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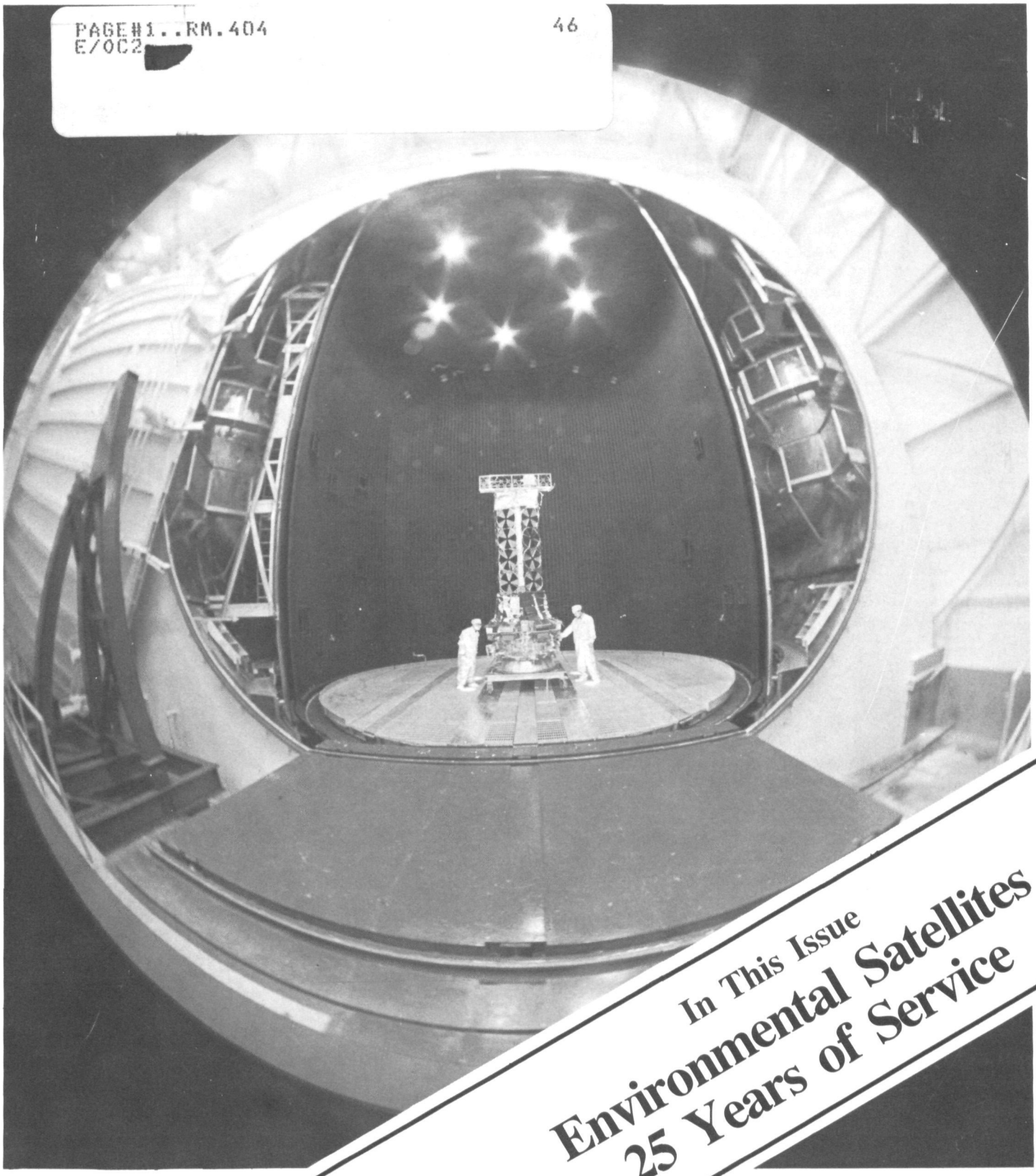

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## Environmental Satellites 25 Years of Service

# National Oceanic and Atmospheric Administration

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*COVER: Technicians at work on the two-story-high weather satellite, NOAA-G. The satellite sits in RCA Astro-Electronics' huge thermal/vacuum test chamber in East Windsor, N.J. (RCA photo.)*

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**U.S. DEPARTMENT OF COMMERCE**
Malcolm Baldrige, Secretary

**National Oceanic and Atmospheric Administration**
**Anthony J. Calio,** Deputy Administrator

**A. Joseph LaCovey**
Director, Public Affairs

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# Newsline

## NOAA, Trust Join In Monitor Project

NOAA and the National Trust for Historic Preservation have agreed to a joint effort to preserve the famed Civil War ironclad Monitor, the Nation's first marine sanctuary. The Monitor's remains lie 220 feet below the surface of the Atlantic, 16 miles off Cape Hatteras. The new program will combine NOAA's scientific and technical expertise with the Trust's historic preservation and fund-raising experience. NOAA will undertake an expedition to the Monitor site this summer, but on a smaller scale than those of previous years.

## Fish Consumption At New High

Americans ate a record 13.6 pounds of seafood each last year, slightly exceeding the old high of 13.4 pounds set in 1978, according to the National Marine Fisheries Service. Record purchases of fresh and frozen seafood and near-record purchases of canned fish accounted for the figures. Increased sales of salmon and canned tuna, in particular, helped boost the total. Luxury products such as lobster, scallop, and clam meats figured prominently. Meanwhile, evidence continues to mount that treating yourself to fish a few times a week may help you live longer by protecting your heart.

## CZ '85, Major Ocean Meeting Held

Nearly 250 of the Nation's leading experts in the ocean sciences and coastal zone management participated in a national symposium July 30–Aug. 2 at Baltimore's Omni Hotel under NOAA sponsorship. They discussed the development, use, and protection of the coastal zone and the Exclusive Economic Zone. More than 60 experts from other countries also attended Coastal Zone '85. Among the attractions: open house on two NOAA hydrographic survey ships, the Peirce, and the Ferrel.

## Innovative Research Planned

A more plentiful lobster supply and improved global crop forecasting by satellite are among the goals of seven exploratory research contracts recently awarded small science and high-technology firms. The awards, all for $30,000 or less, are for 6-month feasibility studies in California, Colorado, and Maryland. The first awarded under the Commerce Department's Small Business Innovative Research Program, they focus on NOAA's research needs. Among the projects: measuring air pollution, better radio navigation, and climatically sound, energy-saving structural design.

## NOAA Honors Oil Companies

Three major oil companies have been honored by the Commerce Department for contributions to the conservation of marine fisheries. NOAA's Acting Administrator, Anthony J. Calio, presented certificates of appreciation to ARCO Exploration Co., Conoco, Inc., and Tenneco, Inc. ARCO's contributions included the use of a vessel, crew, and research team for a pilot study on whether acoustic energy pulses affect deepwater rockfish. Conoco's assistance included the conservation and management of valuable Gulf Coast wetlands; and Tenneco provided federal fisheries scientists with use of an oil drilling platform and support during a 2-week study of the red snapper.

## El Nino Probe Set In Pacific

NOAA's laboratories and ships are probing the equatorial Pacific with an array of oceanographic sensors, seeking to improve early warning of events leading to drastic climatic change. In this area an ocean warming called El Nino, occurring every 2 to 7 years, is believed to have been associated with disasters taking a high toll in life and property, notably in 1982. If the onset of an El Nino could be predicted accurately, the benefits would be tremendous. With deployment of nine buoys, other sensors and the assistance of a weather station established for the project on French-owned Clipperton Island, a new line of defense against unwarned climatic change will have been created.

## NOAA Lends ESA A Satellite

United States and European weather officials have arranged a satellite loan in outer space. NOAA will lend its standby geostationery satellite, GOES-4, to the European Space Agency as a temporary substitute for a satellite that has run out of positioning fuel. The European agency expects its Meteosat to drift out of ground contact this summer. The NOAA satellite, which has been moving gradually from over the Pacific, was due to have arrived over its new Atlantic station by now. NOAA will operate the satellite from Suitland, Md., and Wallops Station, Va., and the European Space Agency will read its weatherwatch from Darmstadt, Germany. During its 765-day operational life, GOES-4 transmitted 28,500 pictures and warned earthlings of many major storms.

## Clean Bill For Mother Nature

Natural sources along the Gulf of Mexico have been ruled out as a significant source of air pollution in the southeastern U.S. by a NOAA study. Dr. Rudolf F. Pueschel said a single power plant, burning low-sulfur coal, will put half again as much sulfur in the air as all the natural sources along the Gulf Coast. The information was derived from an airborne collection of samples over wetlands and coastal waters near New Orleans. The study was part of the National Acid Precipitation Program, a multi-agency investigation of acid rain on the United States.

## Does Cloud Seeding Make Rain?

NOAA and state scientists this summer took to the North Dakota skies seeking to learn whether cloud seeding material really reaches those parts of clouds where rain can be generated. To do so, seeding agents must reach areas where they can turn tiny droplets to ice crystals, generating snow which in turn becomes rain before hitting the earth. Airborne researchers will track the paths of a trace gas (sulfur hexafloride) to determine whether the seeding agent has penetrated regions where it can start the rainmaking process.

## Silver Anniversary

# Weather Satellites — Improving the View

Dan Cotter

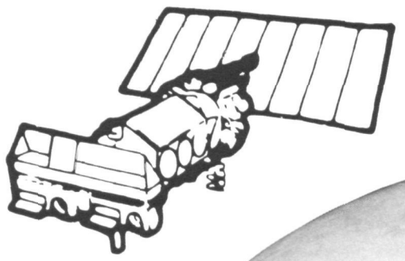
On April 1, 1960, the world's first meteorological satellite was orbited from Cape Canaveral. Named TIROS, for Television Infrared Observation Satellite, it established immediately the accuracy of the vision of its champions. Within hours, its observations were being distributed for use in weather forecasts. The advantage of mapping the earth's cloud cover from satellite altitudes had been demonstrated. It offered revelations too! TIROS I showed clouds banded and clustered in unexpected ways. Sightings from the surface had not prepared meteorologists for the interpretation of the cloud patterns that the panoramic view from an orbiting satellite would show.

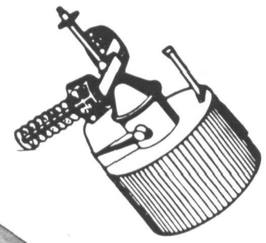
Many of the pioneers had staked their professional reputation on TIROS and the reward was its undeniable success. Yet the triumph of TIROS I was but a single milepost in a longer journey. TIROS II was being readied, and cloud interpretation techniques were being refined. New technology was being applied to make improvements possible.

Sponsorship of the TIROS project began within the Advanced Research Projects Agency of the Department of Defense. In early 1959, responsibility for the project was transferred to the new National Aeronautics and Space Administration. NASA's Goddard Space Flight Center took over from the U.S. Army Signal Corps the job of building and flying the satellite. NASA would work closely with the Meteorological Satellite Section of the U.S. Weather Bureau in applying satellite data to meet the Bureau's forecasting responsibilities.

The satellite, payload and special ground equipment were provided by RCA's Astro-Electronics Division under contract with the Army's Signal Corps Research and Development Laboratory. Douglas Aircraft built the Thor-Able rocket and worked with the Air Force's Ballistic Missile Division and Space Technology Laboratories to mate the satellite to the rocket and launch it.

Two primary ground stations received the data radioed by TIROS I. One at Fort Monmouth, New Jersey, was operated by the Signal Corps. The Lockheed Missile and Space Division and its consultant, the Philco Corporation, operated the second ground station in Hawaii for the Ballistic Missile Division. Analysis and interpretation of TIROS I cloud pictures were provided by the Weather Bureau's Meteorological Satellite Section, NASA, the Air Force's Cambridge Research Center and Air Weather Service, Allied Research Associates, the Army Signal Corps, and the Naval Research Weather Facility. The photos were processed by the Naval Photographic Interpretation Center.





The years since TIROS I have been a period of remarkable progress in meteorological satellites. Although technological advances—notably the advent of the geostationary weather satellite—have played a role, people and organizations have accounted for the real breakthroughs. A new generation has been attracted to the work, pulled to it by the enthusiasm of the pioneers and the wave of benefits that each new improvement has generated.

The progress of the past 25 years can be measured by the extent to which meteorological satellite data are now used. There is probably no national or private weather service in the world that does not receive and use meteorological satellite information in some form. Many operate their own ground stations to receive the data directly; others use weather forecasting products derived from satellite data and transmitted to them by other means; some do both.

The United States has meteorological satellite programs for operational purposes, both civil and defense. The satellites also carry research instruments. Other nations and consortia of nations have their own programs. A globe-encircling ring of geostationary weather satellites is provided by Europe, India, Japan, and the United States.

To the advantage of all nations, operational data, research results, and even spacecraft instruments are exchanged in cooperative ventures. The current polar-orbiters, the Advanced TIROS-N series, carry instruments provided by Canada, France, and the United Kingdom, for example.

International cooperation has been and remains a paramount aspect of the United States' civil meteorological satellite effort. The United Nations' World Meteorological Organization (WMO) links operators and users of weather satellite programs through its coordination of information and training activities. The Global Telecommunications System, coordinated by WMO, is a principal mechanism for conducting the timely international dissemination of weather products derived from satellite data.

In the technology area, breakthroughs and advanced industrial practices have made many improvements possible. Infrared sensors opened the night-side of the earth to viewing, and microwave instruments permit looking through clouds at the atmosphere and surface below. Instruments capable of providing more details about the sizes, shapes, and radiation characteristics in the scene have been added as sensor technology made them possible and when communications and computer equipment permitted the larger data volumes to be accommodated.

There has been a steady move toward quantitative measurements (for example, the early television cameras have given way to calibrated scanning radiometers). The quantitative sensors allow numerical values to be assigned to

*On April 1, 1985, at the Smithsonian's National Air and Space Museum in Washington, Secretary of Commerce Malcolm Baldrige presented specially minted silver medals to 13 meteorological satellite pioneers. These men, from government, industry, and academia, were honored as the ground breakers who conceived and converted to daily reality the satellites that have brought so many scientific and practical benefits to humankind.*

### The Team That Made It Happen

**T. Theodore Fujita,** Chicago, Ill., University of Chicago
**Stanley M. Greenfield,** San Rafael, Calif., Systems Applications, Inc.
**Thomas O. Haig,** Glack Earth, Wisc., United States Air Force
**Rudolph A. Hamel,** Brookville, Md., National Aeronautics and Space Administration
**David S. Johnson,** Annapolis, Md., National Oceanic and Atmospheric Administration
**Dominic J. Juarez,** Fort Wayne, Ind., ITT Aerospace — Optical Division
**Lewis K. Kaplan,** Watertown-Cambridge, Mass., Massachusetts Institute of Technology
**William W. Kellogg,** Boulder, Colo., National Center for Atmospheric Research
**Roy Leep,** Tampa, Fla., WTVT Television Weather Service
**Vincent J. Oliver,** Beltsville, Md., National Oceanic and Atmospheric Administration
**Abraham Schnapf,** Princeton, N.J., RCA Astro-Electronics Division
**Leonard W. Snellman,** Salt Lake City, Utah, National Oceanic and Atmospheric Administration
**Verner Suomi,** Madison, Wisc., University of Wisconsin

the conditions being observed. The temperatures and humidities of atmospheric layers around the globe can be determined this way, as well as cloud-top temperatures, sea surface temperatures, and other environmental factors.

These numerical data have immediate use in applications such as numerical weather forecasting, wind field and ocean current analysis, agricultural frost warnings, severe weather forecasting, and research. The capabilities of some of these sensors extend to an ability to detect and track the greening wave of plant life as favorable growing conditions wax or wane around the world. Techniques have been developed and are being improved to make this fortunate offshoot of meteorological satellites into a powerful new tool for measuring the global vitality of food and fiber crops.

TIROS I was the first of a continuing line of weather satellites. It led to the environmental satellite systems now maintained routinely by the United States and other nations. The mission of these operational satellites has grown to include information about the sea, ice and snow fields, the earth's surface, natural disasters, the earth's radiation environment, and the energy streaming from the sun to the earth.

The operational satellites gather and relay information from remote, automatic sensor platforms in the air, sea, or land that signal environmental data and warn of events such as rising rivers or the tsunamis generated by earthquakes. Some are equipped to relay to rescue agencies the distress signals of downed aircraft or foundering ships. Thus, meteorological satellites not only make it possible to know our environment better, but also help protect us from its caprices.

The need to continue and expand observations of the earth and its environment from space is unquestioned. Even now, the merits of systems designs for the next century are being investigated and debated. In the 1990's the United States is planning to deploy astronaut-tended space platforms as the next step in the evolution of weather satellites.

There is an even stronger summons: to spread ever wider the benefits of these technical wonders. The task has just begun. The work can only be finished when the betterment is available to all people everywhere. A true challenge of the next 25 years of weather satellites will be to fulfill the vision of universal benefits. ■



# As The Satellites See Us— A Space-age Portrait Gallery

NOAA's satellites represent a space-age effort to ease the human burden of storms on land and sea, of thunderstorms and tornadoes, hurricanes and typhoons, floods and winter storms, catastrophic heat and catastrophic drought, and the myriad atmospheric and solar variations which enhance, discomfort, or threaten human life and prospects. The photographs in this section indicate some of the uses satellites have been put to over the past quarter century. Satellites, our "environmental eyes in space," are broadening our knowledge of Planet Earth while providing practical, everyday services which improve our comfort and safety. ■

*Surrounding a satellite image of the western United States taken an hour after Mt. St. Helens sent tons of smoke and ash into the skies in 1980 are photographic wedges showing the cloud's progress over a 6½-hour period. Other photos (from left) are of a satellite antenna in Alaska, the launch of TIROS I and the first weather satellite itself, five hurricanes in progress at once, a coastal storm, and an early satellite mosaic.*

# The Promise of Smoother, Safer Flights

Bill Brennan

In the past 30 years technology has created the situation, believe it or not, where delayed commercial airline arrivals and departures, and white-knuckle turbulence en route, have become the exception rather than the rule in air travel. Enhanced aircraft dependability, performance and design have greatly reduced not only the delays and discomforts veteran fliers once took for granted, but also the risks involved in leaving the earth.

Yet, as recently as yesterday, scheduled airline flights somewhere in the U.S. *were* delayed, flights were rough and uncomfortable, and the security of an aircraft in flight and its passengers was endangered.

Blame it on the weather between here and there. There's nothing we can do about if we insist on flying through it.

Baloney, say some NOAA researchers. There's plenty can be done to make flying more dependable, safer, and more comfortable, even during periods of bad weather.

Scientists at NOAA's Environmental Research Laboratories in Boulder, Colo., are proving their point with several research projects well underway.

One focusses directly upon arrival and departure delays experienced at nearby Denver's Stapleton International Airport, one of the busiest in the nation. About 80 percent of delays there are caused by weather: quick-forming thunderstorms or snow squalls in the arrival and departure corridors used by planes approaching or about to leave the sprawling airport on the plains just east of the Rockies. Or gust fronts sweeping across active runways, creating unsafe cross winds and requiring airport control personnel to "turn around" the airport—change the runways used for landings and take-offs.

Not infrequently, such weather results in incoming aircraft having to circle their destination while air traffic controllers sort out the mess and reallocate arrival slots.

On the ground, the same weather conditions force planes ready for departure to taxi from the end of one departure runway to another when the turnaround occurs after they've left their boarding gates.

An ERL research project now being evaluated at the Denver Air Route Traffic Control Center is giving Stapleton controllers earlier warning of disruptive weather conditions affecting airport operations, and while not eliminating delays completely, certainly reducing them.

This is the PROFS program, the Program for Regional Observing and Forecasting Services. Originally developed to help National Weather Service Forecasters better predict small-scale weather changes in local areas, PROFS' adaptability to aviation-related weather problems was quickly recognized by PROFS director Sandy MacDonald and his staff.

In brief, the PROFS system collects weather information from every conceivable source, digests it in powerful computers, and presents it in a variety of easy-to-interpret visual displays. And it does all this in a matter of seconds, so the weather the forecaster sees is the weather right now!

A special PROFS workstation at the Air Route Traffic Control Center isn't limited solely to letting Stapleton Airport controllers know in advance that their roof is about to cave in, however. It does do this, showing developing weather conditions that in a brief period may cause the closing of one or another runway for a time. But it also aids those controllers responsible for routing trans-

continental air traffic through the 280,000-square-mile Denver sector of airspace.

Weather conditions displayed on the workstation that could have an effect upon flight paths of any of the scores of aircraft in the sector immediately are brought to the attention of the appropriate controllers. They, in turn, advise the aircraft pilots, helping them pick less turbulent, safer routes through, or around storms with more precision than the aircraft crews could do with their on-board weather radars.

"We don't have to wait for an airplane to stick its nose in a cloud to find out what weather conditions up there actually are," notes Dan Austin, air traffic manager at the Denver center.

Safer, smoother, and fuel-saving, to boot.

But PROFS is only one of the ERL projects with pay-offs for the airlines and their customers. Wind research and wind-monitoring systems are another.

The last thing a flight crew needs during the busy minutes of landing and take-off is anything unexpected that changes the flight characterestics of their airplane. But that's exactly what winds can do.

Sudden, intense winds can seriously affect the aerodynamics that keep a plane flying the way its crew wants it to, especially during landing approaches and take-off climb-outs. There's little time or space during these periods of a flight for corrective action; during approaches aircraft power has been dropped to the minimum; and during take-offs the engines are straining to lift the plane away from the ground. It's no time for the factors that keep a plane flying to change suddenly.

In the not-so-distant past a number of deadly and near-deadly incidents have occurred because of unexpected wind conditions at airports as far-flung as New Orleans, New York and Denver. These have been generically described as "windshear" incidents, a sudden shifting of the wind direction/speed with distance, often accompanied by heavy gusting.

ERL scientists, and their colleagues at the neighboring National Center for Atmospheric Research are deeply involved in developing methods for continually monitoring winds around airports and ultimately predicting when hazardous winds will occur, according to Alfred J. Bedard of ERL's Wave Propagation Laboratory.

The winds they're studing are small-scale meteorological events: sudden spurts of wind which sweep across an airport for a matter of minutes only. Sometimes they accompany the leading edge of the cold air outflow from a thunderstorm six to 12 miles away, and are known as gust fronts.

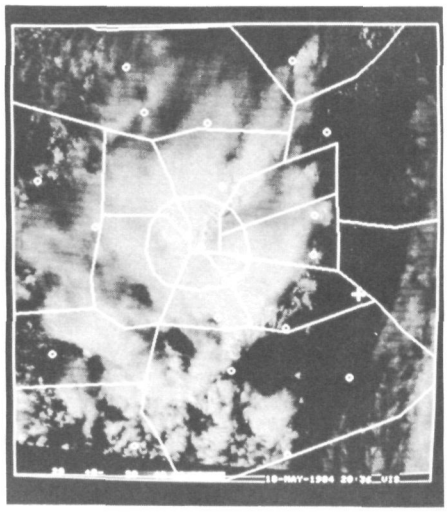
Most major U.S. airports today have gust front detection systems, developed by Bedard and others at ERL. These are arrays of pressure-sensitive instruments installed around an airport, detecting and warning the control tower of an approaching gust front.

But in recent months the scientists have been studying details of another wind threat, more difficult to detect and monitor but every bit as threatening to aircraft—microbursts. A microburst is an intense, short-lived and highly-concentrated downflow of air usually, but not always, associated with a thunderstorm. Upon reaching the ground it rapidly fans out in all directions, creating windshear conditions.

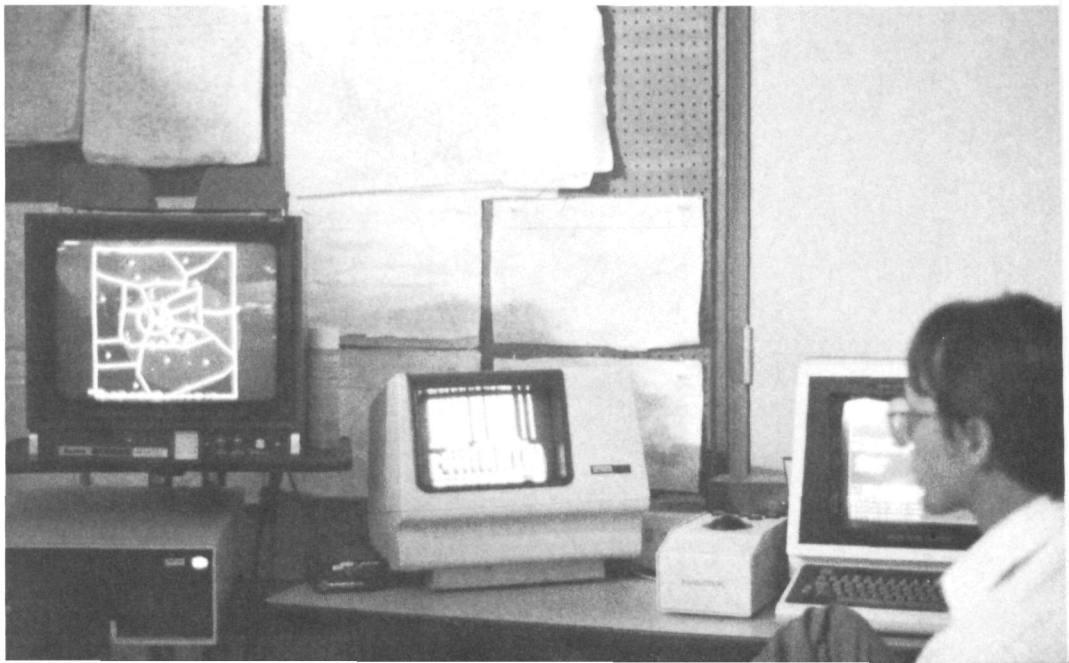
Conventional detection systems, such as that used to identify gust fronts, are unable without modification to "see" microbursts; the latter can be as small as half a mile across, and easily can pass undetected between the gust front sensors encircling an airport.

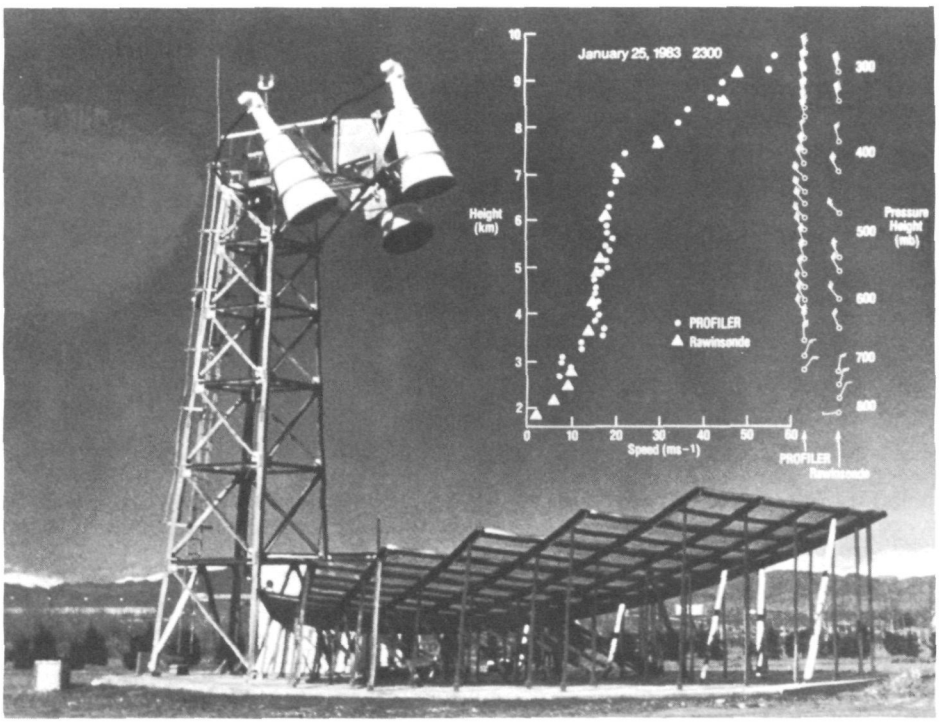
But scientists have determined that Doppler radar may have the ability to identify microbursts as they develop, giving tower personnel some warning. Too, the scientists believe a more tightly-knit array of pressure sensors would be helpful.

The elements—weather—are at odds with flight at times other than during landings and take-offs, however. A plane entrapped within a thunderstorm can have its wings torn off by violent vertical winds, torrential rains can cause engine failure, lightning strikes can render computerized on-board systems useless. The

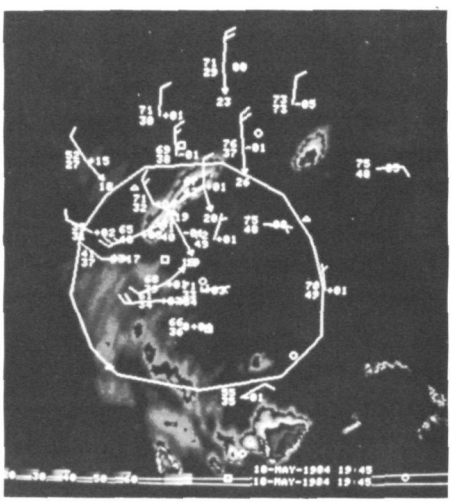


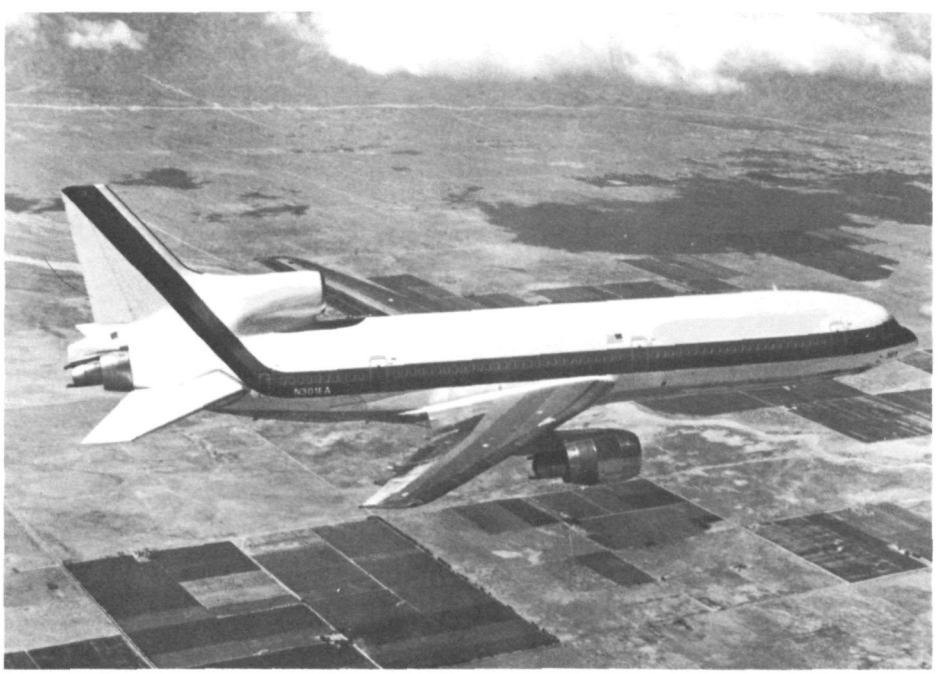
*At the Denver Air Route Traffic Control Center (opposite) a special PROFS workstation (below) supplies a variety of data which might assist controllers routing air traffic through the area. For example, the display enlarged at left shows local features superimposed over a satellite image of clouds in the region.*






*A UHF profiler for mesoscale windfields (above) provides upper-air data, proving remote sensing devices can be as effective as more traditional means of gathering information for aircraft operations. Echoes from local radar (right) are overlaid with mesonet plotting data at the Denver ARTCC. The bottom line is safety and comfort for commercial and private aircraft.*





moral: if you're flying, keep as much space between bad weather and yourself as possible.

It isn't always possible. NOAA satellite pictures dramatically reveal how quickly bad weather can develop over an area. And any pilot of trans-continental flights can tell you of leaving New York or Washington for the West Coast with good weather conditions reported en route, only to find himself up to his ears in weather over the Great Plains.

Private pilots, too, especially those flying without weather radar, can raise your hair with stories of being nearly trapped while trying to pick their way through what looked like a long line of thunderstorms, but in reality was a complex of them, a hundred miles or more thick.

Improved forecasting is the story here, and a bottom-line reason for such ERL research projects as this spring's Oklahoma–Kansas Pre-STORM study, which saw NOAA planes, people and equipment scattered across both states.

The scientific rationale for the study, Weather Research Program scientist John Cunning explains, is to improve understanding of the structure and dynamics of mesoscale convective systems—thunderstorm complexes. The improved understanding will bring, ultimately, better forecasting of the development of such storms, and a recognition of when, during their life cycles, they're safe to confront in an airplane and when you'd better give them plenty of room.

Lightning was mentioned earlier. This phenomenon, also a focus of ERL research, is becoming of even greater concern as airplane manufacturers plan the next generations of aircraft.

The planes of tomorrow will be made of graphite composites and other light substances not as conductive as aluminum and other materials used on present planes, it is generally accepted. How, is the question, will these materials responded to lightning? How much current from a direct hit by lightning will flow into a plane made of these substances, and what will be the effects on the aircraft of nearby lightning?

In the brief years since man first learned to emulate the birds, aviation has made astounding advances in safety and dependability. But, like almost any other human endeavor, flying carries some risk with it, a risk scientists at ERL are attempting to reduce to the absolute minimum. ■

# Providing Personal ID's for Northwest Salmon

Lisa Loop

Way out west they've never taken kindly to horse thieves, so when one of Vern Taylor's mares was rustled and sold for slaughter as he stood by unable to prove ownership, the Colorado rancher-businessman was hopping mad.

Taylor vowed to find a way to foil all horse thieves. He hired a team of engineers to design and develop an animal identification device "on the threshold of technology." He didn't know it at the time, but his ire was to spark a revolution in fish hatchery operations.

Taylor told his engineers he wanted to give livestock an individual identification number that could not be tampered with. The number would be linked to a data base that included the identity, ownership, and history of each tagged animal. That information would be accessible to law enforcement officials around the country.

The engineers came up with the PIT (for Passive Integrated Transponder) tag, a device about the size of a grain of rice that, when implanted in an animal could be detected electronically.

Word of Taylor's PIT tag soon got out, and Earl Prentice, a fisheries biologist with the National Marine Fisheries Service, knew he was onto something important when he first heard of the device in the spring of 1981. Prentice was driving to work at the Manchester, Wash., field station, where he conducts research on salmon husbandry and enhancement, when he tuned in a radio program describing a new high-tech method of electronic identification, consisting of a tiny computer chip programmed with one of billions of unique alpha-numeric codes — the PIT tag.

*The history of this salmon may be carried with it on a tiny tag implanted in its body.*

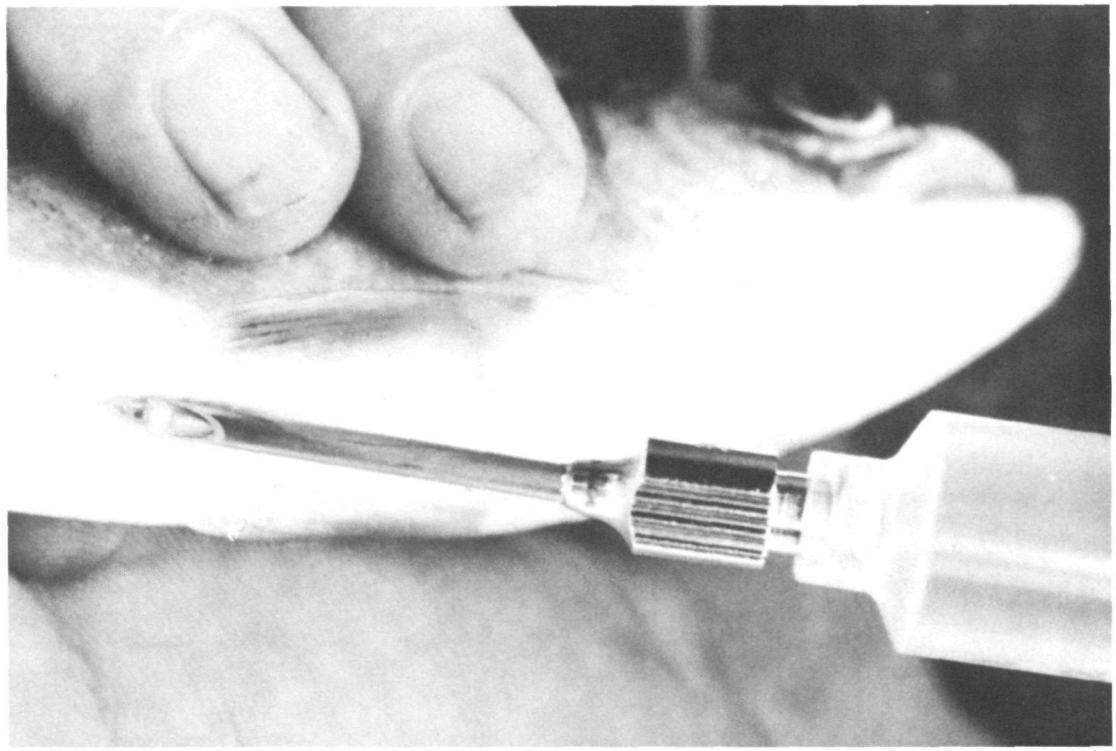
He realized immediately that the new technology could be very important to NMFS research into salmon and steelhead populations.

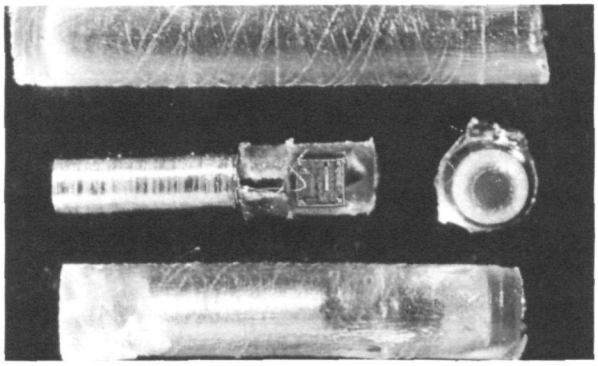
"If it works for livestock, why not for fish," Prentice thought. "If a PIT-tagged fish passed through a dam's fish passage facility, its identification number would allow us to trace its entire life history. It would be like each fish having its own Social Security number."

Today he recalls "I knew that the PIT tag had the potential to revolutionize fish monitoring completely, and could

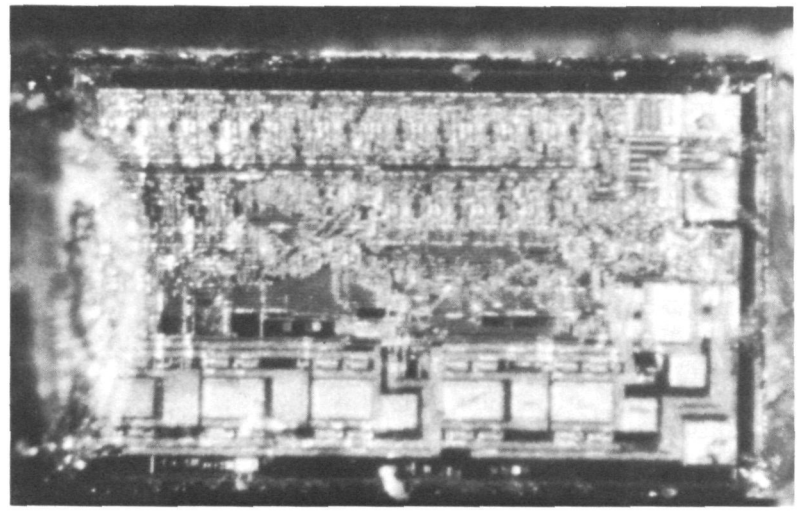
*A PIT tag and 12 gage hypodermic needle are compared to a dime.*

*A juvenile salmon is injected with a PIT tag. The fish will be held for several days, so the tag wound has time to heal, and released. Later, the tag's unique alpha-numeric code will be read electronically as the fish travels through a specially-equipped dam fishway.*





*The PIT tag, including its 40-bit computer chip, its 2,000 wraps of wire antenna, and its special polyethelyne tube. Its tiny plug is to the right.*



*The passive integrated transponder, or PIT, tag is a computer chip attached to a very thin antenna. Here, the electronic section of the PIT tag is exposed.*

have a major impact on the science of fisheries biology."

Technically, the PIT tag is described as a 40-bit computer chip, attached to an antenna consisting of 2,000 loops of wire wrapped around a ferromagnetic core. The wire antenna is about 1/3 the diameter of a human hair, and is laser stripped to bond it to the device's computer chip. The tag is encased in a nontoxic polyethelyne tube to protect it from water damage and to insure that it will be harmless if accidentally bitten.

In 1981, when Prentice contacted Taylor, no one had thought of using the tag to study fish. The two agreed that the idea was feasible. However, it would take time for the tag to be made small enough to insert into a living fish. "The tag was on the very cutting edge of technology," explains Prentice. "We knew that it was possible to bring it down in size, but we didn't know how long it would take to get it developed to the point where it could be used to monitor fish." For 2 years, Taylor's team labored to develop the PIT tag to fit Prentice's specifications.

Finally, in 1983, the National Marine Fisheries Service received a nonfunctional "sham" version to test in juveniles. Eventually, with funding from the Bonneville Power Administration, they began testing adult and juvenile fish equipped with the real thing.

The PIT tags are read when fish move through a fish passage facility either migrating down the river, or returning to their spawning grounds. The passageway is equipped with a specially-equipped monitor, fitted with four electronic tag exciter and interrogator loops connected to a scanner. The loops send out a forty kilohertz electric impulse that excites the transponder. As the tagged fish swim through the passageway, their "identities" are immediately recorded and stored in the computer's memory. Later, researchers can add this information to existing data, or print it out for immediate analysis.

The tag can also be read by a handheld, portable scanner.

Prentice views the tag as having some

important advantages over branding and wire tagging, the methods previously in use to track migrating fish stocks. One of the factors that sets the PIT tag apart from other identification methods is that the tag is detected and decoded automatically, without constraining, anesthetizing, or handling the fish.

Before, researchers could track roughly 5 percent of the fish in the river. The brands were often distorted. The wire tags required that fish be sacrificed for one reading. According to Prentice, with the PIT tag, one person will be able to monitor 95 percent of the tagged fish without ever handling them. The increased efficiency of PIT tagging will add to the weight of monitoring statistics, because a greater total number of data will be available.

While old methods involved the study of groups of fish, the PIT tag allows scientists to consider individuals. Each fish is given a unique electronic identity, since its tag is coded singly. Thirty-four billion codes are available.

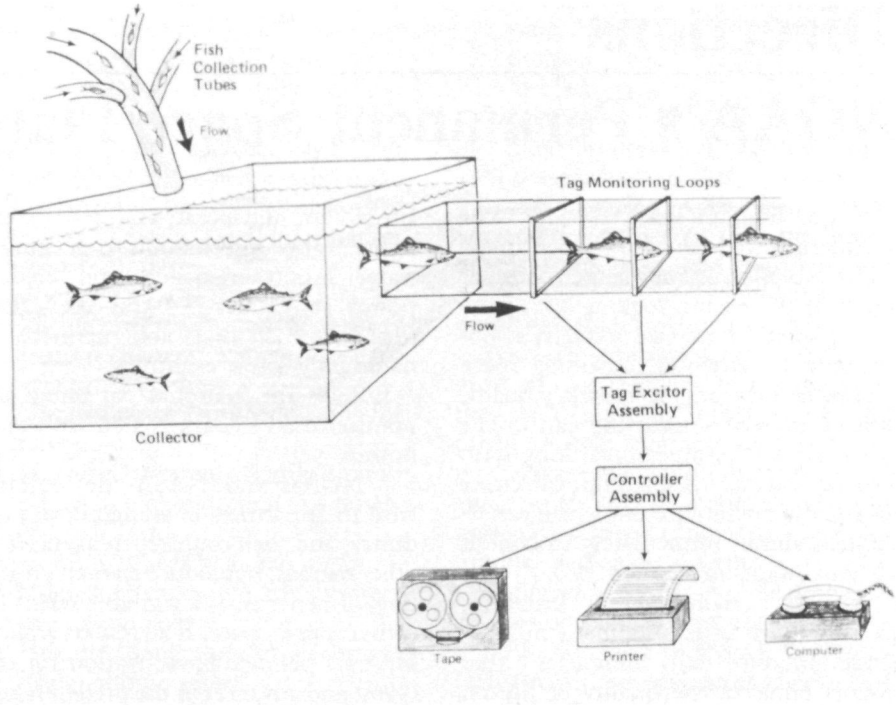
The tags may be reusable, since they have no moving parts to wear out. "They have no battery," says Prentice. He adds, "Though we're testing their longevity, it's conceivable that they will last 10 years or more." He goes on to say that though the PIT tags are more expensive than their predecessors, time saved in manpower will make them more cost-effective. Prentice and Taylor agree that eventually, the price of the tag will drop.

Studies are presently underway to determine the most efficient tagging technique, and one that's safest to the fish. Investigators look at the fishes' behavior, if they become diseased, their growth and survival rates, and how their tissue responds to the tag.

Unlike the old tags, which were usually inserted into the fish's snout, the PIT tag rests in its body cavity. Using a 12 gauge hypodermic needle, researchers carefully implant the tag, then leave the fish in holding tanks for several days while body tissues heal.

This summer, at McNary Dam on the Columbia River, the first PIT monitor will be tested on juveniles. The first adult PIT monitor will be installed at the Columbia's Bonneville Dam in July. If the tests are positive, data from the tags will soon be helping answer questions surrounding the migration patterns of Northwest salmon.

Every year thousands of adult salmon "disappear" on the Columbia. Researchers believe that this "homing problem" of adult fish may be caused in part by thermal blockage, but have been unable to substantiate their theory.




*This diagram depicts the workings of a PIT tag monitoring facility such as those soon to be put into use at the McNary and Bonneville dams on the Columbia River. The fish enter a passageway equipped with tag monitoring loops which send out an electric impulse that excites the tag's transponder.*

"Thermal blockage" occurs when fish stall in their travels upstream because the waters are too warm, due to heat generated by nearby industry. "The PIT tag will provide immediate information on adults during their return journey," says Dick Harper, project manager for the Bonneville Power Administration. "This information should tell scientists whether the fish are being caught, are dying, or are straying."

A similar goal applies to the newly-hatched fish, which travel downstream in water specially released from the dam systems. Tracking allows researchers and managers to determine the best times to release water from the dams, and how much to release. The schedules they come up with are called "flow regimes." "In order to enhance the survival of these juvenile fish traveling downstream, we need to know when to dump water. This tool will aid people in making management decisions about how efficient flow regimes are." says Prentice. The objective is more sensible management decisions that are advantageous to all involved.

Prentice predicts that the PIT tag will provide managers with more and newer data than has been available in the past. He says, "the PIT tag will change the way research is conducted. Before, studies took months to complete. Using this method, a scientist can obtain and analyze information in real-time."

"Real time" means that scientists receive data at the same time that it is actually collected. The "real time" PIT tag information makes it possible for monitoring statistics to be put to work almost immediately after they come in. Prentice foresees that the method will allow management personnel to make more meaningful management decisions, because the answers are close to instantaneous.

The possibilities of this type of data are not limited to monitoring fish migration. The tags can be used for a variety of purposes, such as keeping track of individual fish in genetic experiments.

Vern Taylor reports that the PIT tag is now in demand to help identify a variety of animals, including penguins, elephants, and exotic birds. He predicts that one day all dogs and cats will have one. In the meantime, thanks to an inquisitive fisheries biologist, the Colorado rancher's idea of a way to stop horse thieves has helped to take the science of fish monitoring a great leap forward. ■

# NOAA's Permanent Space Platform

The $1.5 billion space telescope to be launched next year will produce an exciting explosion of knowledge about our universe. While it is looking *away* from our planet, however, NOAA's environmental satellites, including space platforms now on the drawing board, will be focused *toward* the earth. The telescope will produce great long-term benefits but NOAA spacecraft will create an equally exciting payout which can be applied almost immediately to benefit all inhabitants of earth.

Already, environmental satellites, peering down at us from many miles in space, produce daily "miracles" that greatly enhance the quality of life on earth. Among their many services, they provide early warning of severe storms, transmit all kinds of pictures and data that are vital to the world's farmers, fishermen, and ocean and aerial commerce; also information that guides water supply managers and electric power companies — and they help rescue downed fliers and mariners, to name only a few examples.

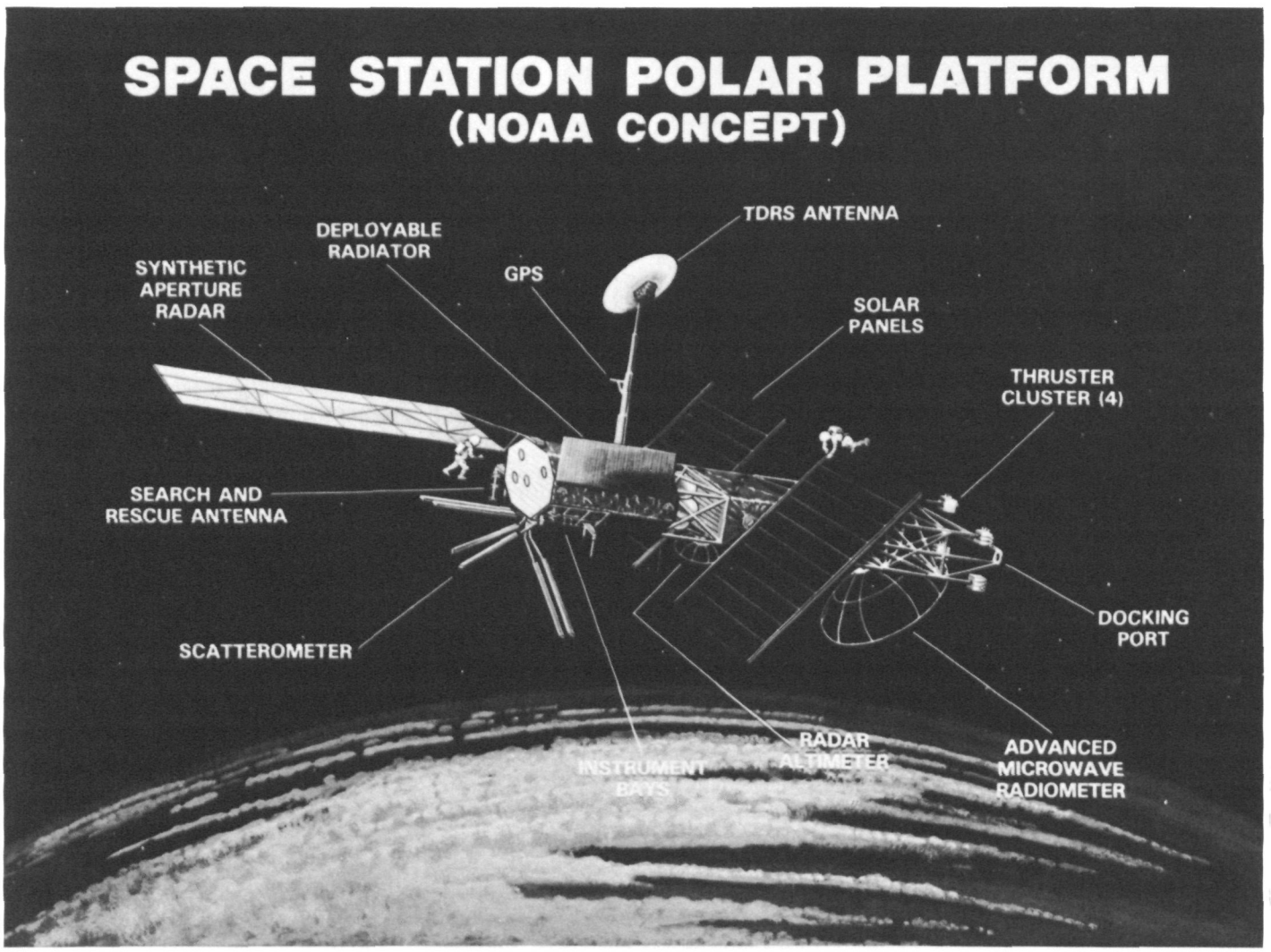
But, as the National Air Show announcer used to bark: "You ain't seen nothin' yet!"

NOAA and NASA are working with their partners in academia and industry, and their counterpart agencies in other nations, to produce an even greater flow of benefits — a veritable scientific cornucopia in space. It all centers around NASA's planned space station for the 1990s, and advances in the present family of environmental satellites, followed by a giant leap forward with two permanent, astronaut-tended, polar orbiting platforms associated with NASA's space station complex.

While a number of technical and management challenges remain to be met, all of the know-how is in place or in sight — including an eagerness among other space-faring nations to help make the permanent platforms a success.

NASA's space station program may provide the ideal opportunity to create a global observation system with strong international participation and great dividends for the entire world. There will be many foreseen benefits — and probably some unforeseen — from the space station itself. But observations of the land, ocean and atmosphere by associated polar platforms is where the potential is clearest.

As satellite scientists view it, there is need for two of these polar platforms, one crossing the Equator in the after-



noon (platform Alpha), and the other in the morning (platform Beta). Similar measurements would be made on both platforms.

These platforms will service a growing global demand for medium resolution (250-1000 meters) imagery and provide daily temperature and moisture soundings for the entire globe — measurements from space that are increasingly essential to numerical weather forecasting models everywhere.

Orbiting altitude is one of the technical challenges yet to be resolved but effective earth observations suggest something around 800 km.

These permanent platforms may be the answer to escalating costs of space activities. Space systems are experiencing a rapid growth in cost that is hampering their wider use. If space is to be a place where routine work is carried out, such costs must be contained

Under NOAA's plans, not only will foreign nations share expertise, hardware, and services, but astronaut servicing via the shuttle route will ensure longer life for satellites and their systems. No longer need a whole satellite go out of service because a bulb or a key instrument fails.

The industrial and scientific community likely to be squeezed hardest in all this? Data processing, information management—computers.

In the near future, satellite research and applications will produce a global view of the atmosphere, oceans and land in unprecedented breadth and depth. This will engender a big shift in emphasis for space management science. An originally technology-driven discipline is becoming increasingly information driven. The challenge has shifted from one of technological feasibility to one of rapid manipulation of very large and ofter disparate data sets.

Clockwise in the accompanying photo are labels identifying the functional areas and services of NOAA's proposed permanent environmental platforms in space, facilities that would be tended by astronauts delivered from a shuttle in an "orbiter maneuver vehicle (OMV)", itself a mini-shuttle.

*TDRS* – (Tracking and Data Relay Satellite) for communicating with other satellites.

*Solar Panels* – producing energy which powers the spacecraft's instruments.

*Thruster Cluster* – (4) – Rocket thruster to maneuver the spacecraft.

*Docking Port* – Dock for the OMV that brings astronauts from a shuttle to service the platform.

*Advanced Microwave Radiometer* – Monitors world-wide weather on land and sea; measures sea surface temperature, precipitation and soil moisture (drought or wet conditions).

*Radar Altimeter* – Measures wave height and sea swells – vital information for ocean commerce.

*Instrument Bays* – Services

- Instruments which measure weather pattern changes, a great assist for aviation and ships
- Monitoring of crop conditions for farmers
- Measuring nutrient distribution in oceans as a clue to locate commercial fish
- Monitor health of ocean areas
- Monitor changes in earth's protective ozone layer
- Measure changes in earth's climate ("greenhouse effect")
  Exploring for mineral deposits
- Measuring global atmospheric water vapor and temperature to produce more accurate weather forecasts

*Scatterometer* – Measures wind speed and direction on ocean surfaces – vital information for mariners.

*Search and Rescue Antenna* – Aviation and marine safety – picks up distress signals from fliers and mariners and quickly advises rescue services around the world. Accurate within 1–5 miles.

*Synthetic Aperture Radar* – Measures snow and ice thickness at the poles, in the Great Lakes, and other parts of the earth, to help mariners steer clear, to plot snow melt conditions which can guide water supply managers and can warn of flash flood conditions; also helps conduct geological searches.

*Deployable Radiator* – Heating and cooling on board the spacecraft.

*GPS (Global Positioning System)* – Helps maritime navigators check their locations. ■

# A New Sanctuary

Fagatele Bay, a 163-acre crater bay near Pago Pago, the capital of American Samoa, has been designated a National Marine Sanctuary. The Nation's newest marine sanctuary was signed into law today by Governor A. P. Lutale of the Territory of American Samoa and NOAA's Deputy Administrator Anthony J. Calio.

The designation, approved by President Reagan, creates the seventh ocean area that has been granted special protection under a 1972 law administered by NOAA to ensure that these unique marine areas are used for the long-term benefit of the public.

Fagatele Bay, the first marine sanctuary designated by the Reagan Administration, is located on Tutuila Island, 7.5 miles southwest of Pago Pago. The bay was formed when the seaward wall of a volcanic crater collapsed, creating an area of exceptional biological productivity with a spectacular coral terrace system that is unique to the high islands of the tropical Pacific. Fagatele Bay provides a habitat for a diverse variety of plants and animals, including threatened and endangered species such as the green sea turtle and the hawksbill turtle.

"This extraordinary ecosystem is rich and complex but fragile and susceptible to a wide range of human and natural disturbances," said Calio. "Management of the site, made possible by this designation, will enable NOAA and American Samoa to protect the bay and its plants and animals."

Scientific research and education are the key elements of the management plan for Fagatele Bay. Traditional uses of the area, such as subsistence fishing and recreation, are not affected by the bay's designation as a marine sanctuary. Sanctuary regulations prohibit activities that threaten the bay's resources, such as dredging and the discharge of pollutants.

The six other national marine sanctuaries are located along the east and west coasts of the continental United States. They are: the Channel Islands off the coast of southern California, Gray's Reef off the coast of Georgia, Key Largo south of Florida, Point Reyes-Farallon Islands off the coast of northern California, Looe Key off Florida's Big Pine Key, and the site of the sunken wreck of the famous Civil War ironclad U.S.S. Monitor off the coast of North Carolina. ■

# Out of the Ordinary — Into the Corps

Don Bishop

If the 14 newly-sworn officers of the 78th NOAA Officer Training Class who reported earlier this year for 11 weeks of schooling at Kings Point, N.Y., are like the ones who have graduated before them, they're in for careers destined to be anything but routine and predictable. From the peaceful classrooms of the Officer Training School they'll move on to a variety of assignments, some charged with a few hard knocks, a bit of adventure, and occasionally real danger.

This group of fledgling NOAA Corps officers is now scattered (mostly on sea duty), but they will always share the "something special" status they gained the moment they put on their NOAA Corps uniforms. They're now part of an extraordinary fellowship, the smallest of the seven uniformed services of the United States. (The other six are the Army, Navy, Marines, Air Force, Coast Guard, and Public Health Service.) Some of them will discover that their graduation is only the beginning of a career difference which will be an integral part of their lives from now on.

They came into the service with scientific educations and in some instances a certain amount of practical experience. Upon graduating from the Officer Training School (which uses the facilities of the United States Merchant Marine Academy at Kings Point) they would move out of the entry level and into a pool of professionals trained in engineering, earth sciences, oceanography, meteorology, electronics, fisheries sciences, and other related disciplines.

But why, the obvious question is, should the approximately 400 NOAA Corps officers—3 to 4 per cent of the NOAA workforce—be singled out, put in uniform, and given privileges paralleling those of the other United States uniformed services?

Meet R.Adm. Kelly E. Taggart, Director, Office of NOAA Corps. He likes to tackle that question.

"Because of the nature of its responsibilities, NOAA must have a cadre of skilled, highly mobile people who will go where they are needed, often on short notice, and do the job that must be done, personal considerations and comfort notwithstanding," Taggart said.

Service in the NOAA Corps hasn't the rigidity or finality comparable to that in one of the armed forces, he added, but the structure of the organization is such that a given officer must expect to take the bad with the good—or exercise the option of resigning.

NOAA Corps officers get the message fairly quickly that they will be on the move a great deal, especially in the early years of their careers. First, there is the mandatory tour of duty on one of the 22 NOAA ships for the first 2 years following graduation from the officer training school. Then come regular changes of duty and often of station every 3 years or so.

"The purpose is to give the NOAA line organizations a pool of skilled scientists who not only bring a knowledge of their particular discipline but a well-rounded understanding of relationships to other disciplines," Taggart said. "Our line organizations look to the NOAA Corps to bring about cross-fertilization in a way that probably couldn't be accomplished in any other way."

NOAA Corps men and women may be found anywhere in the United States, Puerto Rico, and the territorial waters, including the Virgin Islands and Guam. Look beyond U.S. boundaries and you will find them as far away as Antarctica in liaison or exchange positions with foreign governments such as Britain, Canada, France and Australia.

They operate ships, fly aircraft, lead mobile field parties, conduct diving operations, manage research projects, and serve in staff positions and alongside civilian employees.

Always, however, there is the aura that comes with doing glamorous duty in faraway places and wearing a uniform.

Taggart explained the normal progression of assignment as 2 years at sea, 3 on shore, 2 at sea, and 5 on shore. The assignments may be in charting, oceanographic or fisheries work, depending on program needs. Over a period of years, the Admiral feels that an officer should gain a knowledge of West Coast, East Coast, and Gulf Coast locations.

The Corps has a provision for 1 year outside training for every 10 years of service. This means that 8 to 10 officers are doing post-graduate work in a private or government institution at any given time.

Once new NOAA Corps officers enter on their initial assignments at sea, they quickly realize that theirs is not just another government job.

"When you're at sea you often have one hand for yourself and one for your ship," said Taggart. "Survival in a challenging environment is the first

order of business. Then comes getting the job done."

The Admiral added that "it takes a rare kind of individual to work in Alaska (where well over half the new officers go for first duty)."

Lt. Cdr. Wayne L. Perryman, now working in the Oceanic Fisheries Division of the National Marine Fisheries Service's Southwest Fisheries Center in La Jolla, Calif., echoed that sentiment:

"Operating a small research platform in the Bering Sea and Gulf of Alaska was the most exciting and challenging assignment that I have had."

On the other hand, Lt. F. Ronald Philippsborn, a helicopter pilot in the NOAA Office of Aircraft Operations, took a subdued view of the subject of danger:

"Despite piloting airplanes through bad weather, or surveying atop Bilby Towers and skyscrapers, or flying helicopters across the Arctic ice pack in pursuit of polar bears, I have never actually felt that I was in a 'dangerous situation.' If I had seen one developing, rest assured I would have gotten myself and my crew the hell out immediately."

One general conclusion that every NOAA Corps officer seems to reach is that the adventure and occasional danger are all part of the game. If they don't reach the conclusion they aren't likely to reach the Corps' retirement age either.

Another realization that comes early is that, since they will be required to move every few years to a new assignment, they may as well be ever ready to learn something new. This means they must always have one eye on their "career course."

In doing so, they constantly look for "cross-fertilization" opportunities.

"Officers desiring cross-training and assignments outside their main areas of interest have the opportunities to diversify, which is unique within NOAA," said Lt. Cdr. Donald E. Winter, executive officer of the Ocean Assessments Division in the National Ocean Services' Office of Oceanography and Marine Assessment.

Here's where "networking" comes into play. This highly informal communication system "keeps us informed on the current directions of projects in the line offices," in the words of Lt. (jg) Ilene Byron, Ocean Services Program Coordinator with the National Weather Service in Honolulu.

Lt. Kent A. Doggett's career course has taken him into most of NOAA's branches—the National Ocean Service, the Environmental Research Laboratories, the National Weather Service, and the National Marine Fisheries Service.

"The exposure outside of NOAA has been equally extensive," he said, "working directly with such organiztions as the National Center for Atmospheric Research, High Altitude Observatory, U.S. Navy, U.S. Air Force Air Weather Service, the Australian Department of Science, Ionospheric Prediction Service and several colleges and universities."

Another officer, Lt. Cdr. Dennis Pepe, also has considerable across-the-board experience, having worked in the National Ocean Service and the National Marine Fisheries Service before joining the National Environmental Satellite, Data, and Information Service. There he has the gratifying opportunity to help save lives through his assignment as deputy manager for the Search and Rescue Satellite-Aided Tracking (SARSAT) Program.

"The NOAA Corps is an excellent career," said Pepe, citing how he had been able to use science skills learned in college and at the same time enjoying these other positive features: "learning shipboard operations, travel, diving, flying, serving your country, satisfying your environmental concerns, good benefits, decent wages and a variety of assignments to select from or create."

Lt. Cdr. Pam Chelgren-Koterba, a program analyst for the National Ocean Service, added:

"I've been offered other job opportunities, but I've stayed with the Corps because I can have so much more of a chance to make an impact here than anywhere else."

Lt. Cdr. Andrew Snella, Chief, Field Surveys Branch (West Coast) in Seattle, added the observation:

"Yes, I would advise someone to try the corps as a possible job opportunity . . . The NOAA Corps is that missing link between scientific wizardry and operational reality."

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## Lt. Cdr. Andrew Snella

When he joined the NOAA Corps, Andrew Snella's career plans were short and to the point: Complete the required 3 year commitment and then leave.

That was in 1973: he's still there, enjoying the work, ranked as a lieutenant commander, and holding a responsible position as Chief, Field Surveys Branch (west coast) in the National Ocean Service.

He manages three field units—Pacific tide, photo and hydrographic parties—in addition to developing new methods to analyze and track tidal data records and developing new applications for personal computers at the Pacific Marine Center in Seattle, Wash.

(At the time Snella enrolled in the NOAA Corps, just as the military draft was winding down following the Viet Nam era, there was what amounted to a legal commitment to serve in the Corps. Now, however, only "reasonable notice" of intention to resign, usually interpreted as months, is required.)

Snella served the standard initial sea duty required of all NOAA Corps officers (generally 2 to 2-1/2 years), and then began his progression up the service ladder.

His period of work in Alaska, both on shore and while assigned to a hydrographic ship, brought typical adventuresome, and sometimes dangerous, experiences that NOAA Corps officers take for granted. He listed:

"Hydrographic surveying in small launches while severe weather descends upon you.

"Commuting long distances in the winter in Alaska, either by vehicle, boat, or aircraft. Extensive travel is required while stationed there.

"Working in the 'bush' (back country) of Alaska, sometimes for a week to complete a mission such as to establish a remote research outpost.

He has since worked in a variety of assignments—some sedentary, some requiring considerable physical activity—and out of it has evolved the conclusion:

"I've enjoyed it up to this point and have developed some interesting skills."

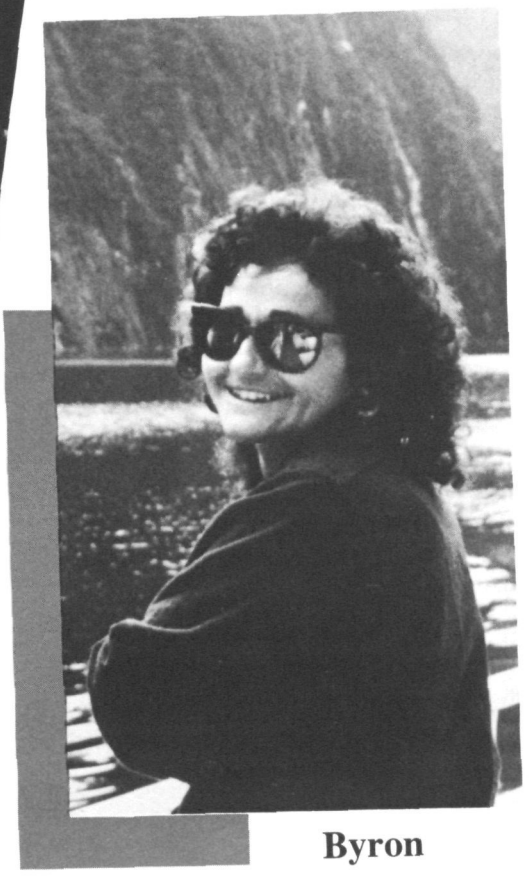
He added that he would advise someone to explore the Corps as a possible job opportunity as long as the person recognized these conditions:

Negative: long hours, minimum state-of-the-art equipment, family separation, and difficulty in mastering any one scientific field (that is, specialization).

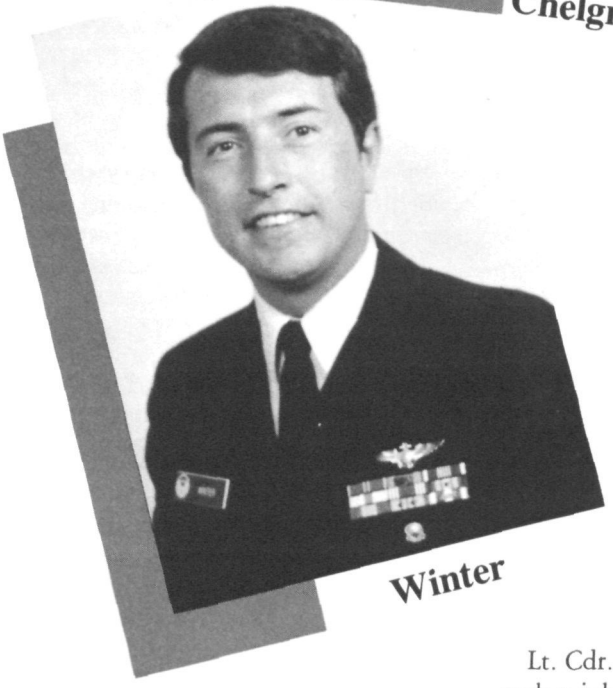
Positive: mobility, responsibility, personal job satisfaction, and variety.

Snella

Chelgren–Koterba



Byron



Winter

## Lt. Cdr. Pam Chelgren–Koterba

Hayfever and sinus headaches—and possibly burns from a boiling coffee pot—are about the only hazards normally faced by a program analyst in headquarters of the National Ocean Service in Washington.

Lt. Cdr. Pam Chelgren–Koterba holds such a job, but her work hasn't always been so tranquil since she joined the NOAA Corps in June 1972.

Now she spends her days "developing relevant information, performing analyses, coordinating findings and recommendations, and preparing written and oral presentations on policy issues relating to NOS." But in previous assignments she has dealt with numerous physically challenging and sometimes dangerous experiences.

For example, as a member of a Pacific hydrographic party in March 1984, Chelgren–Koterba was working in diving operations in South San Francisco Bay when she had a strong vertigo experience. The sensations involved a feeling of spinning and disorientation.

"I had slack lines in my hands and if I had responded to the apparent stimuli I would have tangled myself up completely in these lines," she recalled. "Instead, I allowed myself to sink to the the harbor bottom. After a wait of about minute, the vertigo went away."

Afterwards she went to a Naval hospital to get her ears checked. Doctors found no obvious reason for the vertigo but they had a fancy name for it anyway: intermittent alternobaric vertigo.

"Duty in the NOAA Corps is not an 8-to-5 job," she said.

"When you're on board a ship, you can't just go home at the end of the day. You're there. The requirements are greater, but the opportunities are big-

ger too. You can make a difference in real live programs much sooner than you would as a scientist or engineer in private industry.

"The pay is low compared to private industry, and the seagoing and frequent moves can play havoc with any attempts at a normal social life; but the professional, physical and emotional challenges have more than made up for that in my career."

## Lt. Cdr. Donald Winter

When you're flying a helicopter from the NOAA Ship Surveyor in Alaskan waters, the first dangerous situation caused by weather is perhaps the most memorable, not because it was the most dangerous but because it was the first.

So said Lt. Cdr. Donald D. Winter, who was one of NOAA's first helicopter pilots in Alaska—in 1975.

The incident he referred to happened in 1976 during a seal counting survey along the ice edge in the Bering Sea. Having completed the count in a designated area, he said, "we were flying back to the ship when heavy snow started falling and fog set in. We knew the position of the Surveyor to within a half mile, but once we got to the position, we didn't see the ship.

"The ship said they could hear us but didn't see us, and we couldn't see them. One problem we immediately found was that it was hard to see a white ship floating in white sea ice, while flying in white fog and heavy white snow.

"With all four sets of eyes watching for any signs of the ship, we started a grid pattern search with 200 meter line spacing, hoping to see the ship. Fuel was running low so the grid was abandoned and we set the helicopter down on the ice to see if the ship could find us by either radar or sound. No luck."

Then the vessel's chief engineer came up with the answer on how to get ship and helicopter crew together.

"The Surveyor is a steam operated ship with large boilers," Winter said. "While operating the boilers, deposits of soot build up in the stack and this soot must be blown from the stack with steam on a regular basis.

"Magic, just like black and white, once the stack was blown, a large black cloud of soot came drifting down wind. All I had to do was find the cloud and follow it up-wind. They kept blowing the stack and I just followed the black trail.

"We finally saw the ship when it was less than 50 yards away. Soot never looked as good as it did that day. From that day on, I never complained about the engineers blowing the stack, even if it did leave some soot on the deck."

## Lt. (JG) Ilene Byron

NOAA Corps officers take assignments as they come, and if the officer happens to be a woman (as are about 10 percent of the corps) they ask for—and get—no special consideration when there's an element of physical challenge or even a degree of danger in the task.

In the case of Lt (jg) Ilene Byron, she has never been "in a dangerous situation," possibly because, as she said, "in all potentially dangerous situations everyone maintained a cool and professional manner."

Byron was speaking of the mandatory first assignment aboard ship, where the elements play a bigger part than in most shore-based billets.

As for her most physically–challenging experience, she singled out the time she stood a 4-hour watch while seasick. Her professionalism not only kept her from admitting the illness; it happened to be her birthday and she didn't tell a soul.

Her first–assignment hurdle out of the way, Byron readied herself for her next position.

"You request an assignment in NOAA for the job, not the location," she said. "But when the location happens to be paradise along with an interesting and challenging job, you're doing something right."

Byron's "paradise" was Honolulu, where she is Ocean Services Program Coordinator with the National Weather Service, Pacific Region.

"A part of my job is to answer public inquiries on various ocean and weather topics or I tell them who to contact," she said. "Another part is to stay informed on ocean technology developments and studies on ocean sciences. With only a bachelor's degree I have talked with and assisted world-class scientists."

She is also called upon to interview students at the University of Hawaii who are considering a career in the NOAA Corps.

"So of course I advise people to try for it," she said. "It is a unique, exciting job, one that gives you responsibility. The opportunities are endless. You have the chance to see science in action."

## Lt. Kent A. Doggett

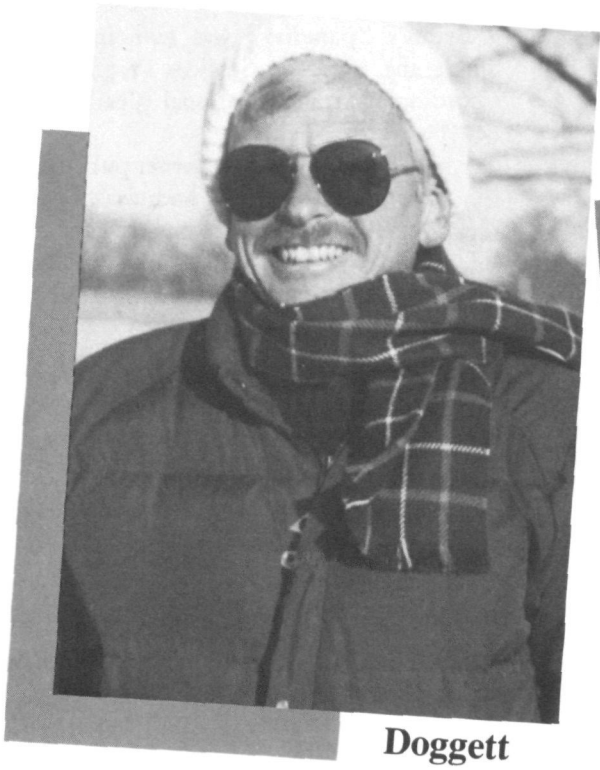
Unless you don't mind having your story topped, avoid discussing the subject of hostile work environments with Lt. Kent A. Doggett of the NOAA Corps.

At present you would appear to be on safe ground because Doggett is operations officer of the NOAA oceanographic ship Researcher based in Miami and who would complain about that environment?

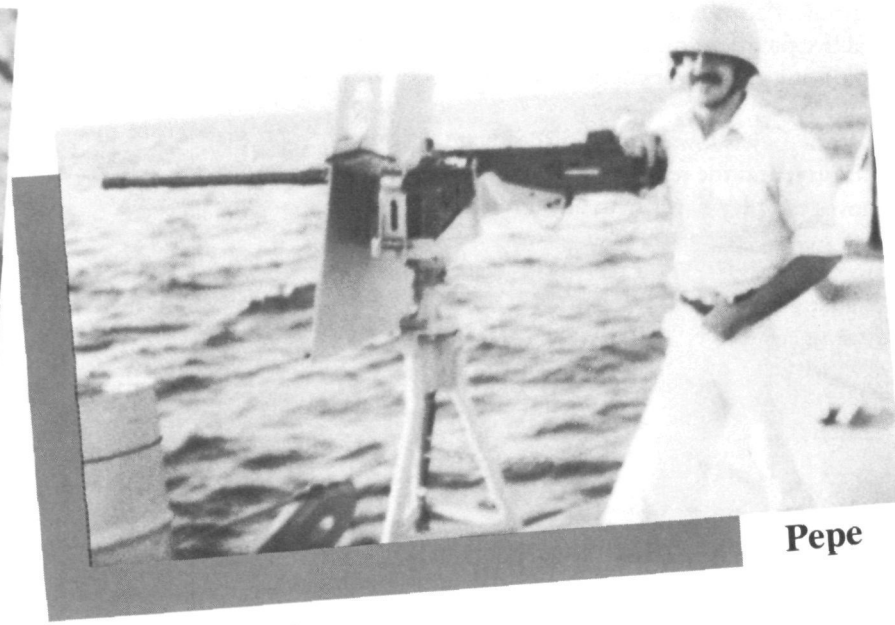
But look into his career and you find that he was assigned from July 1975 until June 1977 to another NOAA ship, the Surveyor, which spent much time in Alaskan waters. Duty in that area can have exciting moments, such as when Doggett was a scuba diver working under the Bering Sea ice pack. The best thing he could say about this kind of assignment is that at least the water temperatures were above freezing because of the salt water.

(Doggett pointed out that the scuba work was by no means his primary function and the description of it makes things sound worse than they really were.)

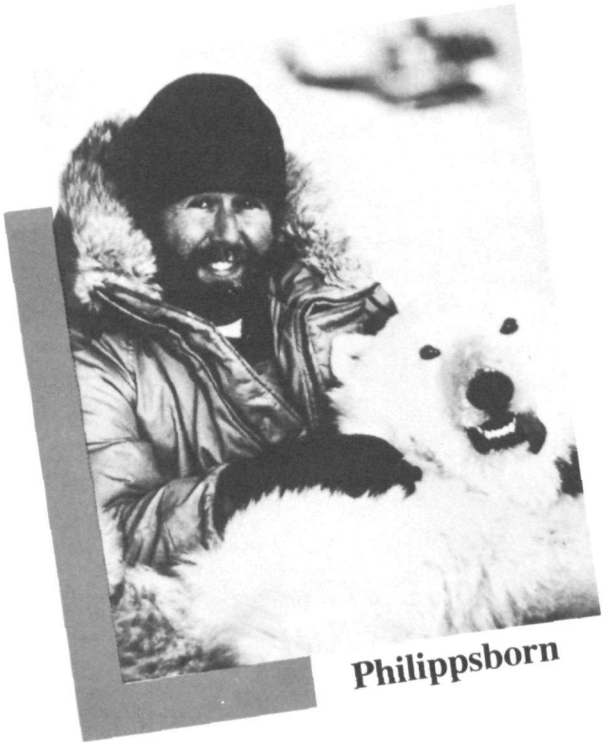
Eventually transferred from Alaska, Doggett by September 1979 had only a



Doggett



Pepe



Philippsborn

Perryman

memory of conditions of the Bering Sea, especially in view of having a tour of duty in Hawaii.

But that year and until May 1983 he was stationed at Learmonth Solar Observatory in Western Australia, where summer temperatures routinely reached 110 °F and two to three cyclones hit the region each year. Furthermore, the nearest city (Perth) was 800 miles away.

In Australia Doggett was the liaison between NOAA's Environmental Research Laboratories' Space Environmental Services Center and the United States Air Force and Australian Department of Science, Ionospheric Prediction Service.

The work in solar astronomy/activity investigations added a dimension to Doggett's career that was welcome, unexpected and, he said, worth all the cold and hot inconvenience he experienced in the Alaskan waters and the Australian outback.

## Lt. Cdr. Dennis Pepe

Lt. Cdr. Dennis Pepe was serving as operations officer aboard the NOAA Ship Oceanographer in 1980 enroute to the People's Republic of China (PRC) to participate in a joint oceanographic project and to be the first U.S. vessel to enter the country in 30 years.

But while the ship was still in the Sulu Sea between the Philippine Islands and

Borneo, studying internal waves, he encountered more excitement than he had expected.

American hostages were being held in Iran at the time, and concern was felt that the Oceanographer could be hijacked by pirates operating as a "political group" and cause further embarrassment to the United States.

Shipboard precautions included hijack drills, darkened ship oceanographic stations and constant monitoring of the horizon and radarscopes. As an added safety measure, four Philippine marines were taken aboard.

"There were several false alarms," said Pepe, who is now deputy manager for the Search and Rescue Satellite-Aided Tracking (SARSAT) Program, which is in NOAA's National Environmental Satellite, Data, and Information Service.

"The Philippine fishermen would occasionally mark their fish traps with palm trees rigged vertically to a raft. One evening a contact was observed on the radar and the information passed via radio to the escort vessel. The escort vessel picked up the contact and raced off at high speed in the general direction of the contact. Several minutes later the sky was full of tracer fire from the vessel's machine guns. The escort vessel pulled alongside the contact and observed it with its searchlight—only to discover the vessel has attacked a palm tree float."

The Oceanographer arrived without any significant incident in Manila, and then proceeded to Xiamen and Shanghai, PRC, where the greatest threat to life and limb was from millions of bicyclists.

## Lt. F. Ronald Philippsborn

"I always felt that the initial sea tour is a watershed in any NOAA Corps Officer's career," said Lt. F. Ronald Philippsborn.

But then he went on to explain that his tour aboard the Discoverer in Alaskan waters, while worthwhile, "did not prove to be the tropical adventure I had envisioned after talking to the NOAA Corps recruiters."

Philippsborn added that he had no initial expectation of joining the NOAA flight program, but that's what he did, spurred by his longstanding wish to make a contribution in the study and protection of the environment.

Philippsborn is assigned to the NOAA Office of Aircraft Operations in Miami, with flying helicopters as primary duty. He also may be called upon to fly NOAA Shrike Commander twin-engine planes. These and other aircraft perform a lot of missions for NOAA but not always in warm climates.

The pilot said that in 1984 he participated in a hydrographic survey in the Bahamas, but he also drew assignments for the Peard Bay (Alaska) Ecological Systems Study, a U.S. Fish and Wildlife Service polar bear tagging project, and a soil moisture survey by airplane of the upper Midwest.

"There is always inherent risk when operating in remote areas under potentially hostile environmental conditions," Philippsborn said. "I feel that my training and experience with NOAA have given me the ability to assess that risk and decide whether a given project can be accomplished safely, and what specific safeguards and equipment are necessary."

## Lt. Cdr. Wayne L. Perryman

Don't get the idea that conducting a census of porpoises is work designed for a clerk wearing a green eyeshade.

Counting cetaceans—and, for that matter, protecting pinnipeds—can lead to some pretty exciting times.

(For the edification of you uplanders, a cetacean is a fishlike aquatic mammal such as the whale or porpoise; a pinniped is an order of aquatic mammals that includes the seals, walruses, and similar animals having finlike flippers as organs of locomotion.)

NOAA Corps Lt. Cdr. Wayne L. Perryman of La Jolla, Calif., is a specialist in this kind of activity at the Southwest Fisheries Center of NOAA's National Marine Fisheries Service.

He coordinates marine mammal research in the Channel Islands and Point Reyes National Marine Sanctuaries. These sanctuaries provide important breeding areas for four species of pinnipeds that NMFS manages under the Marine Mammal Protection Act.

Perryman cited an example of how his work is far from prosaic:

"In 1979 NMFS conducted a major assessment of porpoise stocks impacted by the tuna purse seine fishery in the eastern tropical Pacific. The survey involved use of two research ships and an old World War II PBY aircraft that we used to search for dolphin schools from airports along the west coast of Central and South America.

"On one mission from El Salvador we went 500 miles offshore before turning back, when we met very strong head winds.

"We still had plenty of fuel to return to El Salvador's only major airport, but we were well behind our flight plan and it was starting to get dark. In the distance we could see lightning from a major tropical storm that had closed in on the Central American coast.

"By the time we reached the coast, San Salvador Airport was closed by rain and high winds. It was too dark to consider any of the small unlighted coastal airports and the seas were too rough to consider landing the old flying boat in them. We had just about enough fuel to make it to Guatemala Airport, the only airport we could reach that was not closed by the weather.

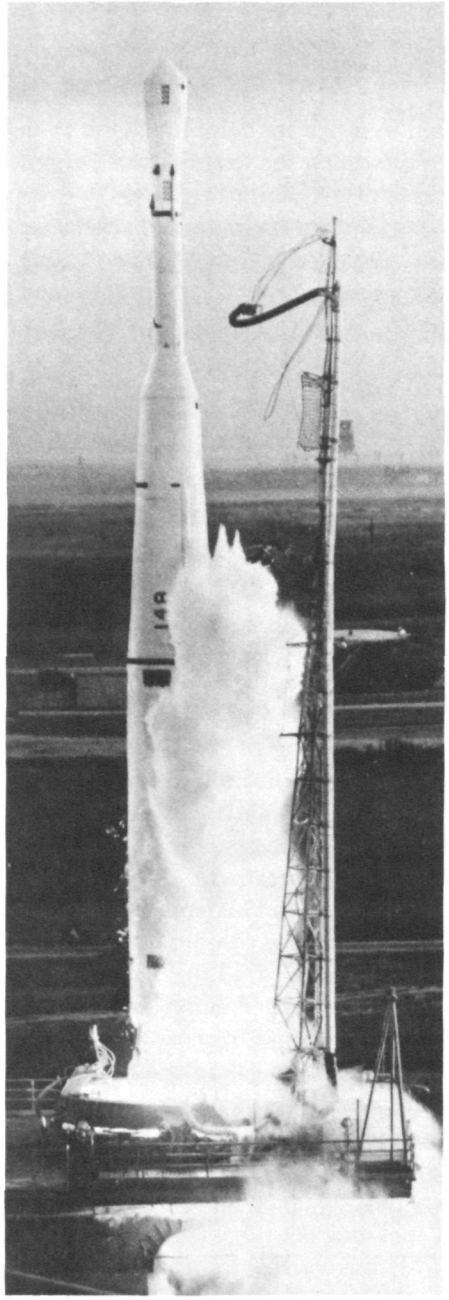
"We made it to Guatemala City, only to realize that the weather had closed in and we couldn't find the airport. Now we didn't have enough fuel to go anywhere else.

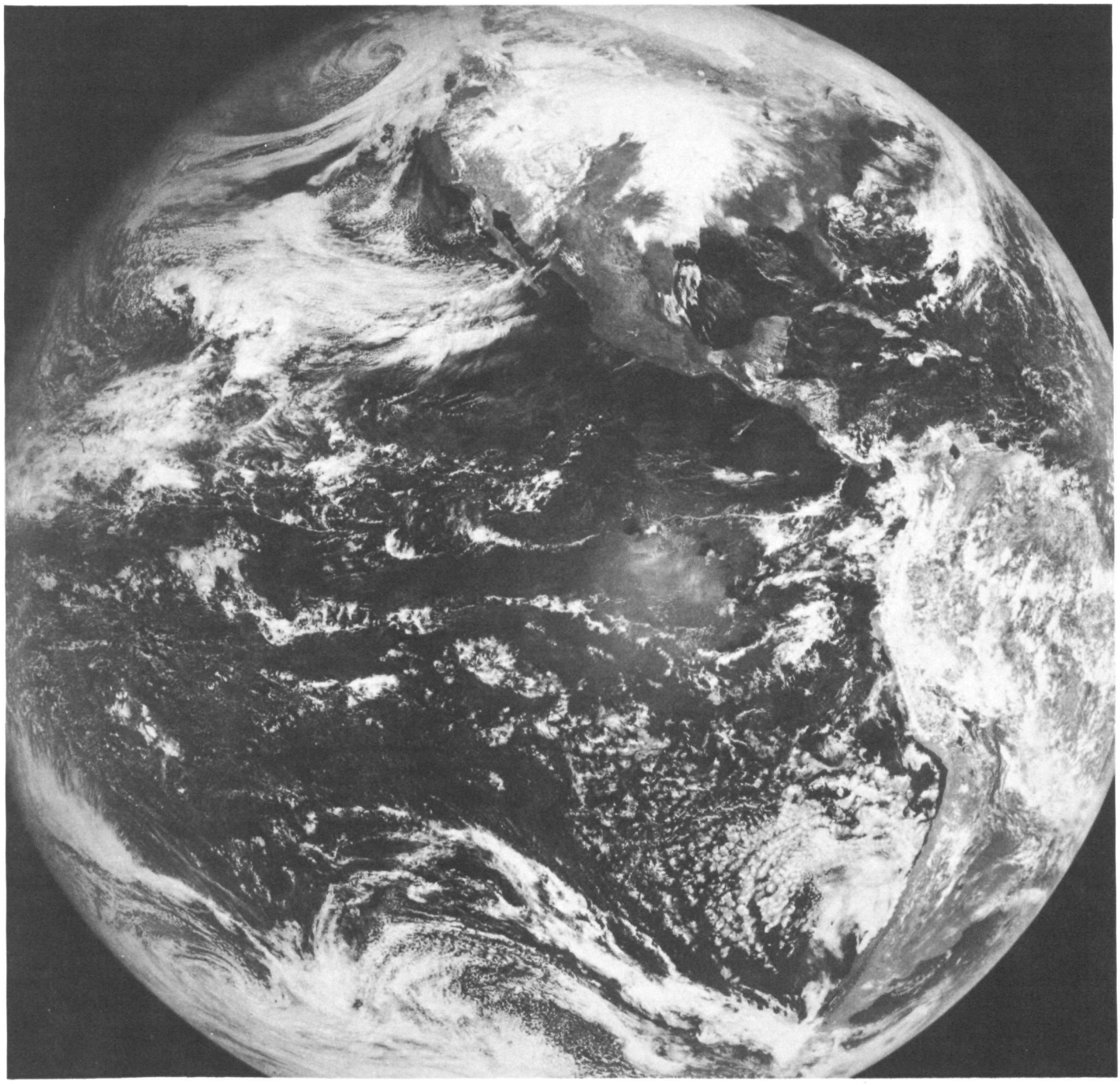
"Through a break in the clouds one of the pilots spotted the airport landing lights and we spiralled out of the sky to a rough landing. When they checked the next day, one tank showed a few inches of fuel and the other was empty.

"This story still scares me." ■

# VIEW FROM SPACE

## Satellite Imagery—Then and Now





At 6:40 a.m. EST on April 1, 1960, a three-stage, 90-foot tall Thor-Able rocket lifted a drum-shaped, 270-pound satellite from the launching pad at the Atlantic Missile Range at Cape Canaveral.

Shortly afterward, TIROS I, the first U.S. weather satellite, was in circular orbit around the Earth, ushering in a revolution in meteorology.

In spite of its name (TIROS stood for Television InfraRed Observational Satellite) the satellite did not carry infrared equipment. Its "eyes" were two TV cameras: a wide-angle camera designed to cover an area roughly 800 miles on a side, and a telephoto camera for more detailed images.

The first television pictures from space were remarkable considering the state of the art, but their resolution left something to be desired.

TIROS' initial effort (left) was a grainy shot looking west at Nova Scotia and the Gulf of St. Lawrence. At the top of the photo is Ile Anticosti at the mouth of the St. Lawrence River. The coast of Maine stretches south before being obscured by clouds.

It's hardly fair to compare a 25-year-old photograph with a current one, but the image above, made by GOES in March of this year, shows how far satellite technology has advanced in the past quarter century. The blurry vision of clouds over a thousand miles of topography has given way to a sharply defined view of a hemisphere.

Even to the untrained eye, the view from space is getting better every year. ■

# Filling In Ocean Weather Blanks

Don Witten*

Bouncing through high winds at 300 miles an hour, the weather reconnaissance aircraft slowed its speed and dropped to 1,500 feet above the Atlantic Ocean about 450 miles off Cape Canaveral, Fla. It was flying northward along the path forecast for Hurricane Josephine as the storm moved up the East Coast last October.

Slowly, the jet's rear door slid open and two airmen, secured by safety harnesses, shoved a 450-pound buoy into the clouds. A red and white parachute carried the device to the swirling surface below.

No sooner had the buoy hit the water than it began transmitting observations from the surface to a depth of 600 feet to NOAA's National Hurricane Center through the agency's polar orbiting satellite overhead. The plane roared on, dropping two more buoys at 50–mile intervals along the storm's expected path.

Twelve hours later, Hurricane Josephine and a NOAA P-3 weather research aircraft, flying at 10,000 feet in the storm's eye, passed over the three buoys. The P-3 recorded atmospheric measurements confirming the accuracy of the data the buoys were sending.

"This sophisticated experiment provided the first direct and realtime observations of ocean surface and subsurface conditions during the passage of a hurricane," says Jerry McCall, director of the National Data Buoy Center in Bay St. Louis, Miss.

"It clearly shows just how far we have come in the application of buoys to weather forecasting and environmental monitoring since a national data buoy network program was initiated in the late 1960s."

**Tina Saarlas contributed research assistance for this article.*

Today, weather buoys constitute a significant element of the National Weather Service's basic observation program upon which all forecasts are based. Some 48 buoys provide more than 400,000 observations a year from fixed positions in the Atlantic, Gulf, and Pacific coastal waters as well as in the Great Lakes during the warmer months.

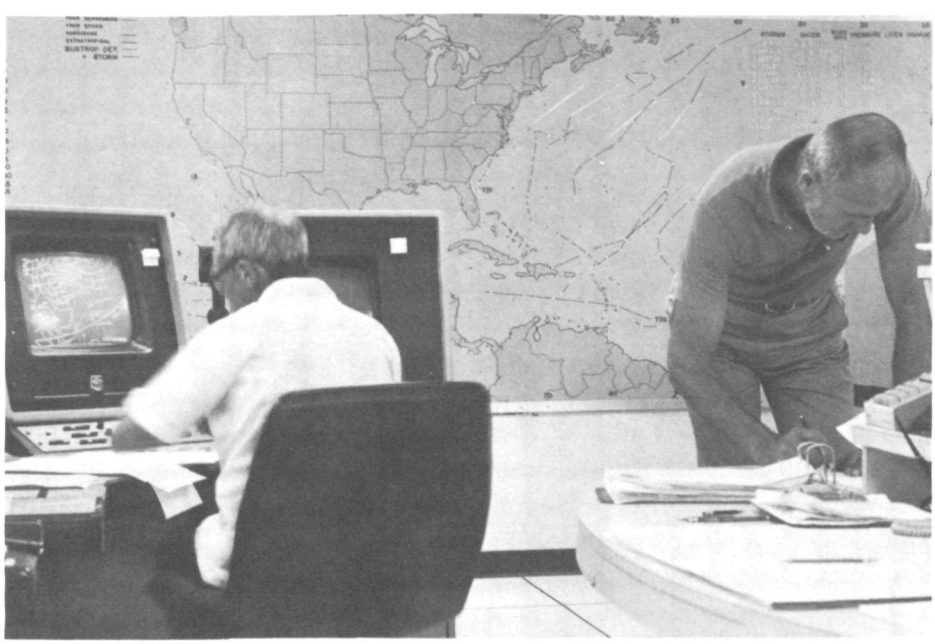
Observations from the buoys, along with those from cooperating ships, land stations, satellites and other sources, flow into the National Meteorological Center in Suitland, Md., several times a day. There, they are processed with sophisticated models of the atmosphere by a super computer to produce guidance forecasts and graphics. These are used by local National Weather Service Forecast Offices to develop forecasts across the United States.

Environmental buoys are a relatively recent development in a long history of efforts to fill in the vast data blanks occurring in ocean areas.

Accurate weather forecasts are dependent upon the collection of three-dimensional observations of the atmosphere over a sizable portion of the globe. But the oceans, covering three quarters of the Earth's surface, pose a tremendous hindrance to the collection of such broad-scale observations. Through the years, continued efforts to overcome this obstacle have included the use of voluntary observations from ships at sea, dedicated weather ships, satellites, and buoys.

The most logical way to collect weather data at sea is to use ocean-going ships as ready-made observation platforms. The World Meterorological Organization maintains an international scheme by which vessels are recruited to collect and transmit observations to meteorological centers ashore. This idea dates back to 1853 when delegates of 10 maritime countries met in Brussels to discuss the subject. They defined a uniform system for the collection of weather and oceanographic data from the oceans and the use of these data for the benefit of shipping in return.

Today, marine observations are provided on a global basis by 7,200 volunteers aboard commercial vessels in the Voluntary Observing Ship Program. The program operated by the National Weather Service includes another 1,800 observers.



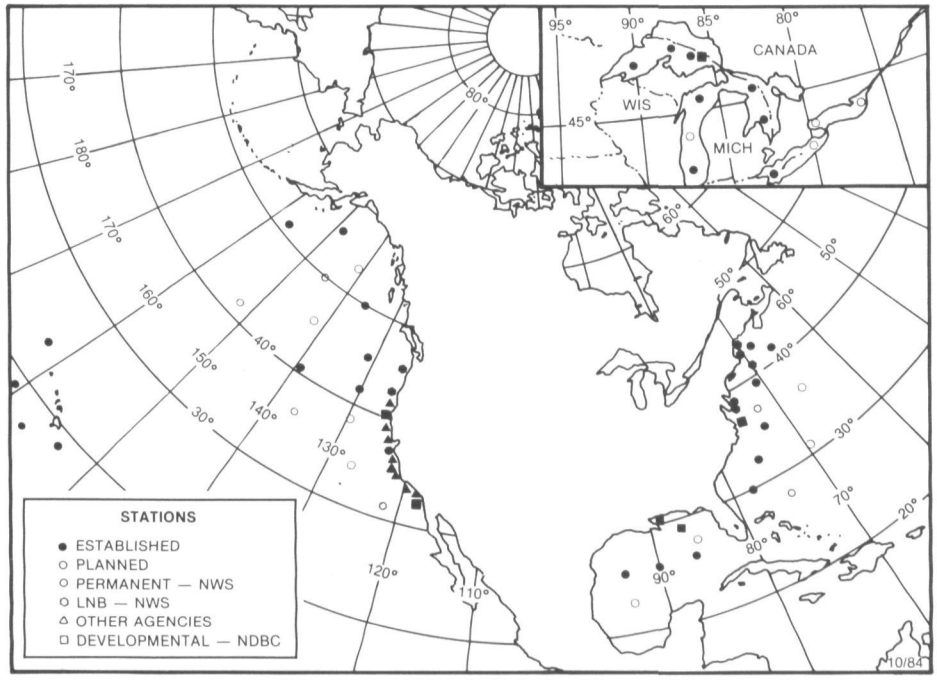
*Data buoy information is especially useful to meteorologists at NOAA's National Hurricane Center in Florida.*

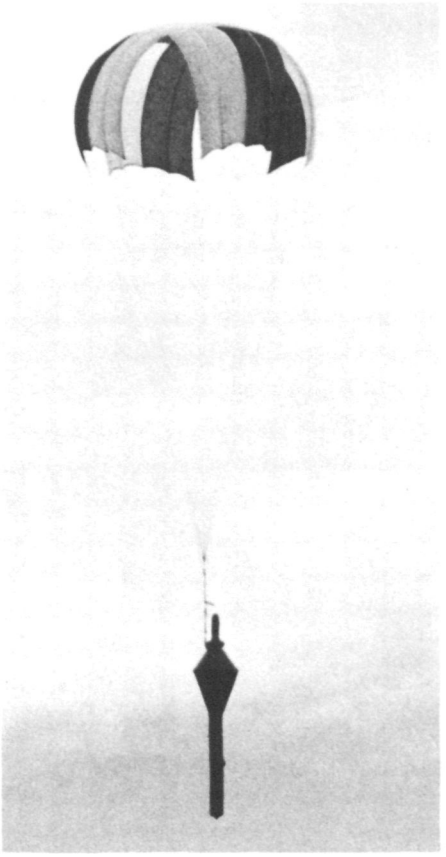
*It's heavy going for these discus buoys under tow to stations in the Gulf of Mexico, but they're built to take much worse poundings and continue transmitting through hurricane-force winds and waves.*

During the early 1940's, the flow of weather observations was interrupted by the Second World War. Hundreds of trans-Atlantic ships were being sunk by German submarines operating in the North Altantic and radio silence was imposed for their protection. Although weather observations were collected during the war by military vessels, they were not radioed to port when taken but delivered by hand when the ship docked. Obviously such observations were of limited use.

Dedicated ships were deployed by the U.S. Coast Guard during this time at the direction of President Roosevelt to provide support for pilots ferrying thousands of aircraft across the Atlantic Ocean to Europe. During the war, as many as 12 "ocean station" ships were positioned along the air route to Europe, providing meteorological observations, navigational aids, and search and rescue support for the aircraft.

**NDBC BUOY LOCATIONS**





*A relatively small data buoy parachutes to the ocean below.*

*The size of NOAA's "monster" bouys is apparent in this photo taken during maintenance checks.*

At first, the weather ships made only surface observations. But the war provided a strong stimulus for the adoption and application of new technology to instrumentation such as upper air sounding systems. The resulting high altitude observations were important in light of the weather ship's role in supporting trans-Atlantic flights.

After the war, the U.S. attempted to maintain the costly weather ships because of the need for repeated surface and upper air observations from known fixed locations over vast ocean areas. But economy prevailed and the weather ships disappeared one by one. Last to go was Canada's ocean station Papa in the Gulf of Alaska, deactivated in 1983.

With the end of the World War II, marine observations once again began flowing by radio from commercial ships. Yet there was still the need for more observations from the oceans, and the war that had interrupted the flow of this vital information had spawned improved technology which provided the basis for new ways to collect marine observations. These included the earth satellite and the weather buoy.

A weather observer in its own right, the satellite also made it possible to collect information directly from offshore buoys as well as units deployed anywhere in the world's oceans.

The navigational buoy has been a familiar guide to the mariner for at least 200 years. But it was not until the closing years of the Second World War that researchers demonstrated the feasibility of using buoys for environmental monitoring. By the 1960s several ocean-oriented agencies had begun separate efforts to develop environmental buoys. Recognizing the need for a comprehensive buoy development program, Congress enacted legislation calling for a national program. By the end of 1967, the U.S. Coast Guard had established the National Data Buoy Development Project.

Environmental buoy development was transferred to NOAA with the creation of the agency in 1970. The center of operations for the buoy program was transferred from Washington, D.C., to Bay St. Louis, Miss., and named the NOAA Data Buoy Office. In December 1982, the NDBO was placed under the administrative management of the National Weather Service and renamed the NOAA Data Buoy Center. On May 10 of this year the NOAA Center was again renamed, this time as the National Data Buoy Center to reflect its broadened mission as the Nation's center of environmental data buoy technology and application.

NDBC has engaged in a continuing data buoy developmental process based on experience and technological expertise gained through the design, fabrication, deployment and maintenance of environmental data buoys. Through this process, the Center has developed the current network of 48 moored buoys which require considerably less service and maintenance than early buoys dating back to the first experimental unit deployed off Cape Hatteras in 1971.

Although the Coast Guard turned over the environmental buoy program to NOAA, that service is still deeply involved in the program. By interagency agreement with NOAA, the Coast Guard deploys, retrieves, and maintains

the NOAA buoys. Coast Guard cutters and aircraft aid in the testing, inspection, and search for buoys gone adrift.

Also by this agreement, the Coast Guard provides 15 officers full-time to the National Data Buoy Center. One of these is Captain Phil Kies, who serves as the deputy director of the Center.

Kies recalls being aboard the weather ship Bravo 250 miles south of Greenland when the first all-jet trans-Atlantic flight occurred in 1958. He passed information about the observed upper winds to the pilots of the KLM flight as it flew overhead.

"I never thought I would get involved in the observation program again. It is exciting to see the progress we have made in the past 27 years," Kies says.

Kies noted that, since the moored buoys operate on battery power, they need to be retrieved about every 2 years.

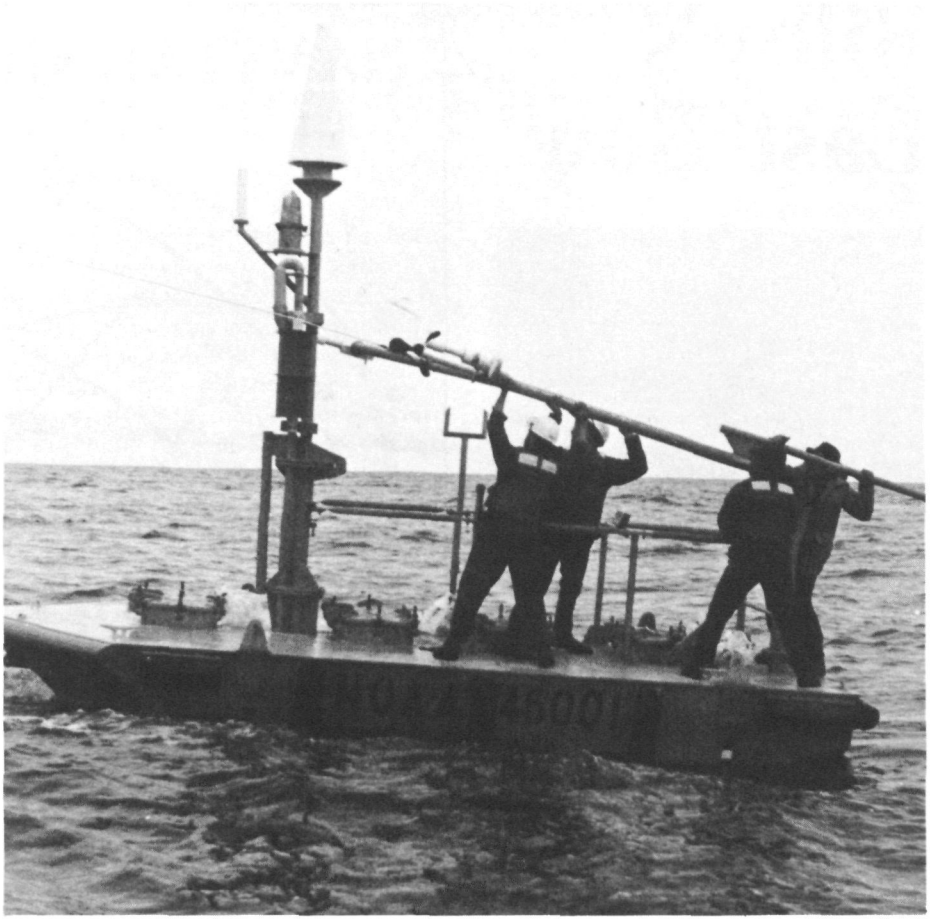
"It is difficult for people to envision the complexity of deploying or retrieving a large ocean buoy, one that is large enough to house a family of 8 or 10 people," Kies added.

The NDBC deputy director noted that the mooring line for a large buoy consists of several miles of nylon line measuring 5 inches in circumference, coupled to as much as 1,000 feet of large chain at either end. The moorings have to be retrieved from the ocean depths while manuvering the recovery ship without entangling the mooring line in the ship's propeller.

"The mooring line costs about $2 a foot so if you make a mistake, you are talking about a 20,000 foot line and $40,000 in taxpayers' money," Kies said.

Beyond the large, moored buoy program, NDBC has made significant progress in the development and application of smaller, drifting buoys. The first significant application of such buoys for weather forecasts was for the Global Weather Experiment, conducted in 1979 by 147 member nations of the World Meteorological Organization. The primary purpose of this year-long endeavor was to assess the ultimate limits of predicting weather beyond several days and to investigate the mechanisms underlying climatic change.

During the Global Weather Experiment, some 300 drifting buoys were deployed in strategic locations in the Southern Hemisphere. These units provided reference measurements of the surface temperature and atmospheric pressure to verify the accuracy of meteorological observations made by polar orbiting satellites.



*Coast Guard personnel and employees of Computer Science Corporation, the NDBC support contractor, raise the mast on a Nomad buoy during its deployment off the coast of Alaska.*

Drifting buoys have been utilized for a number of scientific and practical applications. For example, NOAA has deployed 50 units in the Southern Hemisphere as part of the Tropical Ocean and Global Atmosphere (TOGA) experiment. This 10-year program was developed to help understand better the interchange between the ocean surface and the atmosphere—information vital to weather forecasters and climate researchers alike.

The buoys are also a popular tool for keeping tabs on icebergs, mapping ocean currents, and for environmental studies. Several oil consulting firms have used the buoys to map currents in the Gulf of Alaska as an aid to selecting sites for oil rigs where any leaks would cause a minimum of environmental damage.

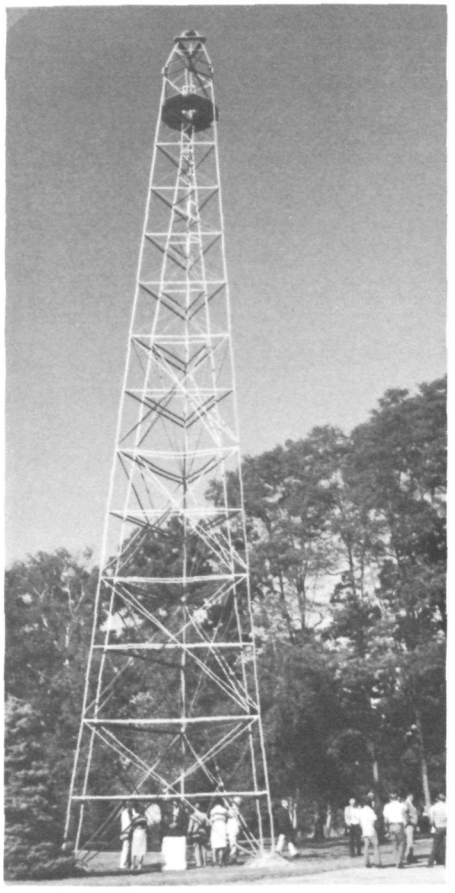
Whether they monitor the weather or the environment, ocean buoys have become a valuable part of NOAA's observational network. They continuously provide much-needed information from the data-sparse ocean areas where many of tomorrow's killer storms are born. ■

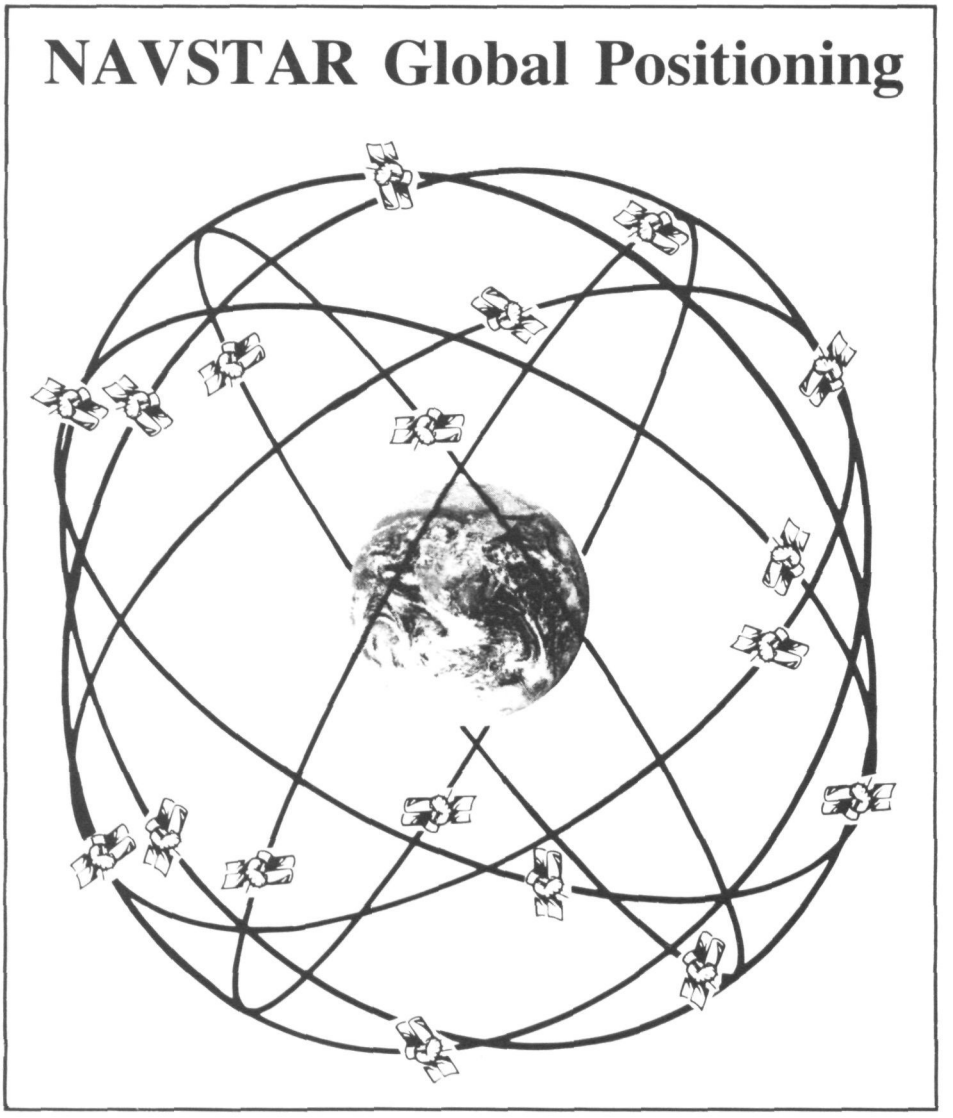
## Unexpected Advice

During the Second World War, observations from the weather ships became highly valued for their quality and location. Some World War II veterans conjecture that the Germans probably broke the code in which weather observations were transmitted and used the information to their advantage. Abetting this theory is the fact that, while these ships remained in fixed and well-known locations and would have made easy targets, none was sunk.

Dr. George Cressman, director of the National Weather Service from 1965 to 1979, recalls hearing about a German submarine that surfaced near a U.S. weather ship during the war to inform the American crew that they had a problem with one of their weather instruments. It seems that the suspect instrument's readings were not consistent with those from the weather ship's other instruments. (Cressman hastens to add that he has no way of substantiating the story.)

# Bilby's Last Bow






Jasper S. Bilby never made the list of the 10 best known Americans, but for many years his name stood high—about 120 feet—in the history of surveying. Now that achievement has been overtaken by the march of satellite technology.

In 1927, Bilby was an employee of the U.S. Coast and Geodetic Survey, predecessor of the Office of Charting and Geodetic Services in NOAA's National Ocean Service. Then as now he and fellow surveyors were concerned with measuring distances and elevations throughout the United States.

In traditional surveying, horizontal positions of points are determined by reciprocal observations of directions and distances to neighboring control points to form a network of triangles. Theodolites and electronic instruments measure these angles, and line-of-sight observation is required.

Since natural and man-made objects often interfered with line-of-sight measurement, Bilby designed what eventually became known as the Bilby tower, a portable steel structure that could be readily dismantled and moved about the country by a survey team. The towers were usually about 12 storeys high, which placed the surveyors' working platforms sufficiently above most obstacles and ensured accurate measurements.

Bilby towers became a familiar part of the American landscape for generations of residents and surveyors alike, but now a less costly, less labor-intensive, and more accurate technique has been developed to replace the Bilby tower observational mode. This new method, the NAVSTAR Global Positioning System (GPS), uses signals transmitted continuously from an array of evenly spaced earth satellites to derive the positions of ground-based GPS receivers.

The satellites, launched by the Department of Defense, are 12,000 miles in space. When one GPS survey receiver is placed at a known station and another is at an unknown one, the three-dimensional coordinates of the unknown station can be computed from satellite signal measurements. Results are 10 to 100 times better than with the Bilby tower.

The National Geodetic Survey, taking advantage of the GPS satellites now observable, has carried out GPS surveys in 12 states since 1983. A typical example was that carried out in the summer of 1984 in Mississippi. The positions of 29 stations were obtained to an accuracy of better than 1 inch over distances of about 6 miles between stations.

Meanwhile, the Bilby tower had its final moment of glory last September when a classical survey was carried out in Connecticut in cooperation with the state department of transportation. To commemorate the final erection of a Bilby tower by the survey organization, a special brass disk was placed at that spot to establish a permanent control point. Naturally, it was named "Bilby." ■

# NOAA's Fishery Fact Finders

At any one time more than a hundred scientists at nearly a score of fisheries laboratories around the country are at work on an array of studies aimed at better understanding creatures of the sea and their environment. Their projects range from studies of possible links between oily fish and the risk of heart attacks to "imprinting" hatchling turtles to coax them back to a protected nesting colony when they grow up.

Here's a report on what some of the scientists are doing.

* * * *

At the Northwest and Alaska Fisheries Center in Seattle two researchers, Drs. Virginia Stout and John Spenelli, have developed a relatively inexpensive way to concentrate two special components of fish oil, one of which may lessen the risk of heart attacks.

Called eicosapentaenoic acid and docoahexaenoic acid — mercifully shortened to EPA and DHA — the components are only two of some 30 saturated and unsaturated acids that make up compounds that are known to chemists as triglycerides. To most of us triglycerides are simply fat.

EPA and DHA are found in the fat of marine finfish in much higher concentrations than in land animals. DHA plays a vital role in the basic functioning of brain and visual cells. Without it, rats fail to develop proper brain function or sight. More importantly, fish oil seems to reduce the risk of heart attack, and scientists in Japan, Denmark and the United States have found that DHA lowers serum cholesterol — implicated in heart attacks — in rats' blood.

Although further research on how DHA and EPA work will require larger concentrations of these two compounds, there's a stumbling block: the current price for 99 percent pure DHA and EPA is about $1000 a gram. That's because it's extremely difficult to separate these compounds from the complex mixture of similar compounds in fish oil. And at that price research is too expensive.

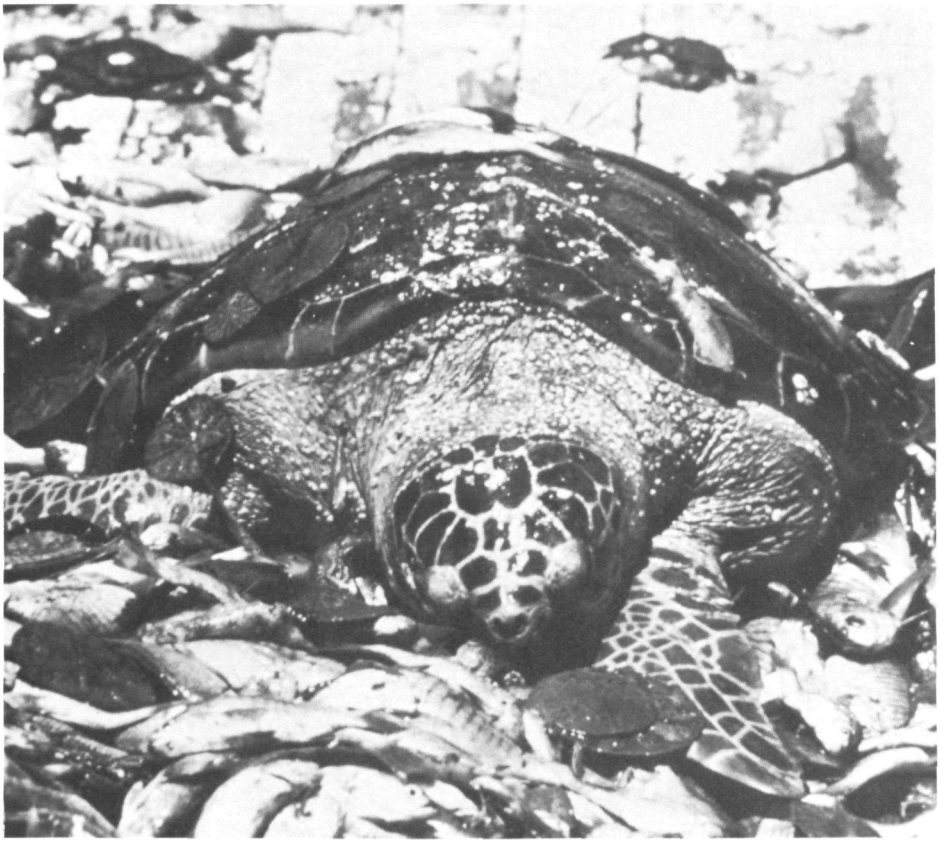
Spenelli and Stout use a novel approach to separate the EPA and DHA using fluid carbon dioxide at pressures up to 3500 pounds per square inch. Although fluid carbon dioxide has been used commercially to extract petroleum from spent oil wells and to decaffeinate coffee, its use as a fish oil separator is new. The approach is so new, in fact, that the NOAA researchers have applied for a patent for their process in an effort to lower the price of EPA and DHA.

* * * *

In the spring of 1984 U.S. Fish and Wildlife personnel collected hundreds of Kemp's Ridley sea turtle eggs from the animal's only known nesting site, Rancho Nuevo in Mexico. From there they were transferred to the Padre Island National Seashore near Corpus Christi, Tex., where, following incubation, the new hatchling turtles were briefly exposed to the Padre Island surf to "imprint" them. The final leg of this unnatural, but vitally important, journey took the baby turtles to the National Marine Fisheries Laboratory in Galveston where about 1,100 survivors were nurtured for a year. Last May those survivors, now large enough to be safe from many of their predators, were released a few miles off Padre Island.

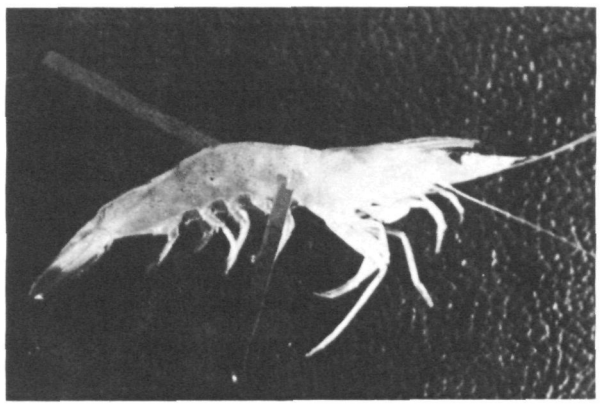
Dubbed Operation Headstart, this cooperative venture has reared, tagged and released more than 9,000 Kemp's Ridley turtles since 1978. The scientists' hope is to take advantage of the turtles' instinct to return to their nesting site — hence the brief dip in the Padre Island surf for the hatchlings — and thereby establish a new protected nesting colony on the Padre Island National Seashore.

Even through the headstart part of the program has been very successful, it remains to be seen if the turtles will in fact return, salmon-like, to their new nests. It can take 10 years or more for the turtles to become sexually mature.

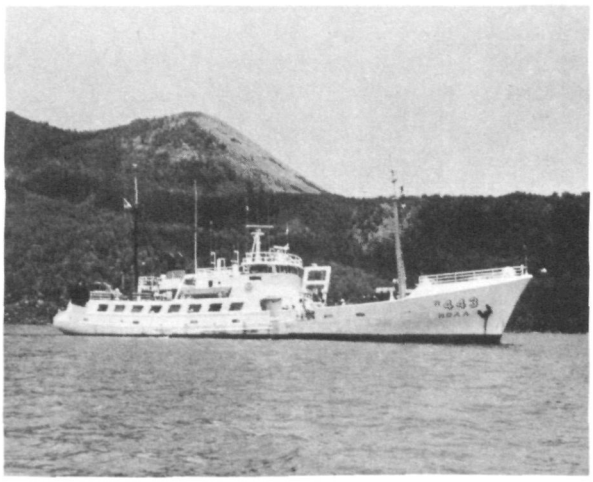


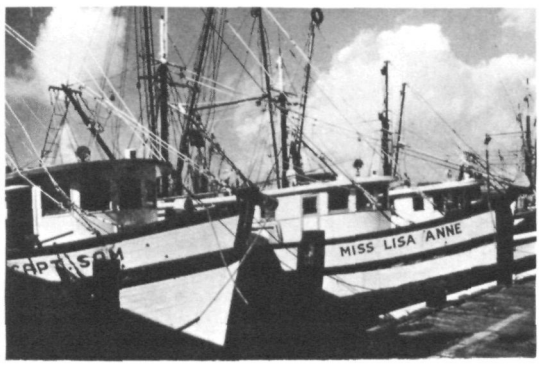
*A Kemp's Ridley sea turtle sits unhappily among other sea creatures netted by a Gulf trawler. NOAA researchers are trying to get these turtles to nest on Padre Island National Seashore near Corpus Christi, Tex.*

*This little fellow is part of a shrimp tagging study being conducted by NOAA in the Gulf of Mexico.*



Preparations are underway for a large-scale shrimp tagging study in Texas and Mexican waters to determine the size of shrimp migrations across the U.S./Mexican border. Although shrimp is the biggest cash fishery in the Gulf of Mexico, with almost $440 million worth landed in the Gulf last year, recapturing the right shrimp could make some fishermen a bit richer. The study involves NMFS's Southeast Fisheries Center in Miami, the Mexican National Fisheries Institute, the Texas Parks and Wildlife Department, and the Louisiana Department of Fisheries and Wildlife. Researchers will tag and release some 120,000 shrimp.






*(Clockwise from above) Shrimpers may be rewarded from $50 to $500 for helping NOAA researchers; hauling in shrimp traps on NOAA's Oliver Cromwell; the Cromwell plies Pacific waters; and snappers are under study in the Mariana Archiperago.*

Although the NOAA fisheries research ship Oregon II will recover some of the tagged shrimp later in the season off Port Isabel, Tex., NMFS scientists hope to lure shrimpers into the project with an offer they may not be able to refuse. Returned tagged shrimp accompanied by accurate information of where and when they were found could make the shrimp too valuable to eat. Shrimpers will have a chance to win from $50 to $500 in cash award drawings for their efforts. NMFS plans to advertise the potential boon heavily at fish houses and on radio, TV and in newspapers. A similar reward system is being offered in Mexico by that country's Fisheries Institute.

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Georges Bank off New England once supported a productive herring fishery. But since the early 1970s, the stocks have been almost non-existent. That may be changing. Researchers at the Northeast Fisheries Center collected "encouraging" numbers of tiny post-larval herring at three locations on the eastern half of the Bank during a survey this spring. Although the catches were still low by pre-1970s standards, the very presence of the fish is considered good news. The scientists will conduct further surveys this fall and winter, and NMFS biologists say there is a "glimmer of optimism" that a resurgence of Georges Bank herring stocks may be underway.

* * * *

Fisheries scientists at the Southwest Fisheries Center's Honolulu Laboratory have discovered that the Mariana Archipelago in the South Pacific may have several fisheries with an economic potential greater than fishermen on the island chain realize. They estimate, for example, that snappers and groupers, which currently are harvested to the tune of about 30–40 metric tons a year, have a much greater potential. The maximum continuous yield for these fishes is more than 100 metric tons a year, according to the researchers. At current prices that could bring about $350,000 – $400,000 additional dockside value to the island economy.

Of even greater potential is a deep-water shrimp resource. NMFS biologists say the Marianas' shrimp stocks could sustain harvests of about 162 metric tons a year, worth more than $1 million. Right now these shrimp are not harvested. ■

# Pike's Palatable Peak

The pike is a freshwater fish and the mere mention of its name on this page, regularly devoted to the gustatory preparation of marine fishes, would be anathema if it weren't for that fact that one of the classic recipes for pike—a deceptively simple forcemeat preparation in which the fish is bound with cream and egg white and is then poached—lends itself perfectly to a number of marine fishes: sole, dab, turbot, flounder, in fact almost any close-grained, non-oily white fish. Traditionally, the poached fish patties, called "quenelles," are covered with a delicate, salmon-colored but shellfish-flavored sauce called "Nantua," and are garnished with shrimp. Because the quenelles are poached only in water, and because the Nantua sauce is subtle in its flavor, only the freshest fish should be used.

The recipe calls for using a food processor or, if you make the forcemeat half at a time, a blender. It's perfectly possible to make quenelles the way they were made for a couple of centuries, by forcing the finely ground fish through a seive before combining the other ingredients, but this is really one instance where modern technology produces a superior dish, and produces it much faster.

The quenelles are rather unimposing in appearance at the table. You can liven things up a bit by garnishing each sauced quenelle with two or three boiled, peeled shrimp and some watercress. In fact, shrimp are a necessity because you need their shells to make the Nantua sauce. The fish should be accompanied by something relatively simple: rice, small buttered potatoes, or even shoestring potatoes, and green peas or a salad. Serve with a crusty French bread and your best white burgandy.

## QUENELLES DE BROCHET

2 pounds of fillets of pike (sole, flounder, or other white, non-oily fish may be substituted)
2 egg whites
2 cups heavy cream
salt
freshly ground white pepper
freshly grated nutmeg
watercress

Cut the fillets into strips about one inch wide and six inches long and put them in a single layer on a cookie sheet. Put the cookie sheet in the freezer for about one-half hour, just long enough to give the fillets some stiffness so that they can be ground in the food processor more easily.

Put the egg whites into the food processor, equipped with a chopping blade, along with two or three slices of fish. Blend for a few seconds and then quickly add the remaining slices, one by one, while continuing to blend. You may have to turn off the food processor from time to time to stir down the mixture with a rubber spatula. Blend for about 15 seconds after the last slice is added. Finally add salt, white pepper and the cream, and blend for about 10-15 seconds more. The idea is to obtain a homogeneous mixture of fish and cream that still retains some of the character of the fish. You don't want to make baby food.

Using two wetted tablespoons, form the forcemeat mixture into patties about the size and shape of a large egg and drop them, one at a time, into a skillet of simmering, salted water, deep enough to come at least half-way up the quenelles. Poach about 5-8 minutes, turning once. Keep the first batch of quenelles, covered with wax paper, warm in the oven while you finish poaching the remaining fish.

The quenelles can be either served from a platter and sauced and garnished at the table or you can place two or three quenelles on each dinner plate, sauce and garnish them in the kitchen, and then send them to the table at once. Serves six.

## NANTUA SAUCE

1 cup or more shrimp peelings, taken from about 18-24 moderately large shrimp that have been boiled for 3-5 minutes in salted water
6 tbs. butter
1 cup (more or less) very hot water
1 cup scalded cream
2 tbs flour
2-4 tbs. very finely minced cooked shrimp

In an enameled or stainless steel saucepan combine 4 tbs. of the butter with the shrimp shells and hot water in a food processor. Process for about 30 seconds. Pour the mixture through a fine seive, forcing as much butter as possible out of the shells before discarding them. Cool the water/butter mixture in the refrigerator until the butter hardens and can be separated from the water.

Over moderate heat melt the remaining 2 tbs. of butter until it begins to foam. Add the flour and, using a wire whisk, cook for a minute or two, but don't let the mixture, called a roux, color. Off heat add the hot cream all at once, and return the pan to the flame, stirring constantly until the mixture thickens to the consistancy of heavy cream. Add the cooked shrimp and heat through for a few seconds. Off heat once again, swirl in the reserved shrimp butter mixture. Sauce the quennels immediately, and garnish with boiled, peeled shrimp.■

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*A NOAA discus buoy heads into the sunset. See page 24.*