program.

The Distribution Division handled approximately 75,000 orders in the 1973 fiscal year. Sales totaled about $3.7 million.

The Distribution Division was located for many years in the Department of Commerce Building in Washington and when it outgrew its quarters there it moved temporarily to 4200 Connecticut Avenue, N.W., at the old site of the National Bureau of Standards. It left in Sepember 1972 to make room for the Washington Technical Institute and moved to its present location in Riverdale which has been leased from the American Car and Foundry Company. Railroad products were manufactured there until 1966. The facility was completely renovated so that practically the only evidence of its former existence is its outside walls. The division occupies 25,000 square feet of office and shop space and 80,000 square feet of warehouse space. It is the most commodious quarters the facility has known in the long years of its existence. □

Their search for scientific careers in the field, on land and sea, led six women to the NOAA Corps

FROM MS. TO ENSIGN

BY ANN K. COOK

"Challenging."
"Fascinating."
"Fantastic."
"Unique."
"Just the thing I've been looking for."

That's how several young women view their budding careers in the Commissioned Corps of the Commerce Department's National Oceanic and Atmospheric Administration—a few of the reasons they are now NOAA officers.

Smallest of the nation's seven uniformed services, the NOAA Corps has some 350 officers who serve throughout the agency in its National Ocean Survey, National Weather Service, National Marine Fisheries Service, National Environmental Satellite Service, Environmental Data Service, and Environmental Research Laboratories. About half of the officer complement normally is assigned to duty aboard ship, carrying out deep sea research, hydrographic and tidal current surveys, and wire drag operations.

Until mid-1972, when the first woman officer was appointed, the Corps was all-male. In the following year, two more women joined. When the 46th NOAA officers class began its training in December 1973, six of its twenty-two members were women.

All have college degrees in the sciences or mathematics. Deborah Astle of Pico Rivera, Calif., has completed course work for a master's degree in earth sciences from Northern Arizona University. Christine Carty, Mattituck, N.Y., is a biochemist from Cornell University. Cheryl Cavin, Belle Fourche, S. Dak., holds a bachelor's degree in chemistry from the South Dakota School of Mines. Evelyn Fields, of Norfolk, Va., majored in mathematics at Norfolk State College. Karen O'Donnell, of Newport Beach, Calif., earned her bachelor's degree in marine biology from California State College, Long Beach. Mary Zoeller, from Wilbraham, Mass., concentrated on biochemistry at Worchester Polytechnic Institute.

The women also share a love of outdoor life and a desire for work in the field on land or sea, rather than in an office or administrative post. It was this aspect of NOAA Corps, as well as the opportunity to participate in a variety of scientific work, that led them to join.

"The NOAA recruiter talked about being at sea, then on shore duty with a field party, living in trailers," Deborah Astle recalls. "That kind of life appeals to me."

Chris Carty, an experienced lifeguard and water safety instructor, loves the water —"swimming, diving, sailing, every aspect of it I can think of." When she went for a campus interview with the NOAA recruiter, she asked him why she should join the Corps. "He said that if you like going to sea, doing a variety of things, traveling, responsibility—then join. I loved all of them. Everything seemed to be pointing me to the NOAA Corps, and I went with it."

With a degree in biochemistry, Mary Zoeller faced a career choice between medicine and oceanography. She applied for a NOAA Corps appointment, because she found the agency's ocean projects interesting, and because the life and work of NOAA officers sounded "totally different."

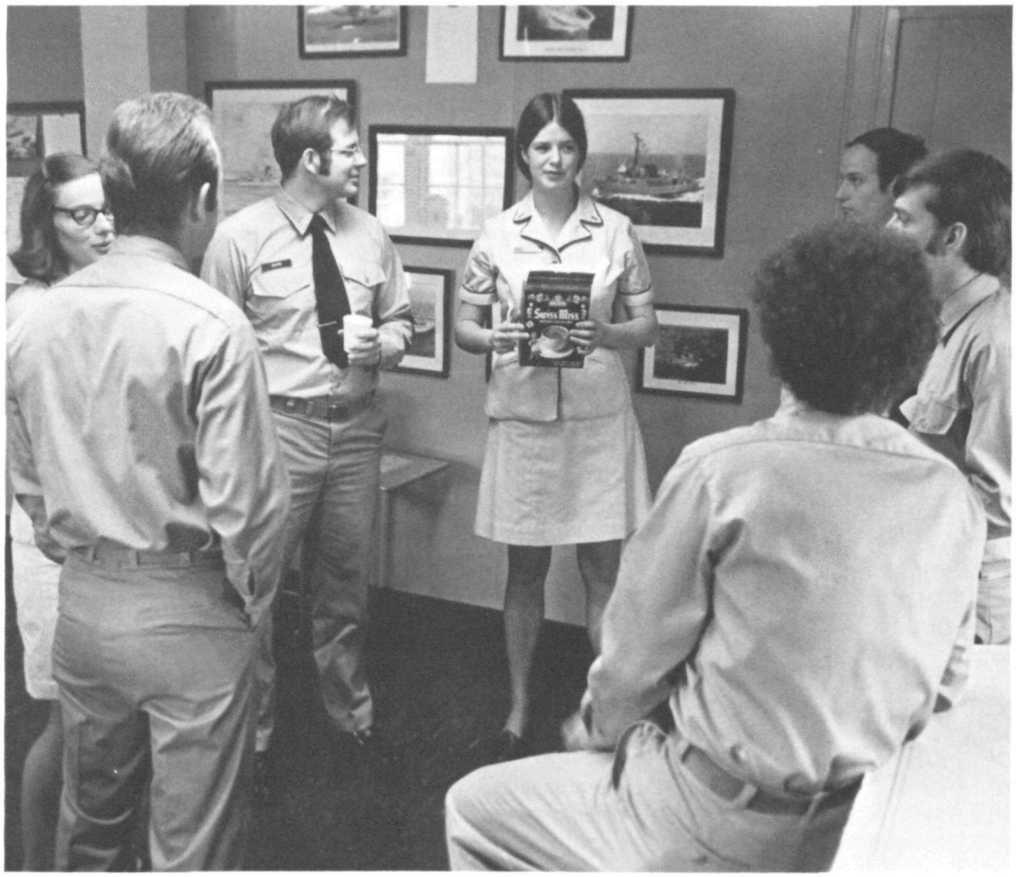
Karen O'Donnell originally intended to work for the fish and game department in her state, studying marine ecosystems, but as her college graduation approached she found job openings very limited. She learned of NOAA and the NOAA Corps quite accidentally, from a brochure, and was impressed with the agency's diversity, variety, and challenge.

Before beginning the NOAA Corps training, Cheryl Cavin had never seen the ocean. She had wanted to study marine biology, but wasn't able to attend a coastal college offering such a major. After talking with the NOAA Corps recruiter on his visit to her South Dakota school, she decided to accept the challenge. "It was not just the challenge, but the idea of doing some meaningful work as well."

Evelyn Fields is the only one of the group with previous experience in NOAA. Before her appointment to the Corps, she worked for a year as a cartographic aid with the National Ocean Survey's Atlantic Marine Center in Norfolk. "At AMC," she says, "you see the ships, you see the officers and you know what their backgrounds and qualifications are. But I never really gave a whole lot of thought or consideration to joining the Corps, until it was suggested to me. Then I thought 'Why not?' It seemed to be a unique experience, something to look forward to, a new set of challenges. I'm always looking for some kind of challenge."

In a two-and-a-half-month program at the NOAA Officers Training Center—located at the U.S. Merchant Marine Academy, Kings Point, N.Y.—new officers are taught the skills needed aboard ship and in scientific and research activities. They are introduced to the ways of the sea by rowing Monomoy boats on Long Island Sound, and advance through motor launches and sail-

The six women in the 46th NOAA officers class cross the Kings Point campus. Front, from left: Christine Carty, Evelyn Fields, Deborah Astle. Rear: Karen O'Donnell, Cheryl Cavin, Mary Zoeller.



At the NOAA Officers Training Center, new officers learn skills needed aboard ships and in scientific and research activities. (Top) Four women officers in class. (Left) A break for snacks and talk between classes. (Above) Evelyn Fields and Christine Carty plot the route of a training cruise, with instructor Lt. M.R. Johnson, and (right) learn use of electronic navigation aids from a Merchant Marine Academy instructor.

boats to cruises of several days' length aboard the Academy's vessel, the KINGS POINTER—learning the mechanics of ship handling and navigation.

A major problem the women encountered as their training began was the overprotectiveness of their male classmates.

"The men were too helpful," Ensign Astle says, "and we had to straighten them out right away. We needed to learn things on our own, just as they did."

"Some of the activities are strenuous for women," Ensign Fields points out, "especially handling the heavy lines on a ship. The first time I did it, I thought I was going to pass right out.

"But you do the best you can, and the men let you go right ahead and try it. If they see that you're having trouble, or you ask them to lend a hand, they pitch in and help. They realize those lines are heavy. They realize we don't have the same strength they do, and that it takes us a bit longer to get the job done."

Deborah Astle describes the officers' training as "a completely new experience, new environment, new language—everything is really unique." For Cheryl Cavin, "it's so different from college. Everything you learn is practical and has immediate application."

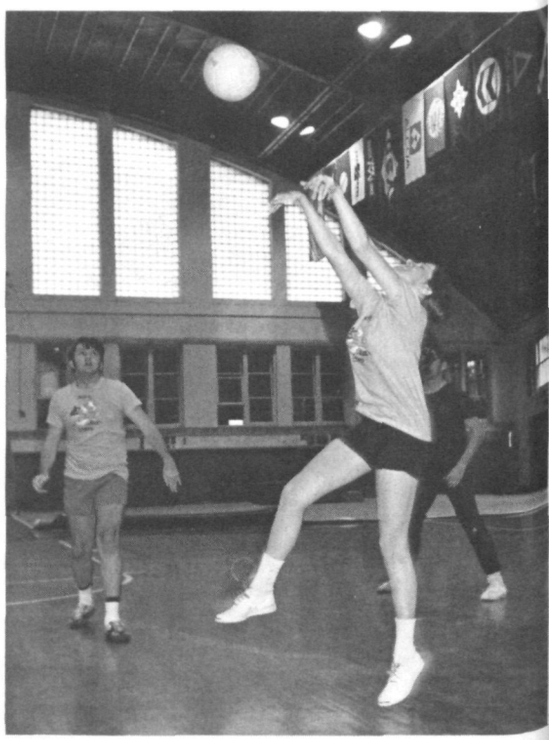
Chris Carty's friends thought she was crazy when she sent her application to the NOAA Corps. "So I told them I'd learn a lot about seamanship and how to handle a boat, and I'd save my money for three years. Then I'd buy a large sailboat and take them around the world."

Now, Ensign Carty says, she's "amazingly surprised at how much I like it. There's a lot of doing and a lot of responsibility, which I'd just as soon have. I like sailing, I like rowing, I like steering the boat, handling lines. I just like being on the water, in the water, under the water—so it's working out unbelievably well for me."

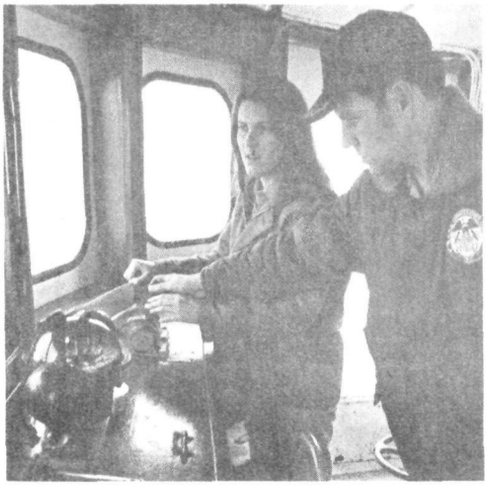
But she may still sail around the world some time.

After learning hydrographic surveying techniques at the Atlantic Marine Center, the six women began their first assignments: Evelyn Fields and Karen O'Donnell aboard the NOAA Ship MT MITCHELL, based at Seattle; Mary Zoeller and Chris Carty on the RESEARCHER, which operates out of Miami; Deborah Astle on the OCEANOGRAPHER, also at Seattle; and Cheryl Cavin with the Atlantic Hydrographic Field Party, based at the Atlantic Marine Center.

Members of the Corps serve in all elements of NOAA's worldwide organization, with assignments including such diverse responsibilities as ship command, piloting photogrammetric planes, research and administration. The varied disciplines involved extend to aeronomy, meteorology, hydrology, oceanography, geodesy, geomagnetics, seismology, satellite technology, and cartography. During a typical 30-year career, an officer may expect to have 15 years of fixed shore duty, nine years of sea duty, and six years of shore duty in mobile field parties.



(Top left) Karen O'Donnell helps lower a Monomoy boat, and (top right) she joins the men in rowing while Deborah Astle acts as as coxwain. (Left) In the bachelor officers' quarters, Ensigns Fields and Sarb practice on nautical knots. (Above) Mary Zoeller lofts the volleyball in coed physical education class.



(Left) Cheryl Cavin at the helm of a training vessel. (Above) Mary Zoeller takes her turn, getting some pointers from Lt. Cdr. J. W. Dropp.

Sea duty is normally the first assignment for newly appointed officers.

"I'm really excited about getting out to sea," Ensign Astle says. "All your life, you face obstacles and barriers because you're female. Now they're trying to put us on an equal footing with the men. We'll have a chance to prove ourselves, to show that as women we are capable of carrying out all the operations aboard ship."

The women's long-term career interests cover a wide range, but given the opportunity to work in their chosen fields, they anticipate staying in the Corps for some time.

Two—Chris Carty and Cheryl Cavin—are especially interested in the fisheries aspect of NOAA's mission.

"The NOAA Corps is beginning to look for people with biology backgrounds, which is what I have," Ensign Carty says. "I'd like to work on fisheries vessels and be able to do some ship handling along with a little bit of biology. I'm shooting to learn as much as I can, and if they keep teaching me new things, then I'll keep with it."

Cheryl Cavin, too, "would very much like to get into fisheries work, on ships, and in some kind of shore assignment in a fisheries laboratory—not an administrative job."

When her second assignment comes along, Deborah Astle hopes for field work related to geology.

Karen O'Donnell, a certified scuba diver and experienced underwater photographer, would like to have the opportunity to work as a diver in the NOAA Corps, while Mary Zoeller's interest is in oceanography.

As for Evelyn Fields, "I know that NOAA does a tremendous number of different things—new things almost every day. In the Commissioned Corps, you will become involved with things you know nothing about, but you're going to learn from the bottom—become proficient and knowledgable.

"Basically, that's what I'm looking forward to—the opportunity to learn a variety of things and see where my aptitude lies." □

NOAA monitors wind shear, the pilot's ancient foe,

THAT MAN MAY WALK AWAY

BY CARL A. POSEY*

You turn base and begin the long, controlled fall back to earth called a landing. The airplane descends against a resisting atmosphere, a slab of air in motion.

There are some imperfections. You've let yourself get a shade slow coming around to final, and you cheat just a bit by skidding the plane into alignment with the runway. Sloppy. Dangerous. But, all things remaining equal, you will get your airspeed up, restore balance to your turn.

Then a sudden change of winds drastically alters the marginal equilibrium of your landing. The stall warning horn moos as the skid and the shortage of airspeed are transformed into a sickening roll of a cross-country stall, and a dive toward the big numbers at the end of the runway.

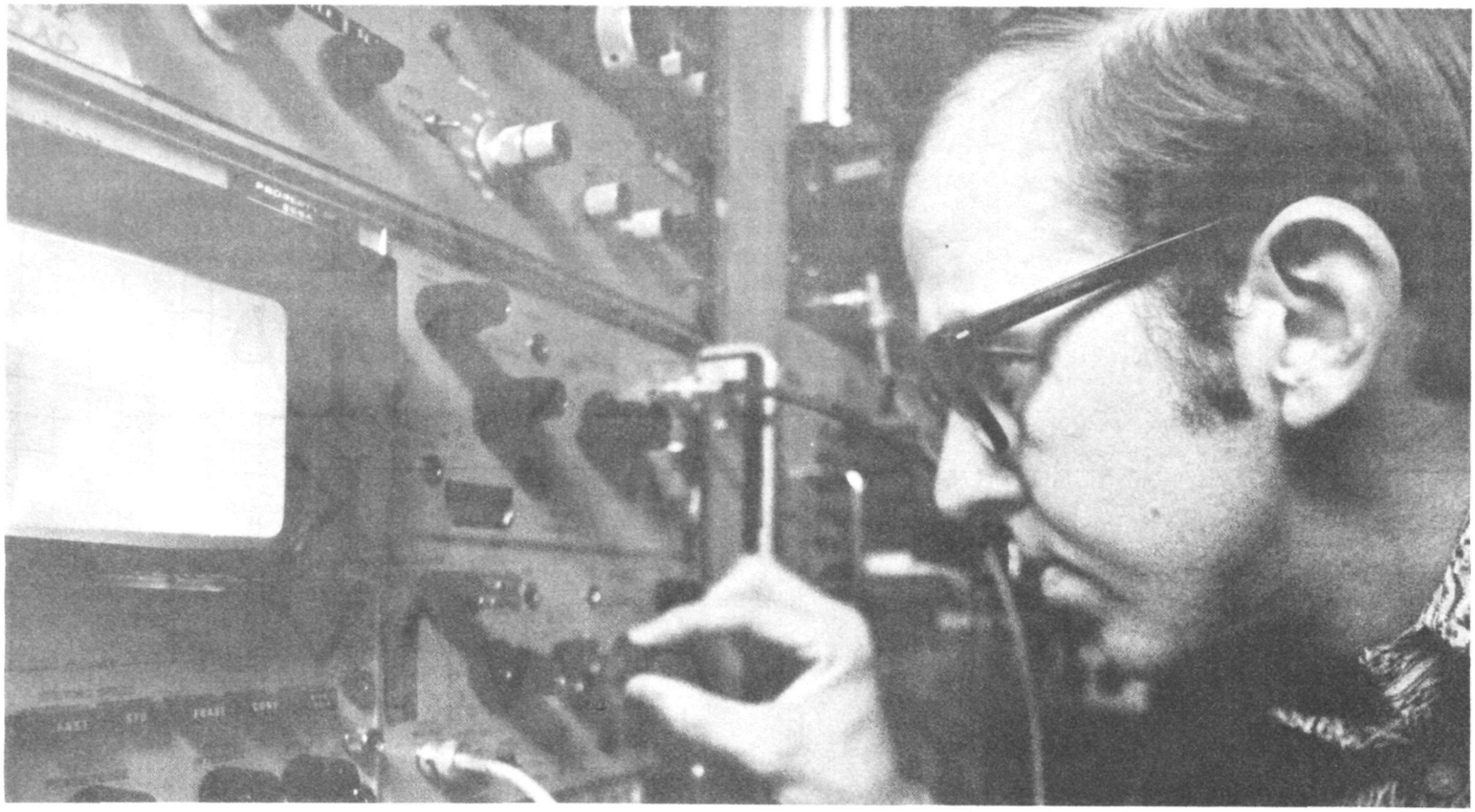
Wind shear, the sudden change in wind velocity with altitude, is not the worst thing in an aviator's atmosphere, but it rates high. The hazard lies in the element of surprise, particularly during those phases of takeoffs and landings when an airplane may be only a gust of wind—or a sudden calm—away from an accident. At the very least, being ambushed by wind shear near the ground can elicit a sincere and shaky "oops!" from a pilot. At worst, it can furnish the critical ingredient in an aeronautical tragedy.

What this insidious child of the atmosphere does is turn marginal situations into dangerous ones. A pilot can correct for wind shear if he detects it in time. But in a tight takeoff situation his detectors are busy elsewhere, and his aircraft can be sideways and headed for the ground before he knows it. A final instrument approach, no matter how many engines are pushing you along, can be turned into an undershot landing or a missed approach (and back into the soup) by unforeseen wind shear sneaking in when you are more than a little preoccupied. The record abounds with close calls attributed to wind shear surprises, and includes a number of serious accidents.

Scientists with the Environmental Research Laboratories' Wave Propagation Laboratory in Boulder, Colo., are applying the special expertise of the Atmospheric Acoustics Group, led by Dr. F. F. Hall, Jr., to making wind shear one of the known quantities in takeoffs and landings, under a contract with the Federal Aviation Administration.

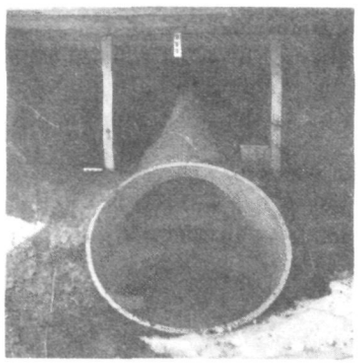
Dr. Donald W. Beran and his colleagues —Ben. C. Willmarth, R.J. Keller, D.E. Hunter, and E.J. Owens—are developing a system that uses pulses of sound to probe the atmosphere above an airport, measure winds in the vertical air column, and detect the region of maximum wind shear. This information can then be relayed to pilots, permitting them to anticipate sudden imbalance in the forces controlling their lift-

** Carl Posey, a pilot, describes this article as one in which he took an uncommonly personal interest.*

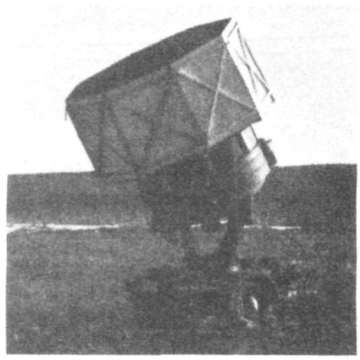


Jeff Keeler adjusts minicomputer-generated display in the van. The traces show wind speed and direction profiles with altitude.

Sound from the main speaker is bounced upward from this dish.



One of the system's horn-shaped antennas gapes from its bunker.



Sounders mounted on searchlight carriages probe to 150 meters.

The echo data is sorted out by the electronics in this NOAA van.

off or landing.

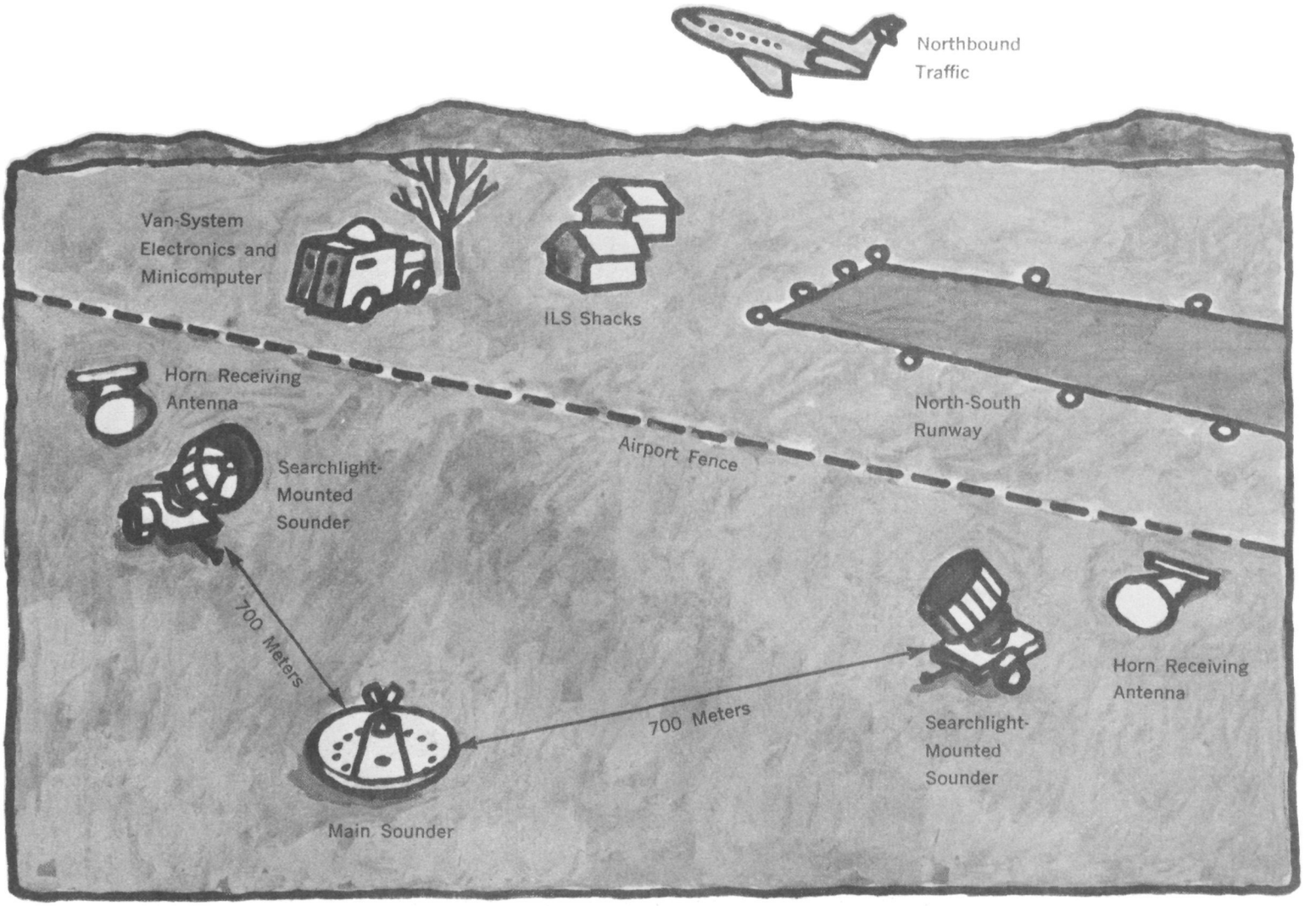
"Right now," Dr. Beran says, "we are between phases in the development of the acoustic wind shear detector. Our first phase, conducted at Table Mountain, north of Boulder, was completed last summer and substantially proved we can detect wind shear—or rather the turbulence that accompanies wind shear—to altitudes of about one kilometer.

"In the second phase, we installed the system at Denver's Stapleton International Airport, and put a real-time readout console in the tower for about a month. This gave air traffic controllers a chance to see the type of information available from the system, and how it might work into their operations."

In a field plowed for winter wheat (the corn was being harvested when the installation first went in) the acoustic wind shear detector components are arranged along a 700-meter by 700-meter "L" just east of the north end of Denver's long north-south runway. The big sounder in an open pit at the apex of the L bounces sound pulses vertically out of a parabolic dish, probing the atmosphere to better than half a kilometer. Two other sounders at the extreme ends of the L are mounted in surplus military searchlight carriages, and angled about 20 degrees from the vertical. These probe the lower 150 meters of the atmosphere over Stapleton International. Behind each searchlight-sounder a large horn-shaped listening antenna is installed in a wire-covered bunker. A van in a cottonwood grove several hundred meters from the L and closer to the runway, houses the uncommonly advanced, mini-computer-based data system which sorts out winds and wind shear from the air-changed echoes.

The system works by beaming a sound pulse into the atmosphere, then "listening" for the scattered echoes returned from air turbulence, which identifies layers of wind shear. By detecting the Doppler effect—the change in frequency as the sound waves are blown toward or away from an array of receivers—produced by wind motion, the system can, with the help of a minicomputer, measure wind speeds at 30-meter-height intervals from near to surface up to half a kilometer.

The Stapleton installation seems almost to be part of the prairie ecosystem. Every ten seconds the big, half-buried vertical speaker emits a sound something like the call of a tree frog—a very robust tree frog—followed five seconds later by the smaller-



frog beeps of the two searchlight-mounted sounders. Sometimes birds in the nearby patches of scrub and bramble peep a reply. In fact, local wildlife has been pervasive in the project.

"We've seen a couple of big German shepherds we think are living wild out here," says Jeff Keeler, a Colorado University graduate student working on the project, "and we're a little diffident about coming out here at night. The cables—we've got several miles of electrical cables running around out here—are snake grey and up at Table Mountain we had some trouble with hawks attacking and 'killing' them. So we've buried our cables. The bunker wiring was being eaten by rabbits so we put chicken wire over the openings; but the rabbits burrowed in anyway. Right now we're all living in harmony."

The other wildlife near the site is a reminder of the system's reason for being. Every few minutes the north-south runway launches another brightly feathered, northbound bird, ranging from little two-place Cessnas on up to stretched DC–8's and occasional jumbos.

The idea is to display the wind shear information in a console in airport control towers. In its present incarnation, the system's readout display shows, for the levels on either side of the level of maximum wind shear, the wind speed in knots, magnetic wind directions, and the heights of winds being displayed, in feet. The device also displays surface wind speed and direction and the strength of surface wind gusts.

Because most wind shears are not strong enough to create serious problems for aircraft, the tower display is equipped with a red warning light that is activated when wind shears reach or exceed seven knots per hundred feet, a value which can mean trouble. When the warning light is off, the winds displayed are those associated with the strongest shear layer between the ground and half a kilometer. When the light is flashing, the display shows winds associated with the first critical shear layer above the ground.

Inside the van one comes upon a neat array of minicomputer and electronics looking much more like a production unit than one expects from an experimental system. The sound of the speakers is closer now to the noise of sonar, not in hot pursuit of a submarine, but gently feeling its way through comfortably deep water.

Each pulse illuminates a bright green screen, and the scatter is visible as the air backscatters its echoes. Facing the scope is a minicomputer with a video readout, which, once switched on, sorts through its lists of parameters and displays vertical wind profiles.

"While we had the system in the tower," Keeler says, "we were running the data into the readout there. Now we're linked by telephone line with Boulder and get a direct readout on a console there, along with a hard copy printout of recorded data."

Airplane activity picks up outside and the sound pulse on the screen turns into a green fingerpainting of noise, then clears as the pulse becomes audible to the antennas again. "The noise of aircraft taking off can really wipe us out," Keeler explains, "and when they use this runway to take off to the south we get an awful lot of noise. But much of the time we get good, real-time, continuous data, which is why we're here."

In the next phase of the project, the NOAA scientists hope to develop specifications for two prototype systems for further testing by the FAA. Then, if the systems perform well, the acoustic wind shear detection system may become part of the instrumentation used by major airports in the National Aviation System. And it may even be feasible at some not-too-distant future point to develop readouts for aircraft, trading a red light in the cockpit for a fickle wind's shear surprise. □

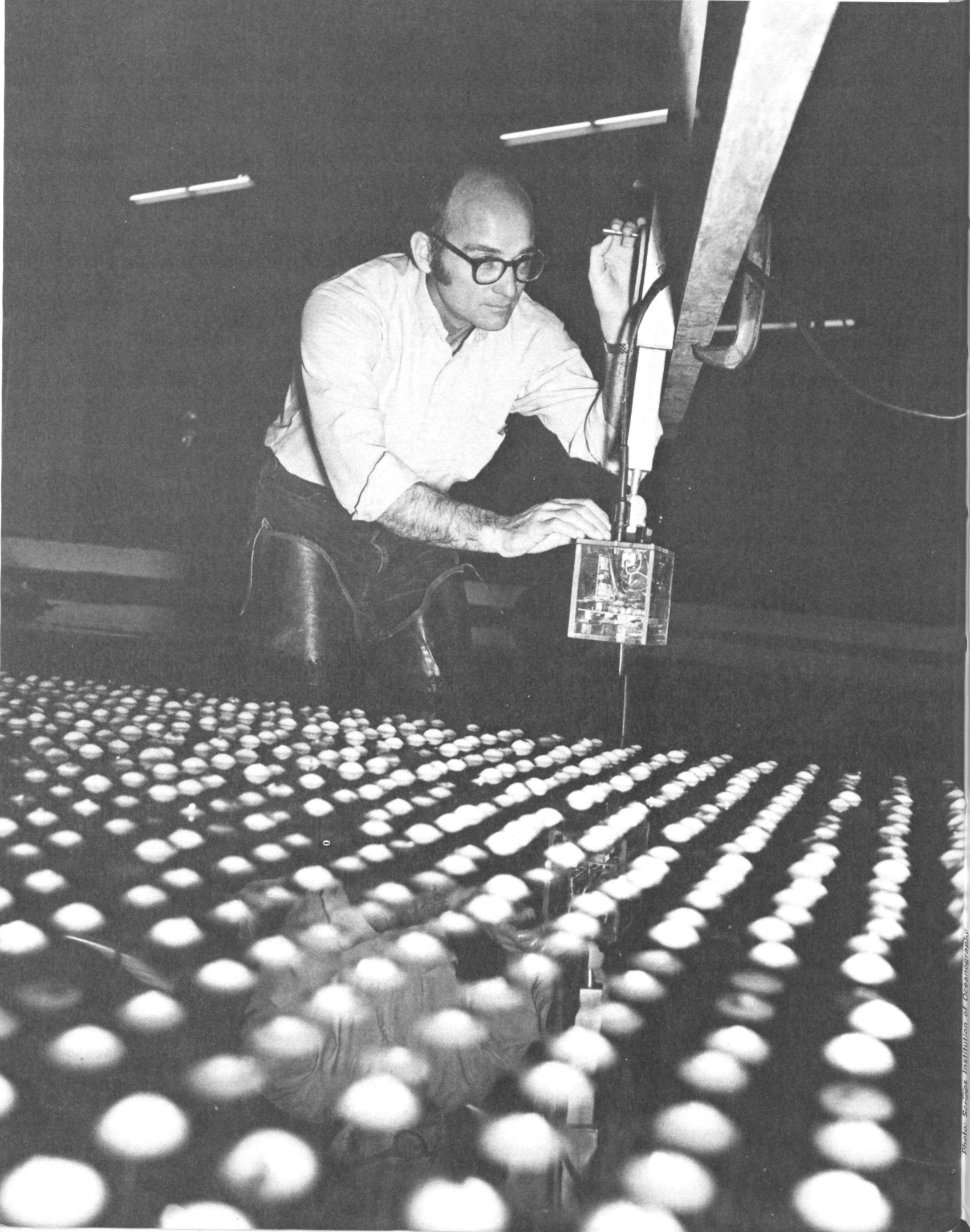


Photo: Scripps Institution of Oceanography

Tethered-float breakwaters will roll with the punches

Sapping The Storm-Wave's Fury

BY BARBARA A. FIRGER*

(Opposite page)

During studies of a tethered float breakwater system, Richard J. Seymour adjusts a wave height measuring instrument among the 1,800 tethered, floating, foamed-plastic spheres used in feasibility tests.

On January 8, when Richard Seymour visited one of San Diego County's beaches, a few miles from the Mexican border, he says there was hardly any beach left. Rocks were sitting on the front steps of houses and beachfront hotels. A marathon wind- and rain-storm had buffeted the West Coast for nearly a week, causing flooding and landslides in Oregon. Adding to the problems on the date of Seymour's beach visit and the following day were unusually high tides caused by the conjunction of sun, earth and moon.

Until the storm stopped, ocean-watchers were wondering whether the southern California beaches would survive.

If an idea developed by Seymour and his former professor, John D. Issacs, proves out in a prototype experiment, future ravages of storm and tide may be softened. The two-year old project, at Scripps Institution of Oceanography, is sponsored by NOAA's National Sea Grant program and the State of California.

Imagine a mid-ocean blue water sailor's haven, flat and calm. Or a harbor that takes the kick out of storm-tossed waves.

How about a portable breakwater easily and speedily moved in, possibly airlifted, to protect a beach from sudden storm or long-term nibbling by erosion?

Picture a watery landing strip for commercial seaplanes or a portable "boom" that could be unfurled and deployed to surround and contain an oil spill.

None of these is overzealous speculation but real possibilities for a tethered float breakwater based on what Isaacs (professor of oceanography at SIO and director of the University of California's Institute of Marine Resources) originally dubbed, with tongue in cheek, "non-Archimedean."

The way the system works is deceptively simple.

The term "non-Archimedean" refers to any of a group of objects submerged or floating on the sea for which the ordinary Archimedean laws of displacement according to mass do not seem to apply.

According to Archimedes, a body at rest in a fluid (like a boat sitting on the water) displaces its own mass and the water it displaces weighs as much as the body displaced. The newly designed breakwater is based on arrays of light objects, displacing much more water than their own mass, taut-moored just below or barely breaking the sea surface.

For an intriguing variety of reasons, the tethered floats would have the effect of retarding wave motion by oscillations which disipate storm-built wave energy.

Issacs says the idea that tethered floats behave strangely in waves first occurred to him during World War II when he was in the Pacific on a submarine net engineering project.

His early theoretical work was on the dynamics of bodies which displace more than their own weight and so must be held down by a tether or some other constraining force to keep them from rising. When such objects are struck by pressure waves moving through the water, they are accelerated in an exaggerated fashion. The pressure waves exert the same force they would on a body of water occupying the same volume: But, since the body has much less mass, it is accelerated much faster than the water would have been.

In the case of a tethered float being acted upon by a wave, Seymour explains, the float doesn't simply roll with the wave and transfer the wave's energy on toward shore. Instead, the float first rushes ahead of the wave, pushing water aside, since it is accelerated much faster than the water surrounding it. Then, when it reaches the end of its tether, the float swings the other way, working in opposition to the wave. By this switch in direction, the energy transferred to the float by the wave is dissipated in the turbulence of the float working against the water around it.

The more floats in such a breakwater, Isaacs and Seymour explain, the more energy will be removed.

Studies at SIO originated when Seymour and Isaacs decided to test the professor's belief that ocean waves would lose much of their energy if they were to meet "patches" of near-surface spherical, tethered floats that would "drag" on waves to a greatlv magnified degree in comparison with fixed objects of the same dimensions.

A model built by Seymour after two years of studies at SIO's mesa-top Hydraulics Laboratory wave basin utilized 1800 tethered floating foamed plastic spheres (about ping-pong ball size) in a rectangular pattern of 30 rows in one direction and 60 rows parallel to artificially created wave crests.

A 1/60 scaled-down version of Avalon Harbor (which usually rests safely in the lee of Catalina Island) with a traditional rock breakwater and model boats simulating a marina and recreation area was subjected to carefully controlled scaled-down waves.

About six times a year, the real harbor is buffeted by treacherous waves from the East raised by the Santa Ana winds. A permanent solid breakwater for such an infrequent need would be extravagant but a cheap and portable system might be an excellent solution to that local erosion problem.

As Isaacs had expected, the experimental spheres reflected some wave energy back into the model's "sea," scattered some of it by the bouncing of waves between the spheres, but removed most energy by the frictional "drag" of the tethered bodies moving back and forth against the wave motion.

A prototype installation at a yet-to-be-selected site in the Channel Islands west of Santa Barbara off the Southern California coast will enlarge the SIO experiment like a photo blowup. Construction will begin this year on the prototype which will consist of six to eight hundred spheres in an

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* *Bargara A. Firger is Senior Editor, California Sea Grant*

array perhaps several hundred feet long. Even though this will not yet be the equivalent of a full-scale harbor breakwater, it should give Isaacs and Seymour an idea of how a full-sized version would behave.

In the prototype, hundreds of what Seymour calls "upside-down pendulums," possibly government surplus hollow steel floats, five feet in diameter, maybe 50 each in 25 rows and all five feet apart, would be held just below the surface of the sea by tethers anchored on the sea floor or on a sinkable concrete barge.

One characteristic of a pendulum or oscillator, Seymour explains, is that it responds out of phase to an oscillating driving force. In the wave-basin studies, the back and forth movement of the water forced the float to move.

For wave periods less than the natural period of the float, Seymour reports, the motion is completely opposite to the water motion. At periods close to the natural period of the float, the float oscillator becomes an amplifier that moves back and forth a greater distance than the water does. Both these effects would have the desired result of considerably increasing the speed of water past a float and therefore greatly increasing the drag of the field of floats and diminishing a wave.

By increasing the number of rows of floats through which waves must travel, the amount of energy remaining in a wave could be decreased to any desired level.

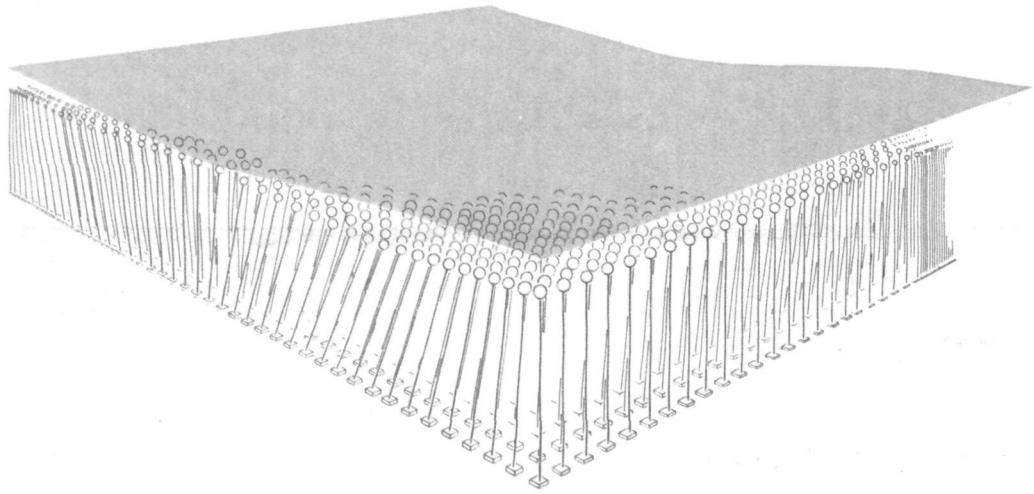
Seymour first became acquainted with Isaacs' ideas on the breakwater concept in a seminar which covered "by design, far-out things, exotic oceanography," Seymour recalls. Isaacs mentioned his early observations of "non-Archimedean bodies" and their behavior. He said the phenomenon looked as though it could be calculated and he and Seymour began to look for a way to work out the problem. They received a grant, first, from the Foundation for Ocean Research. Later, Sea Grant and the University of California gave financial support.

Most recently, the California Department of Navigation and Ocean Development allocated nearly $500,000 toward development of the project in the proposed prototype.

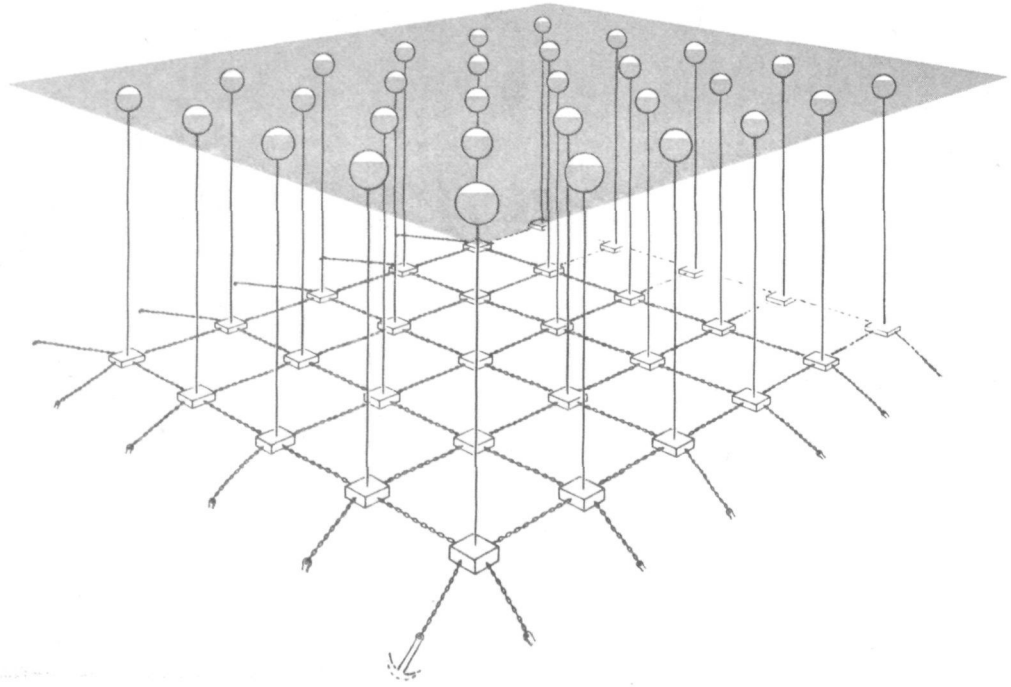
Isaacs' original idea, says Seymour, included a "dream of building a harbor refuge, mid-Pacific, about halfway between Hawaii and Alaska, a square mile of calm ocean as a place for ships to hide out during storms." Discussions with the state agency brought the concept a little closer to home and Seymour and Isaacs began to apply the idea to harbor protection.

According to Captain John E. Bennett, former Director of the Department of Navigation and now a member of the staff of the Director of SIO, prototype breakwater installation—if it proves successful—"could generate a worldwide revolution in breakwater construction within given conditions."

What makes the concept even more attractive is that the new system is highly



A sketch of the tethered float breakwater system shows the hollow, steel spheres in their "upside-down pendulum" array as they would appear with a crest-to-crest wave passing over them. The floats, always somewhat out of phase with the wave, create a drag which would greatly retard the wave's motion. In full scale, the system would utilize hundreds of five-foot-diameter spheres five feet apart.



A method of compensating for tidal fluctuations is shown in the sketch of the tethered float breakwater system above. Anchors placed several feet off the sea floor would permit the spheres to ride up and down with the fluctuating tides, yet be stabilized by conventional ships' anchors embedded in the ocean bottom. The spheres, shown at rest, oscillate to dissipate storm-built wave energy.

deployable and would cost about one-tenth of conventional systems to maintain.

Where there are severe waves all the time, the new breakwater would have to be checked on a regular basis, probably by scuba divers. The principal "wear point" is the attachment of the float to its anchor. This would have to be replaced every few years, depending on local wave conditions.

The purpose of the Channel Island prototype is to determine whether the breakwater is functional.

An alternate design being considered is the use of very large hollow concrete barges which would serve as anchors for the system (eliminating the need for individual anchor units). Floats would be carried on the deck of the barge on long strings, each bearing hundreds of floats. The barge could be towed into position, flooded and sunk very rapidly, making it a tempting choice for harbor or shore protection. This system may be utilized in the upcoming prototype experiment.

For maintenance or towing to another location, the hollow barges would be pumped empty of water and resurfaced. The barges would be approximately two hundred feet by forty feet, containing about eighty spheres apiece.

One of the problems associated with conventional breakwaters, Seymour notes, is the decreasing availability of rock. A serious handicap in many parts of the world contemplating such traditional harbor protection is that they just can't find the size and quality of rocks required. And, says Seymour, "it's just going to get worse, not better."

The tethered float system may be an "interim solution" where there is such a lack of available resources and the breakwater can be built or transported economically for use in water of any depth. In contrast, conventional breakwaters can be built only in shallow water.

According to Seymour's calculations, the cost of rock wall breakwaters is "roughly proportional to the square of the (water) depth. So, if you double the depth, you have four times the cost."

"Conventional breakwaters," he explains, "begin to become very expensive in water depths of fifty feet or more." In water depths much beyond a hundred feet it becomes prohibitively expensive to build a rock breakwater for any purpose.

Estimates are that a floating breakwater could be built for about ten percent of the cost of a conventional rock wall constructed in water 50 feet deep.

Seymour speculates that the cost of floating breakwaters would rise in deeper water only by the cost of the extra cable needed to reach the ocean floor or near-floor anchoring device.

Recalling Isaacs' "square mile of calm ocean" idea, Seymour says, "We're not relying on any pressing interest to do it," mostly because there would be sociopolitical problems to iron out.

Nevertheless, the mental exercise of considering such a project fired Seymour's imagination. And the interest it generated did illustrate the appeal of the "fundamental characteristics and potential" of the system now being contemplated, he says.

Another possible use is the application of the breakwater to offshore deepwater ports for supertankers. Enough has been spoken and written about the energy crisis, real or imagined, to dull the senses of the most ardent environmentalist. Yet, despite the petroleum shortage the prospect of offshore oil spills still makes shore-dwellers queasy.

"A supertanker," says Seymour, "can tie up to a buoy offshore and discharge oil without a breakwater, since it can withstand everything except very bad storms. But it's still a little frightening to people living onshore. Oil disperses after a spill and there's little you can do about it."

An adaptation of the breakwater might be to allow the mandatory deployment of a boom or dam or oil containment device whenever a tanker was loading or unloading. The floating "dam," quickly and easily deployed, completely surrounding a ship, would keep any discharged oil from getting away.

In such a situation, the water would have to be very calm. Big waves tend to push oil out and away from a ship and might break up the comparatively fragile boom.

The way Seymour envisions it, a permanent tethered float breakwater would be there all the time. Since supertankers need about 150 to 200 feet of draught, on the West Coast, such a permanent installation might be fairly close to shore, maybe less than a half mile. On the East Coast, with its extended shelf, the breakwater would be very far from shore, "tens of miles, perhaps," Seymour estimates.

The permanent calm would give tankers no excuse not to deploy an oil containment device whenever they were hooked up to a pipeline and not just in an emergency (when it might be too late).

The combination of the low-cost dam with a breakwater and containment device, says Seymour, would probably "go a long way toward answering the objections of environmentalists to an offshore oil facility."

Letting his imagination roam at a November press conference at SIO announcing the half-million-dollar state award, Isaacs said, "I'm not so sure that (the breakwater) doesn't bring the seaplane back into business. The difficulty has always been choppy, rough landing areas. It just occurred to me that you could lay out a long runway of these floats and have a permanent place for planes to land."

Seymour believes that the priority of using the breakwater as a landing strip may not be high but he says the possibility is "there."

"If you could produce a cheap runway," he says, "it certainly would answer the space utilization and noise abatement problems associated with big jets. The tethered float system is certainly to be considered rather than the conventional floating airport or hard runway system out in the ocean. And using surface waters as a runway would be cheaper."

Along with oil spill containment and noise abatement, another ecological plus for the breakwater is the fact that, unlike conventional structures, it doesn't trap pollutants.

Permanent breakwaters made of rock tend to obstruct the natural flushing action of tides, keeping polluting and sometimes toxic materials inside a bay or harbor.

The tethered float system destroys only surface waves and swell. Tidal currents would pass right through the system to perform their natural function of flushing out a bay.

Where concrete anchors or sinkable barges are used, niches could be designed into the structures to provide an environment for harbor growing of abalone, lobsters or fish.

Potential uses for the breakwater vibrate across a spectrum of practical and playtime applications. For instance:

Temporary breakwaters could be deployed during an ocean salvage operation. Rescues at sea would lose much of their tragi-romantic aura.

Low cost marinas could be constructed along exposed, steep coasts where building rock breakwaters is impossible or prohibitively expensive.

Moveable fresh water marinas could be installed easily, quickly and cheaply in lakes behind dams where there are large fluctuations in water level.

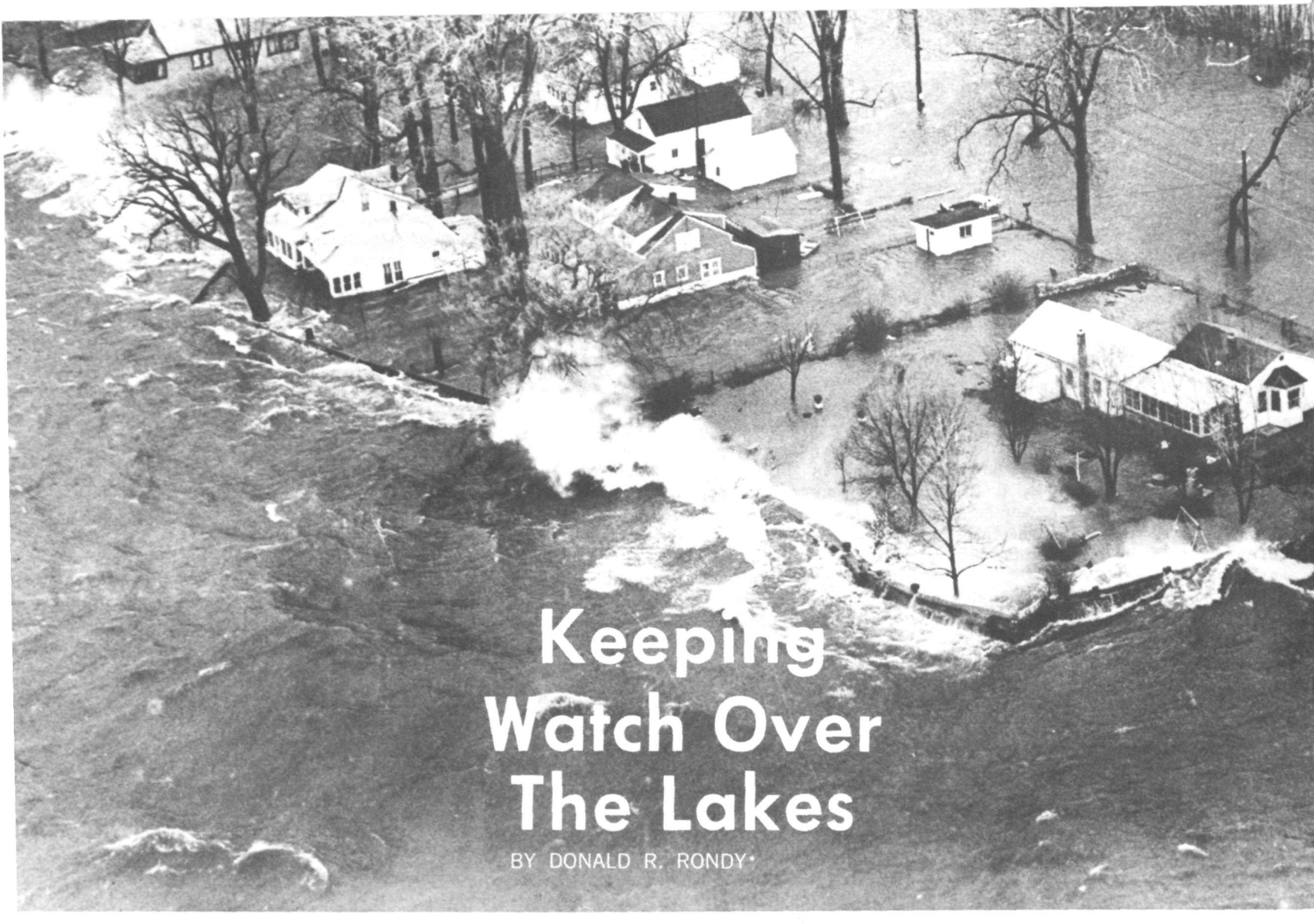
Mid-ocean floating islands for a variety of uses could be built to calm-water specifications if they were ringed with tethered float breakwaters.

Beach erosion could be not only controlled but reversed. By modulating long-shore wave patterns and sand transport, new beaches could be created and old ones revived without the expense and effort of hauling and installing the quantities of sand or sand substitute which are the only quick solution right now.

Shorefront property owners like the ones Seymour sympathized with during the January battering would have access during storms to speedy and inexpensive protection. No more arguments about whether the breakwater off your beach is ruining the next beach down the coast.

With light components such as nylon lines, balloons, and embedment anchors, an installation might even be a community effort put in by sport divers.

Not much more than a year from now, after the prototype system has survived its first winter wind and storm onslaught, the "world-wide revolution" predicted by former Navigation agency director Bennett may have begun. □



Keeping Watch Over The Lakes

BY DONALD R. RONDY*

The Great Lakes, together with their connecting channels, cover an area of more than 95,000 square miles, making this system the greatest chain of lakes on earth. For thousands of years this system lay uncontaminated by man and experienced only the vagaries of nature. The lakes can change in a matter of hours from a state of tranquility to a convulsion of 20-foot waves and uncontrollable violence. The vast forests once surrounding the lakes are now gone and the remaining wildlife is protected, but the lakes themselves have changed little.

Since the time of early explorers, men have been aware of the "flux and reflux" of the Great Lakes levels. Cartier, Marquette, LaSalle, Champlain, and Charlevoix whose lives spanned the 16th, 17th, and 18th centuries were conscious of these phenomena and generally ascribed them to the sun and moon and referred to them as tides. Even today many persons believe that the surface of the lakes is a plane, as even as the water surface in a glass jar, except of course for waves. But, because of constantly changing atmospheric conditions, this situation rarely, if ever, exists.

We now know that the lakes undergo an annual and a seasonal fluctuation, and that superimposed on the seasonal changes are short-term water level disturbances. The seasonal changes in levels usually range between one and two feet and are dependent upon the supply of water that falls as rain or snow on a lake and its basin. The precipitation that falls on the lake surface contributes directly to the lake level, causing a rise almost equal to the amount of precipitation. The precipitation that falls on the land area is indirectly contributed to the lake in the form of runoff and ground-water inflow, and the amount that eventually enters the lake is variable and dependent upon many factors, including the physical make-up of the basin.

Lake levels rise during the spring and early summer when rainfall and runoff are plentiful and then drop during the winter period when the water supply is denied the lake because of freezing conditions. Periods of high lake levels tend to follow years of high precipitation and years of low levels follow years of low precipitation, though this somewhat over-simplifies the relationship. In general, short period water level disturbances include wind tides, astronomical tides, surges, and seiches. A disturbance is usually considered to be any local change from the average lake level and in most cases can be documented by a continuously recording water level gage.

Many persons who are knowledgeable about the Great Lakes are aware of the sudden drops and rises in water levels that sometimes occur. These short-period disturbances and fluctuations may occasionally attain levels of 10 feet above or below average, and are usually caused by winds and variations in atmospheric pressure.

Each of the lakes has its own particular type of short-period oscillation, but Lake Erie with its southwest-northeast orientation records greater differences in levels than any of the other lakes. In January, 1972, for example, water level recorders indicated a difference of 13.8 feet between Toledo, Ohio, at the western end of the lake and Buffalo, New York, at the eastern end.

The tilting of the lake surface of this magnitude is caused primarily by strong, sustained winds. The other lakes undergo these disturbances also, but the results are not as spectacular as on Lake Erie.

Low levels also cause problems. They hinder navigation, cause a reduction in hydro-

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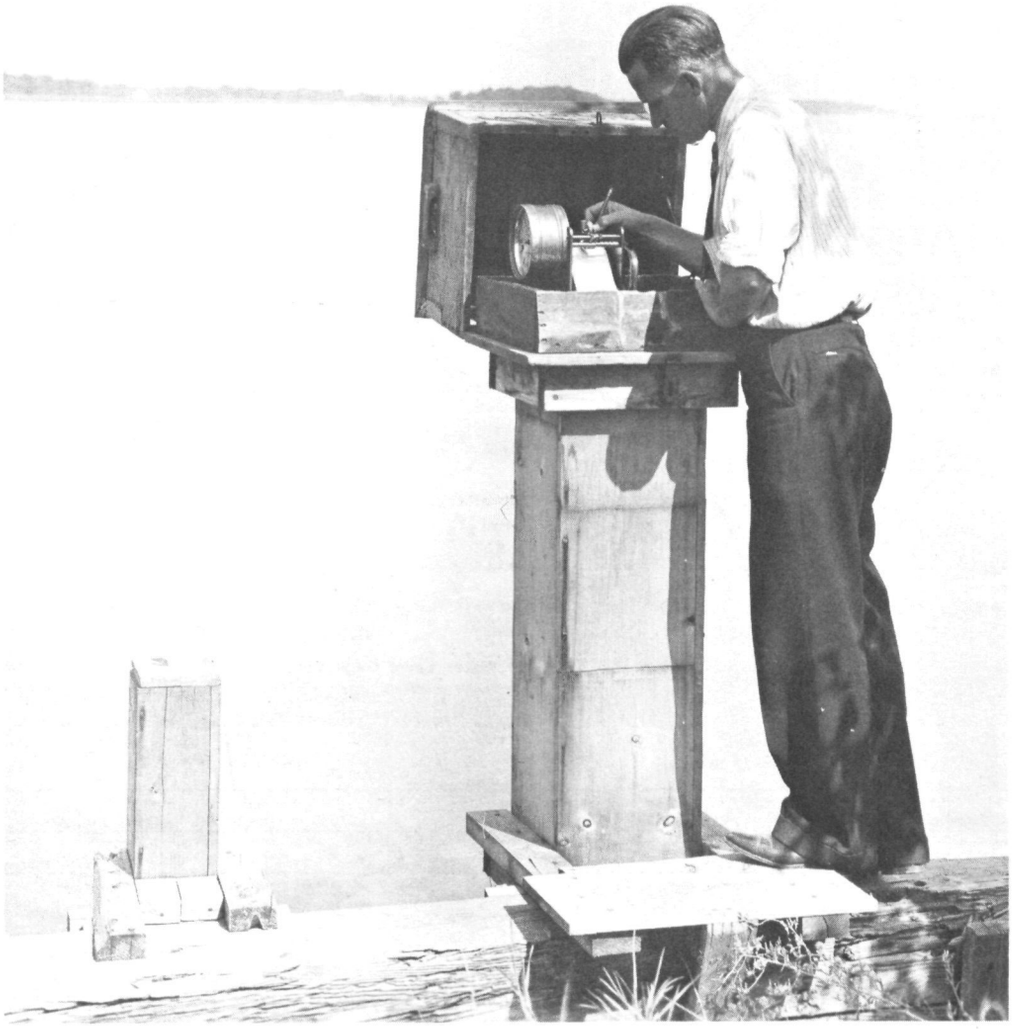
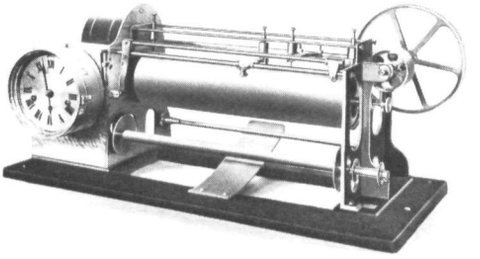
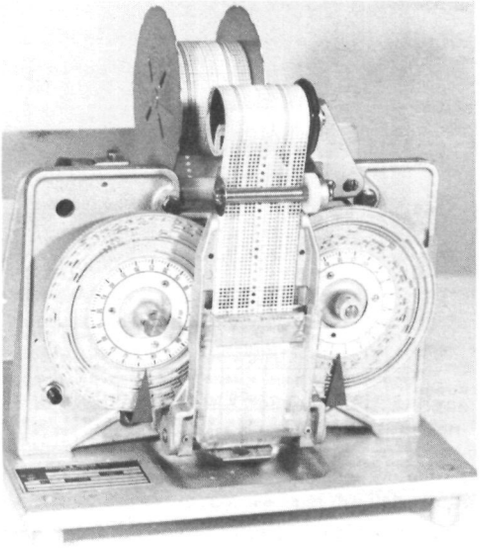




A variety of instruments for measuring lake water levels are shown. At left, a box and float type gage (with measuring stick) and a Wilson Automatic Recording Gage; above, a Haskell Recording Water Level Gage; and below, the more modern Fischer and Porter Digital Water Level Recorder.



power generation, and can be particularly damaging to harbor installations. The western end of Lake Erie and the mouth of the Detroit River are susceptible to low water levels due to wind action. In these areas low water warning lights are displayed and radio advisories are broadcast to mariners.

One other factor affecting the lake levels is the diversion of water into and out of the lake system. There are three significant diversions in the Great Lakes system—the Welland Canal between Lakes Erie and Ontario, the Chicago River flow out of Lake Michigan, and the Long Lake-Ogoki diversion into Lake Superior. Although the net effect of these diversions is rather small, they are important to the system as a whole.

In recent months the lakes have experienced a period of exceptionally high levels and newspaper headlines such as "Lake Levels Becoming Flood Threat" or "Lake Levels Exceed All-time Highs" have been common. The fluctuations of levels from low to high and the determination of flood levels raise the question: How do we know what is high water and what is normal or average? The simple answer is that we measure the lake levels. This is done by relating the water surface to points of known elevation, called benchmarks. The benchmarks are established in the vicinity of the gage site by either instrumental leveling or by long-term water transfers.

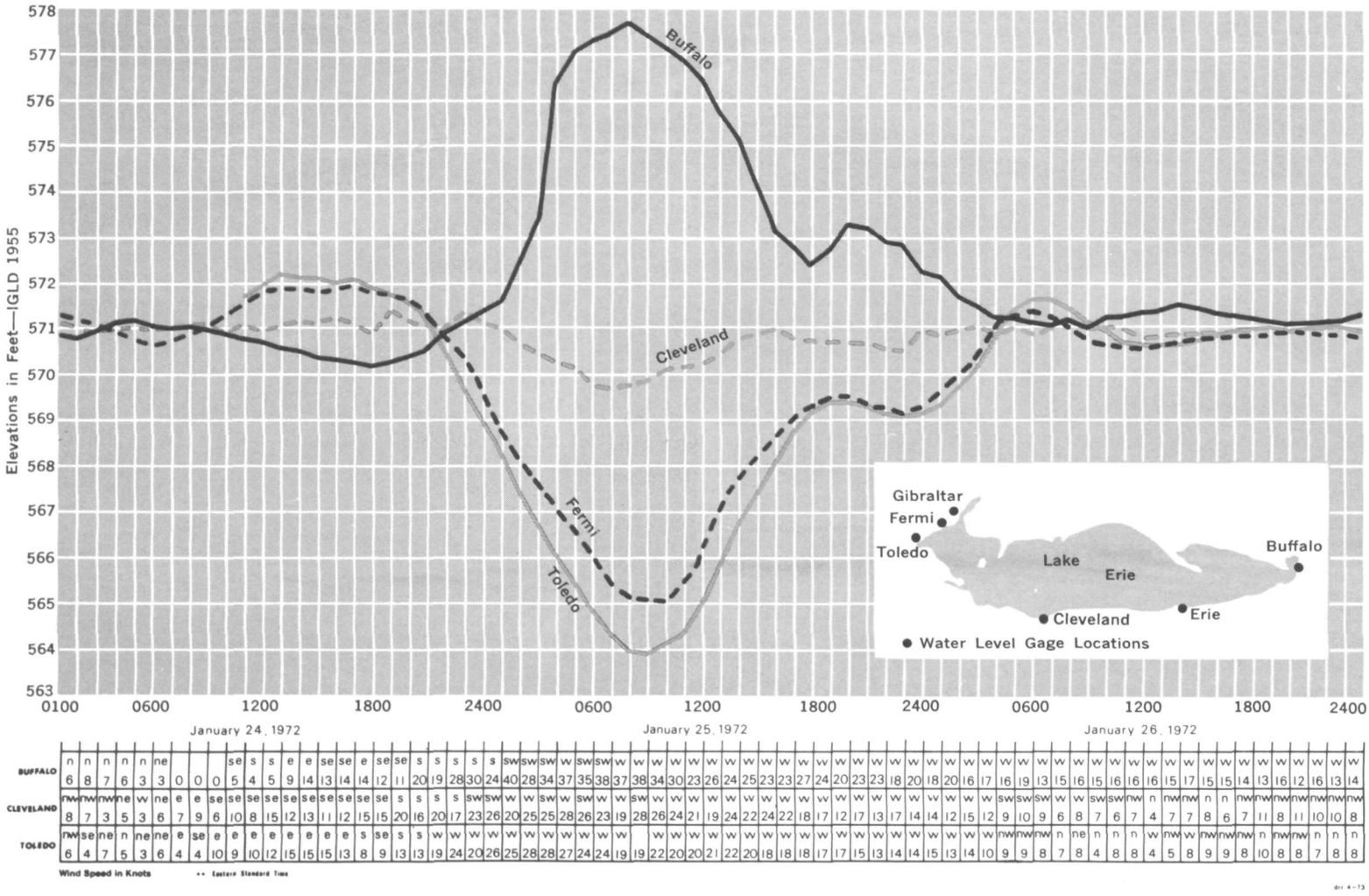
It wasn't until 1876 that a level line was extended to the Great Lakes from the ocean and for the first time it was possible to give elevations of a lake related to sea-level. Early measurements of lake levels were keyed to arbitrarily-selected points and provided information for a specific use and location, but they were difficult to relate to other areas.

One of the first devices used to measure the level of the lake surface was a simple graduated board or rod with reading points from which distances to the water surface were measured. In the period around 1859, it was realized that more data were required to determine the general characteristics of the variation in lake levels and to supply needed information for hydrographic surveys. It was also realized that more accurate data were needed to satisfy the increasing use requirements of commerce and transportation on the Lakes. Two primary needs were the determination of the amount of flow from one lake to another, and the effects of artificial changes in this large hydraulic system.

The collection of the required data necessitated the introduction of a systematic method for measuring water levels of all the Great Lakes. Such a system was inaugurated in 1860 when gages were placed in operation on each of the Great Lakes.

One of the first Lake Survey gages was a wooden water-tight box about six inches square and six to ten feet long. This box, or stilling well, contained a small opening near the bottom to allow water to flow in and out. A cylindrical metal float to which a graduated wooden rod was attached was placed inside the stilling well, the box was mounted vertically, and the rod was read at the box cover. The float was weighted so that reference marks could be aligned. Having little buoyancy, the float tended to sink and give erroneous readings as the wooden rod gradually became waterlogged.

Around 1860 a form of simple automatic gage was introduced, using a pencil to indicate the levels on a paper chart. Then in 1899 E.E. Haskell of the Lake Survey designed and initiated the use of a more reliable self-registering automatic gage. It consisted of a float operating in a pipe stilling well, which through a pulley and counterweight system caused a pencil to move across a continuous roll of paper 16 inches wide. A clock movement kept the rate of



This remarkable chart, produced from data recorded by Lake Survey Center gages during a winter storm on Lake Erie, shows how wind-driven water "drained" from the Lake's western portions (Toledo, Fermi), piled up on eastern coastal regions (Buffalo), and remained relatively stable along the middle shoreline (Cleveland).

travel of the paper at two inches per hour, and the paper roll contained a one month's record.

Another automatic recording gage used for temporary installations and during hydraulic measurements was the Wilson Gage. This gage also recorded an analog trace on a narrow continuous roll of paper and was used by Lake Survey during the period 1903–1940. In 1955 the more modern Leupold Stevens analog water level recorder—similar in operation to the Haskell Gage—was put into use.

As the reliability of automatic data processing increased and computer facilities became available, more and more emphasis was placed on automatically processing the large amounts of data received each month, and in 1964 a digitizer was put to use converting the analog records to a punched card system.

In an effort to expand and update both the data collection and data reduction phases, digital water level recorders have also been tested. The digital recorder records data on a sixteen-track paper tape, which is later run through a translator where the data is transferred directly to punced cards for computer tabulation. This procedure lends itself well to the varied tabulations of water level data provided by the Lake Survey Center.

Water level data transmission on a real time basis became a fact in 1966. A Bristol impulse type transmitter was installed near the mouth of the Detroit River, and connected by telemetry to the Belle Isle Coast Guard Station on the river. This system enabled the Coast Guard, during critical periods, to broadcast round-the-clock low water warnings to ships on the Lakes. A similar system was later installed at the Toledo, Ohio Coast Guard Station on the western shore of Lake Erie.

With the present high Lake Erie levels and large areas being inundated along its western shore, this system now serves an additional purpose: it provides data to the National Weather Service for use in broadcasing warnings of possible flooding conditions caused by short-period disturbances.

The Lake Survey presently operates 63 automatic recording water level gages—30 analog, 33 digital—on the perimeter of the Great Lakes. In addition, ten telemetering units are in operation and a number of seasonal gages, averaging about 65, have been established to aid in evaluating datum planes and differential movement at the gage sites.

The many uses to which the water level data are put require a rigid quality control program, and the Lake Survey Center works continually to make sure that the data are accurate. Water level data are recorded and tabulated to the nearest hundredth of a foot.

Industry, government, and private groups on the Lakes use the data for such purposes as forecasting lake levels up to six months in advance, making lake regulation decisions, determining diversions, calculating evaporation, maintaining channels for navigation, and many other activities.

Changes in water level gage instrumentation and techniques are still appearing. For example, the Lake Survey Center has developed and is presently implementing a program whereby hourly water level data can be recorded, stored, and transmitted on command by teletype and telephone. This program provides a form of real time data vitally needed for forecasting lake levels and preparing operational data for the various Great Lakes regulation plans. □

Fish Dishes For Energy Savings

Precious energy can be saved in the home, not only by reducing the use of heating fuel and turning off unneeded lights, but also by *serving foods that cook quickly.*

As an aid to homemakers during the nationwide energy shortage, the National Marine Fisheries Service's National Consumer Educational Service has developed a set of menus— with fresh, frozen, or canned fish as the main dishes—that require only 5 to 30 minutes' cooking time.

One of the main dishes, poached fish, does double duty. Half is served hot on the *first day, and the remainder becomes the* principal ingredient for a salad on the second day.

Further energy savings can be realized by:

—Using pans that cover the burners.

—Allowing frozen foods to thaw at room temperature, when possible.

—*Cooking several dishes in the oven* simultaneously.

—Opening the oven only when necessary.

—Covering pans and utensils for more efficient cooking.

Quick 'n' Easy Poached Fish

1 pound fish fillets, fresh or frozen
1 cup boiling water
2 tablespoons lemon juice
½ small onion, thinly sliced
½ teaspoon salt
2 *peppercorns or dash of pepper*
1 medium size sprig parsley
½ bay leaf

Thaw frozen fish; cut into 2 equal portions. Place fish in well-greased 10-inch frypan. Add remaining ingredients. Cover and simmer 5 to 10 minutes or just until fish flakes easily when tested with a fork. Carefully remove ½ of the fish, drain well and transfer to serving plate. Drain remaining fish and store in covered dish in refrigerator to use when preparing dinner the following day. Makes 2 servings.

Menu 1—First Day

Quick 'n' Easy Poached Fish
Seasoned Cooked Broccoli
Green Salad with Lemon Juice, Salt and Pepper
Half Grapefruit
Tea or Coffee

Arrange well-drained hot poached fish fillet on serving plate. Spoon 1 to 2 tablespoons of your favorite low calorie Russian dressing over hot fish. Makes 1 serving.

Quick-Cook Broccoli

Remove broccoli from freezer in the morning and store in refrigerator to defrost until time to cook it for dinner. Cook in covered pan as directed on package until done yet crisp, 9 to 10 minutes. Season to taste with salt or seasoned salt.

Menu 2—Second Day

Dieter's Delight Seafood Salad
Rye Krisp
Chilled Unsweetened Pineapple Chunks
Skimmed Milk

Dieter's Delight Seafood Salad

Break chilled poached fish (½-pound raw weight) into bite-sized pieces. Arrange crisp washed greens in salad bowl or on dinner plate. Cut one medium-to-small tomato into wedges. Thinly slice ½ of well-washed and dried cucumber. Slice ¼ cup celery. Arrange cucumber slices, tomato wedges, celery slices, and flaked fish attractively on lettuce. Pour 1 or 2 tablespoons of your favorite low calorie Italian, French, or Russian dressing over salad. Makes 1 serving.

Hurry-Scurry Menu
Hurry-Scurry Sardine Supper
Potato Salad*
Bean Salad*
Dill Pickles
Brownies* a la Mode or
Apple Cake Slice*
Beer

Hurry-Scurry Sardine Supper
1 can (4 ounce) Maine sardines
¼ cup catsup
2 tablespoons finely chopped onion
2 tablespoons prepared horseradish mustard
1 hard roll, 6 to 7 inches long*
Soft butter or margarine
2 slices processed American cheese, cut in half diagonally.

Drain sardines. Combine and mix catsup, onion and mustard. Cut roll in half lengthwise; spread cut surfaces with butter or margarine. Top each with ½ of the catsup mixture, then the cheese slices. Arrange sardines on cheese. Broil about 4 inches from heat source, 3 to 5 minutes or until sardines are heated and cheese is soft. Spoon remaining catsup mixture over sardines. Makes 1 serving.

*A 6 or 7-inch length of French or Italian bread may be substituted, if desired.

*Foods purchased at delicatessen counter on the way home

Teen Party Menu
Super Seafood Sandwich
Hot Baked Beans, optional
Potato Chips
Relishes: Dill Pickle Wedges, Celery and Carrot Sticks, Stuffed Olives
Make-Your-Own Sundaes:
(Vanilla Ice Cream with Assorted Sundae Sauces and Toppings)
Big Paul Bunyan-Size Cookies
Milk or Chocolate Milk

Super Seafood Sandwich
6 frozen precooked breaded fish portions (3 ounce each)
6 hamburger buns, split
2 tablespoons soft margarine
3 slices (3 ounces) American cheese, cut in half
½ cup catsup
¼ cup finely chopped onion
6 tablespoons tartar sauce*
¾ cup finely shredded lettuce

Arrange fish portions in greased shallow baking pan. Place in oven turned to hot, 400°F. Bake 15 minutes or until fish portions are heated through. While fish is heating, spread cut surfaces of buns with margarine and arrange cut side down on baking pan. Place in oven 5 minutes before end of heating time. Two minutes before end of heating time top each fish portion with a cheese slice and allow to soften. While fish is heating, combine and mix catsup and onion. To assemble burgers spread bottoms of buns lightly with tartar sauce and top with shredded lettuce, a fish-cheese portion, a dollop of catsup-onion mixture and bun top. Makes 6 burgers.

*Tartar Sauce—Use a commercial tartar sauce or make your own by combining ¼ cup salad dressing and 2 tablespoons well drained sweet pickle relish.

Seafood Buffet Menu
Tipsy Tuna
Gelatin Salad on Salad Greens with
Assorted Canned Fruits
Relish Tray—Celery Curls, Radish Roses,
Stuffed Olives, Kumquats and Watermelon
Pickles
Rolls
Angel Food Cake a la Mode
Chocolate Sauce
Beverage

Tipsy Tuna
2 cans (10¾ ounce each) condensed cream of chicken soup
1 can (4 ounce) sliced mushrooms, drained
1 can (8 ounce) water chestnuts, (drained and sliced)
1 package (10 ounce) frozen peas, thawed
2 or 3 tablespoons sherry, as desired
1 teaspoon curry powder, or as desired
2 cans (7 ounces each) tuna, drained and flaked
1 can (3 ounce) chow mein noodles
⅓ cup chopped salted peanuts or chopped toasted almonds

Combine first 6 ingredients; stir and heat in chafing dish or saucepan on top stove burner until bubbly. Add tuna; heat thoroughly. Serve in chafing dish or casserole over warmer. Serve on chow mein noodles and sprinkle with peanuts or almonds, as desired. Makes 6 servings.
Total heating time—7–9 minutes.

Menu
Hearty Hurry-Up Fish Stew
Tossed Green Salad with Favorite Dressing
Pound Cake Slices Topped with Peach Halves
Served with Strawberry Sauce
Beverage

Hearty Hurry-Up Fish Stew
2 pounds fish fillets, fresh or frozen
2 tablespoons butter or margarine
2 cups thinly sliced carrots*
1 cup thinly sliced celery
1 cup thinly sliced onion
1 cup water
1 can (10½ ounce) condensed cream of celery soup
1 cup milk
1 package (10 ounce) frozen peas, thawed*
1½ teaspoons salt
½ teaspoon marjoram
½ teaspoon leaf thyme
½ package (18 ounce) corn muffin mix (1¾ cups)
1 tablespoon chopped parsley, optional

Thaw frozen fish. Cut fish into 1-inch pieces. Combine butter or margarine, carrots, celery, onion and water in 6-quart Dutch oven or 12-inch covered fryer. Bring to boil. Cover tightly and simmer 10 minutes. Stir in soup, milk, peas, salt and herbs; stir and heat until bubbly. Add fish pieces. Prepare muffin mix as directed on package label, reducing milk by half and adding parsley, if desired. Spoon 6 to 8 mounds onto hot fish mixture. Cover tightly and simmer 10 minutes or until dumplings are done and fish flakes easily when tested with a fork. Makes 6 to 8 servings.
Total cooking time is 28 to 30 minutes.
*If desired . . . You may substitute 1 can (1 pound) white potatoes, drained and diced, for 1 cup each of sliced carrots and peas.

U.S.-SOVIET SCIENTISTS IN JOINT OCEANIC PROJECTS

The first meeting of the U.S.–U.S.S.R. Joint Committee on Cooperation in Studies of the World Ocean took place in Washington, February 25–27. Purposes were to review the results of joint cooperative measures since the signing of the Agreement on Cooperation in Studies of the World Ocean during the summit conference between President Nixon and General Secretary Brezhnev in June 1973, and to plan future joint activities.

The United States delegation was headed by Dr. Robert M. White, NOAA Administrator and Chairman of the U.S. side of the Committee. The Soviet delegation was headed by Dr. Yevgeny I. Tolstikov, Deputy Chief of the U.S.S.R. Main Administration for Hydrometeorological Services and Deputy Chairman of the Soviet side of the Committee.

The Joint Committee reviewed for initial implementation specific projects of cooperation within the six areas named in the 1973 Agreement—large-scale ocean-atmosphere interaction, ocean currents and dynamics, geochemistry and marine chemistry, geology and geophysics, biological productivity and biochemistry, and instrumentation calibration and standardization.

Earlier, in December, Soviet and U.S. scientists agreed on an enlarged program of scientific cooperation and research on marine mammals.

Experts from Soviet agencies exchanged data and opinion with their American counterparts in the U.S. Departments of Commerce and Interior on matters concerning whales, seals, sea lions, sea otters, walrus, and polar bears. Also in attendance were scientists of the U.S. Public Health Service in Alaska, the Alaska Department of Fish and Game, and several private scientific organizations.

The meeting of the Marine Mammal Subgroup—second in a series sponsored by NOAA—generated results in terms of concrete plans for a series of far-reaching bilateral investigations of the life cycles and environmental conditions of several species of marine mammals.

Dr. Robert M. White, NOAA Administrator and head of the U.S. delegation to the U.S.-U.S.S.R. Joint Committee on Cooperation in Studies of the World Ocean shakes hands with Dr. Yevgeny I. Tolstikov, Deputy Chief of U.S.S.R. Hydrometeorological Services and head of Soviet delegation to the committee, upon signing of U.S.-U.S.S.R. Agreement, Feb. 27.

Standing left, Dr. Thomas Owen, National Science Foundation; right, Dr. Donald Martineau, NOAA.

Discussion centered on such topics as:

—the standardization of methods and forms used by the two countries to record biological observations and sightings of pinnipeds (seals and sea lions) and cetaceans (whales and porpoises) at sea;

—the need for attention to technological improvements in presently available methods used to mark or tag marine mammals;

—the continuation of national research programs conducted in each country which seek to define both the population dynamics and the biological cycles of gray and bowhead whales;

—an increased effort by both countries to acquire biological data concerning the Beluga (in Russian "Belukha") whale;

—additional consideration of the experimental use—so far limited to the United States—of remote sensors to monitor walrus populations on North Pacific ice packs.

New Data System Is Readied For NOAA Aircraft

A new airborne data system, described as the forerunner of advanced systems due several years from now, is being prepared for one of NOAA's winged laboratories.

The new system was designed by the Environmental Research Laboratories' Weather Modification Program Office for its Research Flight Facility, headquartered at the Miami International Airport. The minicomputer-centered, $68,000 system is being built by Datacom, Inc. of Fort Walton Beach, Fla., under contract to NOAA.

According to Byron B. Phillips, who leads the Instrumentation Task Force in Boulder that developed the system, the new unit represents a step toward the data systems planned for the new generation of research aircraft expected later in the decade.

NACOA New Members Are Named

President Nixon has announced the appointment of nine persons as members of the National Advisory Committee on Oceans and Atmosphere.

They are (for the remainder of the term expiring October 18, 1975):

—Dr. Winona B. Vernberg, of Columbia, S.C., Research Professor of Biology at the University of South Carolina, Columbia.

(For the term expiring October 18, 1976):

—Dr. William Carl Ackermann of Champaign, Ill., Executive Secretary, Water Resources Research Commission, State of Illinois, Urbana, Ill.

—Tim M. Babcock, of Helena, Mont., Senior Vice President, Occidental International Corporation, Helena.

—Robert F. Bauer, of Whittier, Calif., Chairman of the Board and Chief Executive Officer, Global Marine, Inc.

—Dr. Robert A. Charpie, of Weston, Mass., President, Cabot Corporation, Boston, Mass.

—Dr. Thomas A. Clingan, of Coral Gables, Fla., Professor of Ocean Law, Uniersity of Miami, Coral Gables. Dr.

—Edwin Albert Link, of Binghamton, N.Y., founder, Link Aviation, Inc., Binghamton. Mr.

—Harold E. Lokken, of Seattle, Wash., Manager, Fishing Vessel Owners Association, Inc., Seattle.

—Lieutenant General Thomas S. Moorman, Jr., USAF (Ret.), of Colorado Springs, Colo., retired Superintendent of the U.S. Air Force Academy.

Dr. William A. Nierenberg, Director of the Scripps Institution of Oceanography in La Jolla, Calif., is Chairman of the committee, and Dr. William J. Hargis, Jr., Director of the Virginia Institute of Marine Sciences, Glouchester Point, Va., is Vice Chairman.

Jellyfish May Help Medical Science In Health Fight

The mysterious glow of Pacific jellyfish may lead toward improved detection of certain diseases in humans.

With Sea Grant support from NOAA, University of Washington scientists have found that a substance called aequorin, which gives the jellyfish its glow, can also be used to measure minuscule changes in calcium concentrations in a person's body fluids or cells. Such changes frequently are early signals of cellular destruction in the body, and point to the onset of diseases such as metastatic carcinoma, bone dysplasia, cardiac dysrhythmias, parathyroid disorder, and others.

Physiologist Dr. Kenneth Izutsu and Biochemist Samuel P. Felton produce a purified aequorin from the common jellyfish found in great numbers in Puget Sound at certain seasons. This jellyfish can be seen to glow in the dark if held in a person's hand.

The Sea Grant scientists, staff members of the university's Fisheries Research Institute and Center for Research in Oral Biology, are developing two methods for using aequorin to measure the amount of calcium in such biological fluids as blood, saliva, urine, and cerebral spinal fluid. Changes in the amount of glow, or luminescense, is a measure of changes in the amount of calcium in the fluid being measured. Aequorin was first discovered in 1962 by Dr. Frank Johnson and Dr. Osamu Shimomura of Princeton University.

Phillips To NWS In Major Post

Dr. Norman A. Phillips, Chairman of the Meteorology Department at the Massachusetts Institute of Technology, has accepted the position of Principal Scientist in the National Weather Service.

Dr. Phillips has held the top position in meteorology at M.I.T. since 1970, and been a meteorology professor there since 1956.

In his new post, he will explore new avenues of research in weather prediction at the National Meteorological Center. He is one of the world's foremost authorities on the dynamics of atmospheric motions and the application of electronic computers to numerical weather prediction.

While at M.I.T., Dr. Phillips has done occasional consulting for the NMC and has been a member of the advisory panel for NOAA's Project Stormfury.

Among honors he has received are the Napier Shaw Prize from the Royal Meteorological Society in 1956 and, from the American Meteorological Society, the Meisinger Award in 1960, the Editor's Award in 1969, and the Rossby Medal in 1971. The Rossby Medal is the AMS' highest honor.

WEATHER RADAR PLAN ANNOUNCED

The nation's network of long-range weather radars would be completed and 66 modern short-range instruments would be installed in areas where severe storms are most frequent, under a new Federal plan.

The plan also calls for equipping all long- and short-range weather radars with systems that make it possible to estimate the amount and rate of rainfall.

Included are proposed programs, to be carried out in five phases as funding becomes available, of those Federal agencies concerned with weather radar—the Departments of Commerce, Defense, Interior, and Transportation, the National Aeronautics and Space Administration, and the National Science Foundation. It was prepared by interdepartmental committees reporting to the Federal Coordinator for Meteorological Services and Supporting Research, Dr. Clayton E. Jensen, NOAA's Deputy Associate Administrator for Environmental Monitoring and Prediction.

The basic national network of long-range weather radars provides continuous surveillance for general forecasting and alerts local radar stations to begin operation as significant weather systems approach or develop. In the basic network are 51 WSR–57 systems operated by the National Weather Service, 15 Department of Defense facilities, and—in mountainous western areas—four units established to collect information from air route traffic control radars operated by the Federal Aviation Administration. To fill existing gaps in this network, NOAA plans to install longrange, storm detection instruments in southern Virginia, south-central New York, eastern North Dakota, eastern Texas, and western Nebraska. It also plans to establish units for joint use of the Denver and Alaska FAA air route traffic control radars.

Local warning radars, with shorter range and less power, supplement the basic network in areas where the threat and the potential impact of severe weather is great. At present, 38 modified World War II surplus radars are being used by NOAA's National Weather Service to support local warning programs. Under the new plan, modern solid-state radars would replace the obsolete systems and would be installed at 28 additional National Weather Service offices.

Weather radar remoting systems, presently installed on 32 radars in the basic network, transmit the scope image to users in remote locations.

The new radar plan provides for installation of radar remoting transmitters at 24 sites in the basic network and at seven local radar facilities. Forty-seven additional Weather Service Offices would be equipped with remoting system receivers.

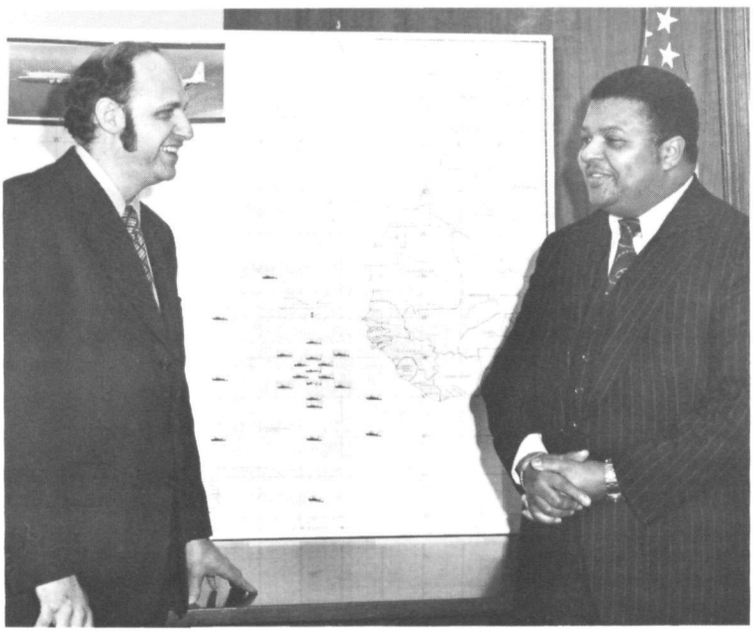
NOS To Produce New Northeast Pacific Charts

The National Ocean Survey will undertake the preparation and production of nautical charts for the northeast Pacific Ocean, covering a vast area extending from the West Coast to Hawaii to Alaska.

A two-year effort will go into the preparation of the first two charts, planned for issuance in 1975, with two more to follow in 1976, and the final chart in 1977.

The charts will be prepared by the agency's Office of Marine Surveys and Maps, headed by Captain Robert C. Munson. One chart, covering the area from the West Coast to Hawaii, will be published at a scale of 1:10,000,000 the remainder at a scale of 1:3,500,000.

SENEGAL AMBASSADOR BRIEFED ON GATE



The Hon. Andre Coulbary (right), Senegal's Ambassador to the United States, was briefed recently on plans for the GATE (GARP Atlantic Tropical Experiment) project by Dr. Douglas Sargent, who heads the U.S. GATE Project Office. Operational headquarters for the experiment, to be conducted this summer, will be located at Dakar, Senegal.

noaa/people

Captain Roger Lanier has been placed in charge of develpiing plans for the National Ocean Survey to convert its operations to the metric system. He is a Special Assistant to the Director.

Stephen Yachmetz, Jr., has been named Chief of the Aeronautical Chart Division in the National Ocean Survey's Office of Aeronautical Charting and Cartography, and Friason Travis has been named Assistant Chief.

Dr. Brian J. Rothschild, Director of the National Marine Fisheries Service's Southwest Fisheries Center in La Jolla, Calif., was unanimously elected Chairman of the Standing Committee for Research and Statistics of the International Commission for the Conservation of Atlantic Tunas at its annual meeting in Paris in December 1973.

Dr. Eugene L. Peck has been appointed Director of the National Weather Service's Hydrologic Research Laboratory. He has served in the Laboratory since July 1967 as a branch chief and most recently as Assistant Director.

Ernest A. Shepard, Jr., is the new Chief of the Photographic Section in the Reproduction Division of the NOS' Office of Aeronautical Charting and Cartography.

Lieutenant Commander Thomas E. Gericsh has graduated from Navigator School at Mather Air Force Base, Calif., and is now stationed at the Environmental Research Laboratories' Research Flight Facility in Miami, Fla.

Lieutenant Commander Bruce L. Keck is the new Field Operations Officer of the Seattle-based NOAA Ship *Rainier*. He recently completed an assignment at the National Ocean Survey's Oceanographic Division in Rockville, Md., as Projects Officer and Acting Chief of the Oceanographic Surveys Branch.

Robert W. Pentney has been selected as the Meteorologist in Charge of the Weather Service Office in Auburn, Wash. He has been assigned at Medford, Oreg., since 1960.

Commander Ronald L. Newsom heads the Marine Engineering Division at the Atlantic Marine Center, Norfolk, Va. He recently was graduated from the Armed Forces Staff College in Norfolk.

William I. Pogermon has been named Program Manager of Substation Management in the National Weather Service's Data Acquisition Division. He formerly served as Chief of the Surface and Upper-Air Staff in the NWS Eastern Region Headquarters.

Commander Robert A. Trauschke has been appointed Commanding Officer of the NOAA Ship *Whiting*. During the past 15 months he has been undertaking graduate studies at George Washington University.

Ben L. Scott has been appointed Official in Charge of the Newark, N.J. National Weather Service Office, where he has been a Weather Service Specialist since 1970.

Lieutenant Commander John P. Vandermeulen is the new Chief of the Electronic Engineering Division at the Pacific Marine Center of the National Ocean Survey in Seattle, Wash. He was previously assigned to the Pacific Marine Environmental Laboratory in Seattle.

T. J. Sheehan has been appointed head of the National Weather Service Office at San Angelo, Tex.

Commander J. Austin Yeager has been appointed Commanding Officer of the NOAA Ship *McArthur*.

James Lander, Deputy Director of the Environmental Data Service's National Geophysical Data Center, and a team of earthquake experts, recently participated in the Emergency Energy Capacity Study of the National Academy of Sciences. The experts are trying to determine the advisability of storing oil and gas for national emergency use.

Anne M. Elder is the new Meteorologist in Charge of the Weather Service Meteorological Office (Radar) in Neenah, Wis. She is the first woman to become MIC of either a WSMO or a network radar station (WSR-57 type) in the NWS Central Region.

Millard L. Cutler has been appointed Chief of the Program Development Division in the National Ocean Survey's Office of Program Development and Management. He formerly headed the Planning, Coordination and Program Support Staff in the National Geodetic Survey.

Lieutenant (junior grade) Thomas E. DeFoor has joined the Environmental Research Laboratories' Boulder, Colo.-based Space Environmental Laboratory as a member of the Real Time Data Acquisition Group. He previously served aboard the NOAA Ships *Fairweather* and *Surveyor* as an electronics officer.

Dr. Joseph Angelovic has been appointed Director of the National Marine Fisheries Service's Gulf Coastal Fisheries Center at Galveston, Tex. He formerly was Chief of the Research Management Division in Washington, D.C., where he served under the Associate Director for Resource Research.

Captain Edwin K. McCaffrey was recently designated the EDS Commissioned Corps Liaison Officer to furnish advice and assistance in assuring optimum utilization and treatment of NOAA Corps Officers within EDS. He was assigned to EDS in the latter part of 1972 following his tour of the NOAA Ship *Mt Mitchell*.

Clifton W. Green, Principal Assistant of the Weather Service Forecast Office at Jackson, Miss., has been selected to head that office.

Sidney Feldman has been appointed Chief of the Instrument Approach Procedure Chart Branch in the National Ocean Survey's Aeronautical Chart Division.

Dr. Alan J. Beardsley of the National Marine Fisheries Service Northwest Fisheries Center in Seattle, Wash., recently was named Director of the Kodiak Investigations of the NWFC. He was previously Program Leader of the Finfish Research Program of the NWFC.

Rene Cuzon du Rest, of the Environmental Data Service's National Oceanographic Data Center, has been detailed to the Office of the Secretariat of the Intergovernmental Oceanographic Commission in Paris, France, for a six-month period. He will occupy this position until a permanent Assistant Secretary is selected.

Dr. Edward F. Klima recently joined the staff of the Associate Administrator for Marine Resources as the specialist for resource research in the Office of Living Resources. Since 1973, he had been on the Plans and Policy staff of the National Marine Fisheries Service in Washington, D.C.

Dr. Abram Bernstein, formerly of the Environmental Research Laboratories, has joined the staff of the National Advisory Committee on Oceans and Atmosphere (NACOA).

The President has appointed **Dr. Steven E. Schanes** and **Robert C. Macdonald** as United States Commissioners on the Inter-American Tropical Tuna Commission. Dr. Schanes is Assistant to the Director for Special Projects, National Marine Fisheries Service, La Jolla, Calif. He succeeds William M. Terry, who died May 6, 1973. Mr. Macdonald is senior partner of the law firm of Macdonald, Dean, McCallister and Snow, Astoria, Oreg. He succeeds William H. Holmstrom, who has resigned.

Max R. Griffith has been selected to head the National Weather Service Office at Montgomery, Ala. Since 1971, he had been in charge of the Weather Service's new network radar weather station at Neenah, Wis.

Frank V. Garcia has been appointed Chief of the Radio Facility Chart Branch in the National Ocean Survey's Aeronautical Chart Division.

Thomas J. Billy was appointed to the new position of National Program Coordinator of projects involving the development of underutilized and latent fisheries within the National Marine Fisheries Service. His most recent position was Deputy Chief, Fisheries Products Research and Inspection Division.

Kenneth L. Core, an Osage Indian with the Environmental Data Service's National Geophysical and Solar-Terrestrial Data Center in Boulder, Colo., recently accompanied a mobile U.S. Geological Survey exhibit to schools on the Navaho Indian Reservation in New Mexico and Arizona to interest minority students in scientific disciplines that will lead to employment with the Federal Government.

William F. Frank, Meteorologist in Charge of the National Weather Service Office at Baton Rouge, La., for the past six years, has been named MIC of the WSO at the Amarillo, Tex., Air Terminal.

James K. Huntoon has been appointed Chief of the Public Weather Branch in the Weather Analysis and Prediction Division of the Office of Meteorological Operations. He was formerly Chief of the Manpower Utilization Staff in the Office of the Director.

Oscar Milne and **Galen Joel** recently were sworn in as Officials in Charge of the weather stations on Majuro and Yap, respectively. All five Trust Territory first-order stations are now headed by Micronesians.

Charles E. Harrington has been named to the post of Staff Geographer by the National Ocean Survey. Before joining the NOS three years ago, he served for seven years with the Defense Department's Aeronautical Chart and Information Center in St. Louis, Mo., and with the Naval Oceanographic Office in Suitland, Md.

Dr. Paul J. Hooker has been named Chief of Statistics and Market News Division for the Southeast Region of the National Marine Fisheries Service.

Would You Do A Fish A Favor? Then Rename It

Common names of various species of fish have long presented problems of identification and labeling of fishery products because the same species may be known by different names in different parts of the country, or even in the next county.

The National Marine Fisheries Service points out that several thousands of marine food species have taxonomically accurate scientific names recognized by fisheries scientists, but because of different common names in different locales, the situation leads to confusion in the marketplace, is not in the public interest, and defies regulatory controls. The problems are accentuated in that many nutritious products are available from species known by names that are commercially objectionable.

NMFS Director Robert W. Schoning said that confusion exists concerning naming and labeling new product forms manufactured from multiple ingredients and various species of fish.

Schoning said he would appoint an expert to coordinate development of an improved procedure to achieve the nomenclature objectives. The coordinator will contact and work with all interested parties in the private and public sectors, and maintain close liaison with the FDA.

CLARK APPOINTED TO DIRECT HYDRO

Dr. Robert A. Clark has been named to succeed Max A. Kohler as the National Weather Service's Associate Director for Hydrology. Mr. Kohler retired December 31 after 36 years of Federal service.

In his new post, Dr. Clark will head the NWS Office of Hydrology, which is responsible for river and flood forecasting throughout the Nation. He was an aviation forecaster for the U.S. Air Force, a hydrometeorologist for the Bureau of Reclamation, and a Professor of Meteorology at Texas A&M University, before joining the NWS as Chief Hydrologist and scientific advisor on hydrology in February 1973.

DROUGHT-BORNE DUST MAY AFFECT WEATHER CONDITIONS

A record of the five-year drought which still plagues the African nations south of the Sahara is written in the skies as far away as the Caribbean Sea, where scientists find that dust from Africa—in increasing amounts since the drought began—may affect tropical weather, disturb the solar energy balance, and diminish regional air quality.

According to Dr. Toby N. Carlson of the Environmental Research Laboratories and Dr. Joseph M. Prospero of the University of Miami, the hot desert winds blowing across the scorched sub-Saharan grasslands, pick up large quantities of the area's topsoil, and carry it across the equatorial Atlantic in well-defined "lenses" of warm dusty air. The study was partially financed by the National Science Foundation.

The scientists noted that since this large-scale transport of African dust began to be measured systematically in 1965, in Barbados, West Indies, dust concentrations have risen markedly—1973 concentrations were 60 percent greater than 1972 values, and there has been a three-fold increase in dust levels since 1968, the period corresponding to the Saharan drought.

"In 1966," Carlsno says, "the summertime dust level in the air over Barbados was about six micrograms per cubic meter of air. Then this value increased to eight micrograms in 1967 and 1968. After 1968, however, the summertime dust concentrations showed a much more rapid yearly increase, reaching 15 micrograms in 1972 and 24 micrograms in the summer of 1973.

"The effect of these increases has been to increase atmospheric turbidity (or decrease atmospheric transparency) to the point where the typical marine conditions one normally finds there have been transformed into the hazy conditions of urban industrialized regions of North America. The difference is that the 'pollution' consists of natural soil particles, and is concentrated much more at 10,000 feet than at the surface."

Carlson believes the dusty layer of Saharan air also removes a significant amount of solar energy from the sun's rays, altering the solar energy balance of the tropical Atlantic.

"As the solar radiation comes down through the atmosphere," he explains, "the dust absorbs some of the energy and scatters additional amounts back to space. Our measurements suggest that the three-fold increase in dustiness since the start of the African drought has contributed to a 10- to 15-percent reduction in solar energy reaching the sea surface in the tropical Atlantic."

The transport of the Saharan dust appears to occur in large-scale pulses from the African continent, with the pulses usually taking several days to cross the Atlantic to the Caribbean. Before it reaches the African coast, however, the air is subjected to prolonged, intense heating, which causes strong mixing in a desert air layer which may be 15,000 to 20,000 feet deep in summer. As this hot, dusty air emerges from the west coast of Africa, it is undercut by relatively cool, moist trade winds which confine the desert air to altitudes above 4,000 to 6,000 feet. Over the ocean, the warm desert air becomes sandwiched between the low-level moist trade wind air below and the 15,000- to 20,000-foot level, which corresponds to the top of the desert mixing layer.

Prospero's research showed that the amount of dust collected in Barbados varies considerably from day to day, especially in the summer months when the atmospheric dust concentrations at Barbados are greatest. During winter, however, the dust content at Barbados is very much smaller than in summer and the color is ash grey or black in contrast to the light red-brown color of the summer's dust.

Frank Heads The National Hurricane Center In Miami

Dr. Neil L. Frank

Dr. Neil L. Frank, 42, has become director of the National Hurricane Center in Miami. He has served as its Deputy Direcor since 1972.

He succeeds Dr. Robert H. Simpson who retired on December 31, after 33 years with the weather service.

The National Weather Service's hurricane center is responsible for the forecasting of all tropical storms in the Atlantic, Caribbean, and Gulf of Mexico.

In addition to the hurricane responsibilities, Dr. Frank will serve as Meteorologist-in-Charge of the Weather Service Forecast Office which is responsible for all forecasts and warnings in the state of Florida.

Dr. Frank has been a meteorologist at the Center since 1959.

He was one of a team of experts from the World Bank who surveyed the 1970 cyclone disaster in Pakistan. His contributions on warnings and remedial actions have established him as a world authority in this particular area.

He was graduated from Southwestern College, Winfield, Kansas, with a B.A. in 1953. He received his M.S. in 1961 and his Ph.D. in 1970, both from Florida State University. He is a member of the American Meteorological Society and the American Geophysical Union.

In 1970, Dr. Frank received the Federal Employee of the Year award in the Professional, Scientific Category in the Greater Miami area.

He is married to the former Velma Becker. They have three children, Pam, Debbie, and Ron.

NESS' Johnson, Other Officials Honored By AMS

National Environmental Satellite Service Director David S. Johnson has assumed office as President of the American Meteorological Society.

Numerous NOAA officials were honored at the AMS' 54th annual business meeting in January.

Three were elected as Councilors:

Dr. Edward S. Epstein, Associate Administrator for Environmental Monitoring and Prediction, Rockville, Md.; Allen D. Pearson, Director of the National Weather Service's National Severe Storms Forecast Center in Kansas City, Mo.; and Dr. Joseph Smagorinsky, Director of the Environmental Research Laboratories' Geophysical Fluid Dynamics Laboratory in Princeton, N.J.

The AMS' Cleveland Abbe Award for Distinguished Services to Atmospheric Sciences for 1974 was presented to Dr. Lester Machta, Director of ERL's Air Resources Laboratory, in Silver Spring, Md., "for outstanding contributions on critical atmospheric problems pertaining to the protection of the environment, especially for his studies of atmospheric constituents and pollutants including oxygen, carbon dioxide and radioactive material."

David S. Johnson

The Society's Award for Outstanding Service by a Weather Forecaster was won jointly by W. Clyde Conner and Raymond H. Kraft.

Mr. Conner is Meteorologist in Charge of the National Weather Service Office in New Orleans, La., and Mr. Kraft recently retired from his position as Hurricane Forecaster at the National Hurricane Research Center in Miami, Fla.

Robert A. McCormick, a former employee of ERL's Air Resources Laboratories, who was detailed as Director of the Environmental Protection Agency's Division of Meteorology at Research Triangle Park, N.C., is the winner of the Society's Award for the Outstanding Contribution to the Advance of Applied Meteorology.

Stevenson To Head Southeast NMFS Region

William H. Stevenson, 46, has been named Director for the Southeast Region of the National Marine Fisheries Service.

The Southeast Region is responsible for certain Federal fisheries activities in 17 Gulf and South Atlantic States plus Puerto Rico and the U.S. Virgin Islands.

Mr. Stevenson served as manager of the NMFS Southeast Fisheries Center's Fisheries Engineering Laboratory located at Mississippi Test Facility, Bay St. Louis, Miss., since September 1970. Among his most recent experiences was directing the fisheries functions of Skylab and Earth Resources Satellite Technology programs. Prior to heading the Fisheries Engineering Laboratory he was Chief of Exploratory Fishing and Gear Research in Washington, D.C.

Sea Grant Project Studies Water Flow

A dramatic example of the often complex nature of coastal water movement has been provided by Sea Grant researchers at the Massachusetts Institute of Technology, who have discovered that:

—Polluted water from Boston Harbor moves seaward through Massachusetts Bay in "blobs," rather than as a continuous tongue or stream;

—The major fresh water flow into the bay comes down in a long continuous tongue, rather than in "blobs," during the spring runoff. This water comes from the Merrimack River, which lies outside the bay and empties into the ocean 35 miles north of Boston harbor.

These findings arose from two related projects, part of a major environmental study of Massachusetts Bay and adjacent waters, sponsored by the Sea Grant program and by the Department of Natural Resources of the Commonwealth of Massachusetts.

The study is designed to provide information on the dynamics of water movement and sediment flushing in the bay. Results of the study are planned to help coastal zone management officials make more informed decisions about waste disposal and other uses of the waters in the area.

Water outflow from Boston Harbor was studied by Joseph Karpen of the M.I.T. Department of Meteorology, using the M.I.T. research vessel *R.R. Schrock* to collect chemical samples and make temperature, salinity, and density measurements. Karpen discovered that the relatively fresh, pollution-laden harbor waters protrude briefly in a long tongue out into the bay at ebb tide (low water). During the flood tide, as the relatively salty, less-polluted bay waters flow toward the harbor mouth, the harbor and bay waters are mixed near the harbor mouth. The tongue of harbor water farther out in the bay is cut off, and remains essentially unmixed.

At slack water, high tide, the harbor water mass in the bay has moved back slightly toward the harbor.

As the tide again ebbs, the harbor water "blob" in the bay reverses its direction, moves seaward, and the cycle begins again as another tongue of harbor water again protrudes into the bay.

The related M.I.T. Sea Grant project measured spring run-off of fresh water into Massachusetts Bay in 1973, and was undertaken by Veshpati Manohar-Maharaz and Dr. Robert C. Beardsley of the Department of Meteorology. They discovered that the Merrimack River accounts for about 90 percent of the total amount of fresh water discharge into the bay during the spring months. This water comes into the bay in the form of a tongue of low salinity water in the middle of the bay, and slowly spreads out to encompass the Boston Lightship to the west and as far out as Stellwagen Bank to the east.

Barnaclewise, More Bang For The Buck

A revolutionary new method of ship cleaning that reduces both time and cost involved in removing marine growth from heavily fouled hulls has been developed by a Seattle, Wash., man, with the help of the University of Washington Sea Grant Program.

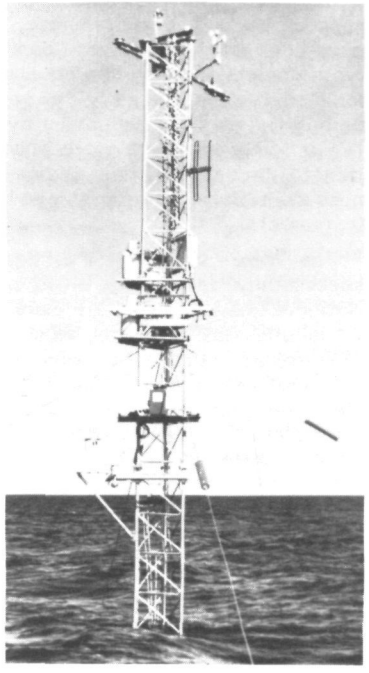
Brad Meyers of Controlled Dynamics Corporation made the ship cleaning discovery by accident. While involved in the explosive removal of propellers from scrap vessels, he noticed that the shock-producing cord being used had removed marine growth and corroded paint from a section of the hull immediately adjacent to the cord. After considerable experimentation, he succeeded in removing marine growth with an explosive cord mesh draped around the hull.

Special instrumentation was developed to determine the levels above which damage would occur to hull plates and below which cleaning would not be effective. The system was revised and a Navy tug was effectively cleaned with no damage.

As a further precaution, Mr. Meyers decided that rather than releasing one hard punch of energy, he would lightly tap the ship several times. Dubbed "Sequential Sea Mesh System," the cleaning system was pronounced workable, and now seems to be on its way to commercial success.

The principle of the unique system is simple. An electrochemical device connected to the diamond-shaped net initiates a controlled amount of energy at a low level. A rapid chemical reaction takes place, the net disintegrates, and a pressure wave traveling at thousands of feet per second removes marine growth, but leaves paint intact. The wave stops when it reaches a delay unit. After a short time, an energy wave is reinitiated on the next level, and so on until the hull is cleaned.

LSC Towers Stored In Water Beds



A new method has been devised for the winter storage of steel towers used in the Great Lakes for research: They are placed at the bottom of a lake, and kept in 40 to 50 feet of water until spring when they are raised to the surface and put back to work.

The unique storage system, devised by the National Ocean Survey's Lake Survey Center, was successfully tested in 1972–73. Now there are three towers at the bottom of Lake Michigan and the Straits of Mackinac, which connect Lakes Michigan and Huron.

Previous practice was to float a tower ashore, using air-filled 52-gallon drums, take it apart and transport it back to Detroit for storage. It was a two- to three-day job, with the same amount of time required to reset the tower in the spring with its instruments.

A Lake Survey technician and scuba diver, Ron Dana, suggested that the towers be stored at the bottom of the lake. It was first tried in the fall of 1972, a tower being dropped into 50 feet of water off Muskegon in Lake Michigan. The following spring, the tower was brought to the surface and re-erected without any trouble.

They're Low:
NITRIC OXIDE LEVELS SURPRISE SCIENCE

Based on the first measurements ever made of nitric oxide in the stratosphere, NOAA scientists report that nitric oxide levels there appear to be lower—by a factor of three or more—than predicted theoretical levels.

Although preliminary, the unique measurements raise important questions about the assumed effects of such jet exhaust products as nitric oxide on the stratospheric ozone layer, which absorbs much of the biologically harmful ultraviolet radiation sent earthward by the sun.

They also raise questions about how well existing theory explains the atmosphere's observed equilibrium between such highly reactive molecules as ozone, and nitric oxide, which destroys ozone through chemical recombination.

The nitric oxide monitoring program is being conducted by ERL's Air Resources Laboratories for and with the support of the Department of Transportation and its Climatic Impact Assessment Program, which seeks to determine the climatic effects of perturbations of the upper atmosphere caused by propulsion effluents from a world fleet of high-altitude aircraft, as projected in 1990. York University in Toronto, Canada, developed the nitric oxide sensor and Utah State University in Logan developed the associated electronics package under contract to NOAA.

"Over the past few years," says Dr. Lester Machta, director of the Air Resources Laboratories, "there has been concern over the environmental effects of a large fleet of high-altitude jets. Part of this has been that certain combustion products—pollutants—would be introduced into the stratosphere, where, because there is very little vertical mixing, they would remain for years and be concentrated in relatively large amounts.

"Also, there has been speculation that one pollutant in particular—nitric oxide—could chemically destroy the stratosphere's ozone layer, reducing the shield and allowing more ultraviolet radiation to penetrate to the earth's surface.

"Until the present measurements were obtained, we had no in-place data on stratospheric nitric oxide concentrations, and so had no way of estimating or predicting the seriousness of these possibilities."

The present measurments were made by a sampling system developed jointly by scientists at York University and Utah State University. Called the "Snooper" (from Stratospheric Nitric Oxide Operative Reactor) sensor, the 214-pound device is carried aloft by large (800,000-cubic-foot) research balloons, taking nitric oxide measurements between altitudes of about 15 and 30 kilometers (50,000 and 100,000 feet). Balloons and flight support have been supplied by the Division of Biological and Environmental Research of the Atomic Energy Commission. Payload assembly launchings, and recoveries are accomplished by Air Force Cambridge Research Laboratories.

New NMFS Deputy Director Sworn in by NOAA Administrator

Jack W. Gehringer (left) was sworn in as Deputy Director of the National Marine Fisheries Service by Dr. Robert M. White, NOAA Administrator. Mrs. Gehringer held the Bible during the ceremony.

WOFFINDEN TO DIRECT NWS' PACIFIC REGION

Charles M. Woffinden has been named Director of the Pacific Region of the National Weather Service. Woffinden's predecessor was Paul H. Kutschenreuter, retired.

He comes to his new post from Scott Air Force Base, Illinois, where since October, 1972, he has been liaison officer between the Air Weather Service and the National Weather Service. In this assignment he also has been providing liaison between NOAA's Environmental Research Laboratories in Boulder, Colo., and the National Weather Service.

In his new position he will oversee Weather Service activities in a huge area of the Pacific extending from the Hawaiian Islands on the east to the Philippines on the west, and from Wake Island on the north to Pago Pago on the south. This area is by far the largest of the Weather Service's six regions in area. In population it ranks fifth, before Alaska.

Second NMFS Survey

Oil, Plastic Contaminants Confirmed

The widespread concentrations of oil and plastic contaminants found in 1972 by Commerce Department scientists over 700,000 square miles of East Coast oceanic waters has been confirmed in a repeat survey.

Analyses recently completed also reveal that most of the tar clumps cluttering the ocean environment from Cape Cod to South America are characteristic of oil wastes dumped from ships and tankers.

The origin of the plastic particles has not yet been pinpointed, but teams of researchers with the National Marine Fisheries Service have preliminarily determined that the plastic bits are not necessarily harmful to immature fish, as was feared.

Tests also have demonstrated that Gulf of Mexico waters, the site of many oil-producing structures on the coast and offshore, are relatively free of oil pollution when compared with other areas in frequent use by maritime traffic, such as the Sargasso Sea (in the middle Atlantic some 300 miles off the U.S. East Coast) and the Mediterranean. Oil concentrations in the Gulf according to the recent findings of investigators from Texas A&M, are similar to those found in MARMAP (Marine Resources Monitoring, Assessment and Prediction program) surveys along the U.S. East Coast—in regions where oil production is not a factor.

Not yet determined is whether numerous larval and juvenile fish populations are susceptible to harmful effects as a result of contact with the oil products scattered throughout the marine environment under study.

In all, the second survey reached south from Cape Cod across the northern coast of South America, east about 300 miles beyond the outer edge of the Bahamas Island chain, and west to the southern outflow of the Gulf of Mexico, into the Yucatan Peninsula.

Oil and plastics appeared in every area sampled, and more than 50 percent of all plankton (young fish and their food) samples collected were tainted with oil. For the second time, concentrations of tar clumps were highest in the Antilles-Bahamas segment (offshore), where the count was five times greater than that in the other three areas and 94 percent of the samples collected were oil-contaminated. Tar concentrations in coastal waters along the East Coast, low on the summer MARMAP survey, were comparably low from North Carolina to Florida in the winter survey, but from Cape Cod to Virginia concentrations were slightly higher.

Sky-Eye Monitors Alaskan Hazards

Potential uses of high-resolution satellite images in providing vital information on Alaska's environmental conditions and hazards are being examined in a one-year NOAA pilot project.

Under a contract from NOAA's National Environmental Satellite Service, a scientific team at the Geophysical Institute of the University of Alaska, led by Dr. Gerd Wendler, is seeking new and improved applications of one-half-mile-resolution images received from the NOAA–2 and NOAA–3 spacecraft.

Alaska experiences a variety of environmental extremes. Its weather hazards include storms, fog, heavy snow, sudden freezes, high winds, and inundating rains. In spring, melting snow and river-blocking ice jams can cause severe flooding.

The very high resolution radiometers (VHRR) on NOAA spacecraft furnish detailed images of the earth, clouds, and oceans, in daylight and darkness. In cloud-free areas, the images provide a measure of sea-surface temperature which affect the way weather systems develop and move over ocean areas toward land. Sea surface temperature patterns reveal the location of ocean surface currents, important information for shipping and for the state's large fishing industry. The radiometer observations of ice on oceans, lakes, and rivers can be used to improve the safety and efficiency of shipping, and images of snow pack in remote areas can aid in assessing the potential for flooding.

SPILHAUS NAMED CONSULTANT TO ADMINISTRATOR

Scientist, inventor, and author Dr. Athelstan Spilhaus has been appointed special consultant on oceanic and atmospheric programs to Dr. Robert M. White, Administrator.

In his position, Dr. Spilhaus will conduct studies, carry out special assignments, and give counsel on NOAA activities in ocean-atmosphere monitoring, Sea Grant, oceanic research, fisheries, and coastal zone management.

Dr. Spilhaus, known as the "Father of Sea Grant" for his concept for the name and activity that later came to be NOAA's National Sea Grant program, has most recently been a Fellow at the Woodrow Wilson International Center for Scholars of the Smithsonian Institution. Formerly President of the American Association for the Advancement of Science (1970), he has also been President of the Franklin Institute (Philadelphia) from 1967–1969, and Dean of the Institute of Technology, University of Minnesota, 1949–1967. He is the inventor of the bathythermograph, a basic internationally-known oceanographic instrument, and the Spilhaus Space Clock. He is a prolific author of both popular and scientific articles.

Dr. Athelstan Spilhaus

Dungeness Crabs Go Last Mile In Style In NMFS Experiment

About four tons of live Dungeness crabs, a gourmet delicacy, have been trucked to West Coast retail outlets over comparatively long distances recently in a unique system developed by NOAA scientists. Heretofore only minor amounts of live Dungeness crabs have been airshipped to markets.

The new shipping method, successfully tested by NOAA's National Marine Fisheries Service laboratories at Seattle, Wash., may make possible the sale of new varieties of live shellfish to customers far from the site of the catch. The NMFS investigations were undertaken in response to the request of a commercial fishing company which supplied equipment and financing.

Experimentation involved the use of a 27-foot trailer truck, the interior of which was lined with Fiberglas and equipped with a specially built piping system supplied with circulating, refrigerated water from a 400-gallon capacity reservoir, fixed to the underside of the van. Built-to-order plastic trays holding eight Dungeness crabs apiece were nested and locked in vertical stacks in supporting frames.

In all, the trailer accommodated 20 stacks of 30 trays or a total of 600 trays containing 4,800 of the large-sized crabs. Chilled salt water was continuously pumped into the top trays of each stack through overhead pipes, to overflow in waterfall fashion through openings and cascade from tray to tray. Holes cut into the bottom trays kept the water continually draining into the reservoir where it was filtered and recirculated into the system.

The new live shipping method is seen as possibly adaptable to other crustaceans, such as lobsters or crayfish. Live seafood marketing in the United States is limited mostly to the Atlantic lobster, and shipment by air is the preferred method. Most of the 40 to 60 million pounds of Dungeness crabs caught annually by U.S. fishermen reaches the market in canned or frozen form.

noaa/update

Survey Team Aids Industry Oil Effort

A test program designed to prove the feasibility of accurately determining the location of oil platforms at considerable distances from shore has been completed by a team from NOAA's National Geodetic Survey.

The team established the latitude and longitude of two platforms in the Gulf of Mexico, 40 and 100 miles (64 and 161 kilometers) off the Louisiana coast, by making doppler observations on a Navy navigation satellite with a geodetic receiver.

Precise determination of the position of offshore oil platforms would enable the oil industry to develop their offshore holdings more fully. At present, boundaries of the oil leases are not sufficiently accurate to allow complete development of petroleum deposits because of the possibility of encroaching on adjacent leases. It has been difficult to determine the exact dimensions of leased areas, and some boundaries are off by a significant amount.

The satellite-doppler effect system could also delineate areas of ecological concern more accurately, thus affording them greater protection. The system can extend the limits of land-based geodetic controls into marine areas, benefiting all forms of marine development, including fishing, seabed mining, and nautical charting.

NMFS Enforcement Post To Pallozzi

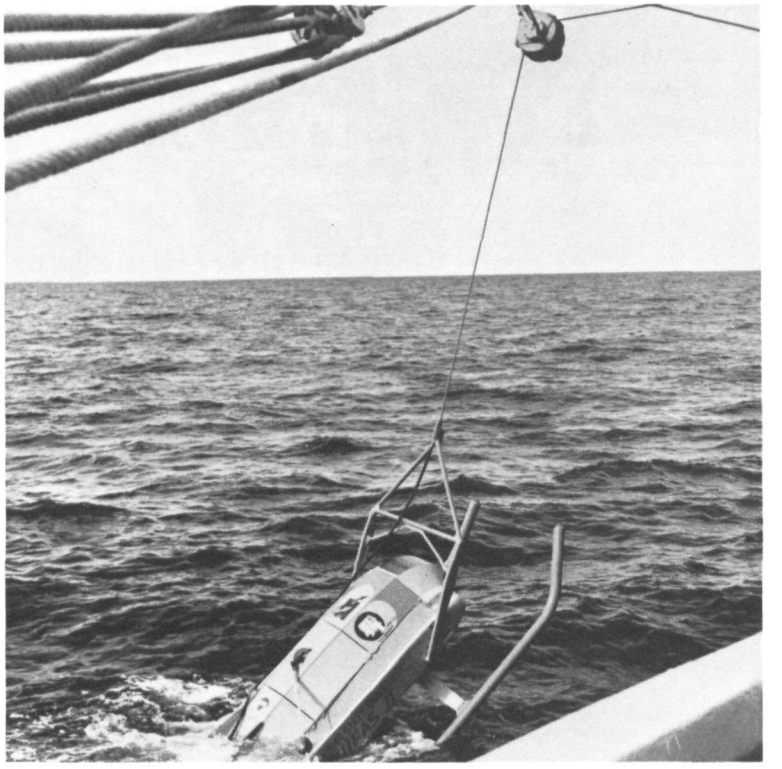
Morris M. Pallozzi has become Chief of the National Marine Fisheries Service Enforcement and Surveillance activity.

Mr. Pallozzi comes to NMFS from positions of progressively greater responsibility as an attorney with the U.S. Treasury Department, which he joined in 1963. His first three years there were devoted to investigatory work related to bank trust departments in several States. The following five years were spent in customs law specialization, with emphasis on the legal interpretation of maritime traffic regulations. During the past three years, Mr. Pallozzi served as a customs law adviser and coordinator for special projects in the field of domestic and international commerce.

RUFAS II, Shadowgraph Scan Ocean Floor

A second generation robot diver that can inspect the seafloor at great depths is expected to aid significantly in locating commercially important stocks of fish and other undersea resources.

Named RUFAS II (for Remote Underwater Fisheries Assessment System), the instrument is towed behind a research ship, and dives on command to look at selected underwater features. Development of RUFAS II was under the sponsorship of two units of NOAA—The National Marine Fisheries Service, and the Office of Sea Grant, through a grant to Mississippi State University.



RUFAS II is lowered into the water from a research ship.

RUFAS II is equipped with roving "eyes" that photograph the surrounding scene by videotape and 35 mm. film, and continuously televise its observations to the mother ship. The 35 mm. photo system can be activated to record interesting phenomena, then turned off to ignore barren stretches of sandy bottom.

Equipped with sonar beams, RUFAS II sends warning signals to the shipboard operators when underwater navigational hazards are detected, so the instrument's "flight pattern" can be altered electronically to avoid the obstacle, be it a rock or a change in the configuration of sea floor.

RUFAS II came into being as a result of collaborative work by Dr. Sidney Upham, Mississippi-Alabama Sea Grant Director, and Dr. Edward F. Klima, former base director of the NMFS Pascagoula laboratory. Principal investigators on the project were Richard D. Benton, Associate Professor of Engineering Technology at Mississippi State University, and Wilbur R. Seidel, Manager of the NMFS Harvesting and Technology Program based at Pascagoula.

And another development in seafloor surveyors has been tested in the Gulf of Mexico by NMFS scientists.

Called the "Shadowgraph System," the acoustical device looks like a torpedo with wings and is towed behind a ship. Its purpose is to convey information to the tow ship concerning configuration of the seafloor detected by electronics systems.

In the recent series of tests to determine the Shadowgraph System's capability as a fisheries research tool, personnel from NOAA's National Marine Fisheries Service deployed the instrument from the research vessel *Oregon II* jointly with the underwater photography sled called RUFAS, towed by the reseach vessel *George M. Bowers*. The two were used together so that the engineers could evaluate the merits of an acoustical image as opposed to an optical image of portions of the seafloor.

Participants in the experiment were the NMFS Southeast Fisheries Center (Miami, Fla.), the NMFS Fisheries Engineering Laboratory (Bay St. Louis, Miss.), Navy's Naval Coastal Systems Laboratory (Panama City, Fla.), NOAA's National Ocean Survey, and the U.S. Coast Guard.

NMFS DISCOVERS INFINITE VARIETY OF MINCED FISH

New types of food products utilizing fish flesh as a major ingredient will soon become increasingly available to consumers at similar or possibly lower prices than comparable food items now available, according to National Marine Fisheries Service experts.

Earlier this year, the NMFS announced that it had demonstrated machinery to strip the meat from either dressed fish or fish "frames" (the remaining skeletons) and recover it. This recovered edible flesh from traditional species such as cod, haddock, or flounder, was previously discarded in many cases, but can be formulated into new, wholesome, marketable product forms attractive to homemakers. The recovered fish flesh in its raw form is called "minced fish" and offers a potential for diversification of the fishing industry into the rapidly expanding convenience and snack food fields.

NMFS personnel recently demonstrated several concepts for diversified uses of the minced fish. As a starting point, a basic pasteurized spread was prepared from minced fish, similar in texture and color to cream cheese, but possessing essentially no flavor or odor of its own.

By adjusting the formulation and taking advantage of the high binding power of the fish protein, one can blend such natural products as oysters, clams, scallops, geoducks, mussels, and sea cucumbers into tender textured products with excellent flavor appeal.

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