NOAA Ships and Aircraft Serving the Nation

U. S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Office of NOAA Corps Operations

The National Oceanic and Atmospheric Administration (NOAA) is a major Federal scientific agency. Its missions include forecasting the Nation's weather and climate, providing America's nautical and aeronautical charts, surveying the coasts and adjacent waters, monitoring and assessing the effects of marine pollution, protecting certain marine mammals and endangered species—and together with the States—managing the Nation's coastal zone and its saltwater fisheries, both commercial and recreational.

NOAA operates, maintains, and supports a core fleet of ships and aircraft used to accomplish many of NOAA's missions. NOAA's highly skilled, experienced ship and aircraft fleet employees work closely with personnel from NOAA's line organizations and program offices to assure success of all program missions. Often, these programs include collaborations from academic institutions as well as international programs and organizations.

This brochure describes some of the activities, accomplishments, and capabilities of these NOAA platforms and personnel, part of a triad of government, academic, and privately owned assets that serve America's needs. Current and future constituents as well as the public may find this information helpful in planning the efficient utilization of these national resources.

July 1995

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NOAA Ships and Aircraft Serving The Nation

Mission Statement of the Office of NOAA Corps Operations

The Office of NOAA Corps Operations (NC) serves NOAA and the nation by providing high quality and cost-effective scientific, engineering and technical services, ships and aircraft research platforms, and personnel in support of missions that lead to comprehensive understanding of the environment. NC continually strives to be NOAA's respected voice of expertise for sea and air operations and agency-wide technical integration, and to lead the agency's field efforts in gathering critical data for environmental assessment, prediction, and environmental stewardship. Our goal is to provide cost-effective, responsive, and safe operation of NOAA's fleet and NOAA's aircraft that support NOAA program needs.

NOAA organizations participating in the programs included in this report are:

NC	*Office of NOAA Corps Operations*
NMFS	*National Marine Fisheries Service*
NOS	*National Ocean Service*
NWS	*National Weather Service*
OAR	*Office of Oceanic and Atmospheric Research*

This document was prepared by the Office of NOAA Corps Operations (NC), a staff office within the National Oceanic and Atmospheric Administration (NOAA), an agency under the U.S. Department of Commerce.

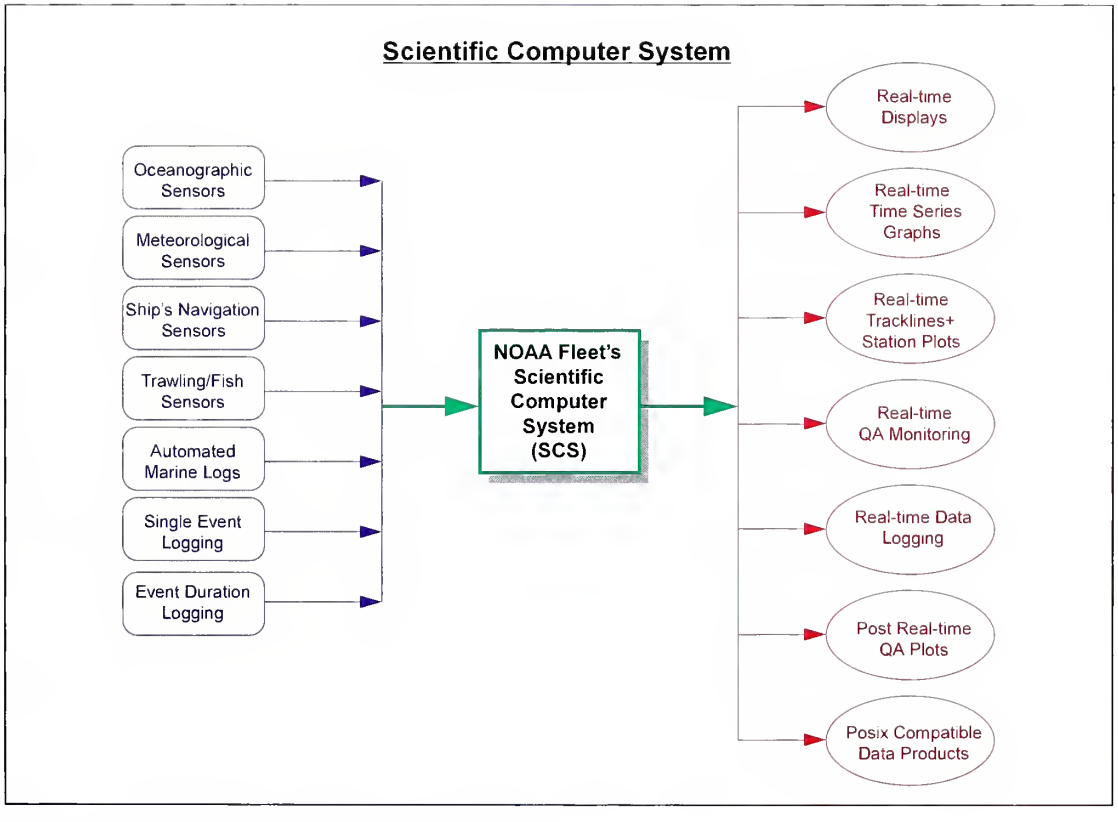
Ship Technology

The NOAA Fleet's Scientific Computer System

The NOAA fleet's Scientific Computer System (SCS) provides sophisticated support to the scientists using NOAA ships. This powerful and flexible tool operates on numerous ships and supports scientists from multiple disciplines as well as many NOAA laboratories and universities. The basic system architecture is fairly standard throughout the NOAA fleet. The system can acquire and process data from the full suite of sensors required by NOAA scientists. SCS can handle very high data rates, it can be readily reconfigured for each cruise, or, if necessary, it is flexible enough so it can be individually configured for individual users on the same cruise.

System implementation, documentation, and training is centrally supported, resulting in maximum efficiency. The cost of SCS is low when compared to similar systems in the university or commercial sectors. The SCS has a simplified user interface and a high reliability rate that allows the ships to operate the system with minimal personnel. This is important because of NOAA's emphasis on reducing vessel crew size and because there are minimal crews on smaller NOAA ships.

The SCS was initially designed and installed in 1988 on the NOAA Ship MALCOLM BALDRIGE by NOAA engineers in cooperation with scientists from NOAA's Atlantic Oceanographic and Meteorological Laboratory (AOML). Since then, NOAA engineers and scientific users have upgraded the system hardware and software, enhancing overall system capabilities. Periodic system upgrades continue to allow users to remain current in a constantly changing data processing environment. To date, the SCS is installed on five ships in the NOAA fleet, and an improved system with additional functionality will be installed on NOAA ships as the Fleet Replacement and Modernization (FRAM) Program progresses. The SCS currently supports ships used by National Marine Fisheries Service (NMFS) and Oceanic and Atmospheric Research (OAR) scientists.



NOAA Fleet's Scientific Computer System (SCS)

Pioneering Work in Multibeam Sounding Systems

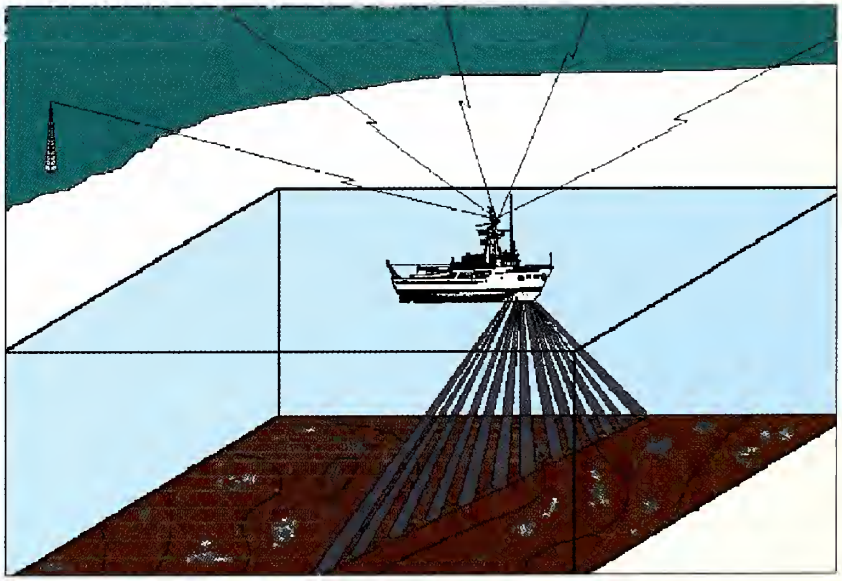
NOAA has been a pioneer in the development and large-scale implementation of multibeam sounding systems in deep, intermediate, and shallow water applications. Through NOAA's pioneering efforts, the nation and the world's scientific communities now have a new technologically advanced hydrographic survey system that meets standards established by the International Hydrographic Organization (IHO). The first civilian multibeam system in the United States was installed on the NOAA Ship DAVIDSON in 1975. During this implementation, NOAA engineers developed application software for this state-of-the-art-system so it could be used for hydrographic surveying. As part of this effort, NOAA fleet operators and engineers developed operating and calibration procedures to meet international data quality standards. The data from these early systems was the first of its type to be used in the creation of nautical charts and bathymetric maps.

In the intervening years, NOAA has implemented multibeam systems on additional ships. During the 1980's multibeam systems were used in the large-scale systematic mapping of the U.S. Exclusive Economic Zone (EEZ). This program was unique in the world in scale and accuracy. Valuable scientific and commercial products were routinely generated and distributed on a national and international basis. In addition to the charting and mapping mission, these systems have been used for the accomplishment of numerous other projects including those for the NMFS, OAR, Department of Defense (DOD), the Canadian Department of Fisheries and Oceans, and private industry.

NOAA continues to be a global leader in the development and transfer of multibeam technology. Currently, NOAA engineers are working closely with the Naval Oceanographic Office to transfer data processing software and expertise to the U.S. Navy (USN) during the installation of multibeam systems on new USN hydrographic and oceanographic ships. NOAA engineers are also working with groups at the University of Rhode Island and the University of New Brunswick to improve software and procedures for processing the increasingly large and complex data sets being generated by advanced versions of this technology, including airborne laser systems.

NOAA continues to modernize its fleet with newer systems. A new intermediate depth multibeam system has recently been installed on the NOAA Ship RAINIER for work on the Alaskan continental shelf. Also, NOAA has recently fielded a state-of-the-art shallow water multibeam system on the NOAA Ship RUDE for use on hydrographic survey projects in critical nearshore areas. As before, this technology did not provide the necessary custom data acquisition and processing software to efficiently process massive amounts of data and to ensure that data would meet international standards of accuracy for nautical charts. NOAA engineers are again working in cooperation with the USN and university personnel to develop adequate software.

The Office of NOAA Corps Operations (NC), is working with the National Ocean Service (NOS), Office of the Coast Survey to install the shallow water system on NOAA ships and launches that support NOS's Coast Survey programs. Procurement of multiple systems by NOAA, as well as NOAA's involvement in software design, development, and system verification is a significant contribution to the development of a global market for multibeam technology.



Shallow Water Multibeam Survey Operations.

NOAA Funds Early DGPS Development

As our nation strives to improve its position in the global marketplace, our government establishes motivational and incentive programs to stimulate growth and competition. Our nation's Small Business Innovative Research (SBIR) Program is one of these initiatives NOAA supports.

In 1987, NOAA awarded a SBIR contract to the TAU Corporation for the development of a prototype Differential Global Positioning System (DGPS) receiver. This prototype receiver resulted in the development of a global positioning system capability that could satisfy positional accuracy requirements in support of NOS hydrographic surveys. The SBIR contract was a cooperative effort with the U.S. Coast Guard (USCG) — one of the many partners NOAA seeks out to form joint ventures to meet our nation's needs and to provide service to our citizens.

Phase I of the contract involved determining the feasibility of using DGPS for precise positioning of marine vessels, and identifying key technical issues including satellite selection, mast motion compensation, navigation processing algorithm, and system performance. The *Phase I* study indicated that use of the DGPS for hydrographic surveying, and other vessel positioning needs, was technically feasible and operationally advantageous.

Phase II of the contract demonstrated a "Proof of Concept" for a DGPS-based system, by developing and testing a GPS navigation system in a marine environment. Horizontal accuracies of better than 5 meters were achieved during the test. This was the first known field test employing the RTCM SC-104 DGPS correction data format, which is now the industry standard.

The outcome from this NOAA SBIR contract established the building blocks, including hardware, software, communication protocols, and data formats currently used by the private and public sectors. The USCG is in the process of establishing a network of DGPS base stations throughout the entire U.S. coastal regions based on the many favorable conclusions of the NOAA SBIR.

Productivity Improvements Using DGPS

As a follow-on to the 1987 SBIR Project, NOAA conducted the first DGPS controlled bathymetric survey on board the NOAA Ship DISCOVERER off the Hawaiian Islands. During a project in the summer of 1991, a satellite-based (INMARSAT) data link was used to transmit the DGPS correction signals from the shore station to the shipboard system. The successful results from this first DGPS controlled bathymetric survey moved NOAA and the nation into a new era of modern technology and operational efficiency.

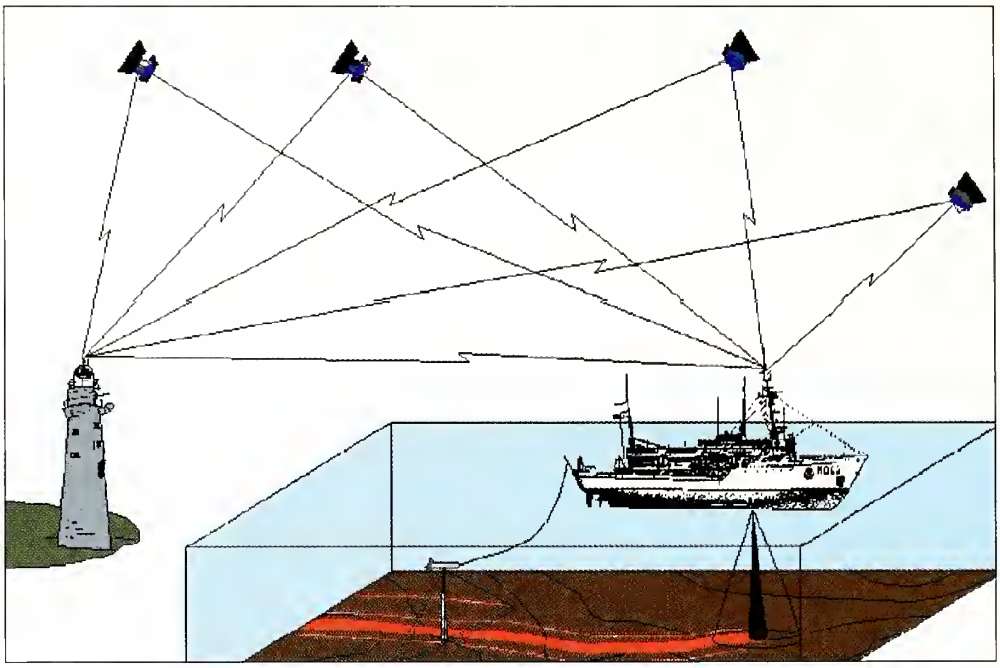
In 1992, NOAA and the USCG jointly began to establish semi-permanent, prototype GPS shore stations along the east coast and the Gulf of Mexico. NOAA immediately began using these systems to improve productivity during hydrographic surveys in those areas. The shore sites use established USCG radio beacons to transmit the DGPS correction signals to any vessel capable of receiving the signal. By 1996, a full network of DGPS shore stations, covering all U.S. coastal waters, including Hawaii, Puerto Rico, Alaska, and the Great Lakes, will be operating. This joint effort was recognized by the General Accounting Office (GAO) as cost effective and management efficient (GAO Report, "Global Positioning Technology: Opportunity for Greater Federal Agency Joint Development and Use," Sept. 1994).

In those areas where current USCG DGPS radio-beacon sites are unavailable, NOAA has developed a mobile DGPS shore site capable of being quickly established and removed to provide position control during survey operations. These temporary sites, referred to as "fly-aways," use commercially available GPS and communication equipment.

In late 1993, NOAA purchased a new generation of military precise P-code receivers. These receivers are deployed on board several NOAA oceanographic and fisheries vessels. Applications have included mapping of an underwater volcano and a marine sanctuary, a study of ocean currents, and fisheries research. The major advantage of using P-code for control is the ability to achieve 17-meter positional

accuracy without the establishment of a DGPS shore site and the associated difficulty of transmitting the DGPS correctors.

All NOAA hydrographic and bathymetric vessels, as well as all major NOAA oceanographic vessels, are capable of utilizing a combination of either the USCG's DGPS radio-beacon sites, NOAA's "fly-away" system, or P-code systems. Use of these position control technologies has vastly improved NOAA's ability to conduct survey operations, especially hydrographic surveying for nautical charting. When compared to previous position control technologies, these systems have increased NOAA's survey productivity by at least 75 percent.



DGPS Implementation in a Hydrographic Survey

Ship Operations

MT. MITCHELL's Damage Assessment of the Persian Gulf

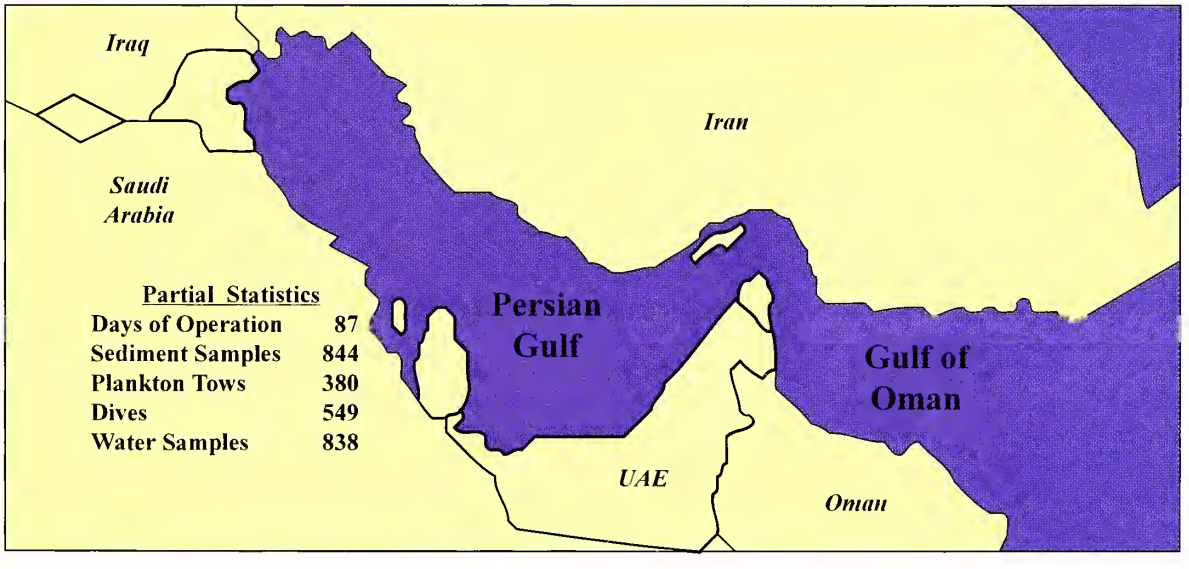
In the early 1990's, the international community was facing an environmental disaster caused by the intentional release of millions of barrels of oil into the Persian Gulf. The international community needed to know the impact of this wartime tragedy, and our nation responded by sending a NOAA ship to the Persian Gulf.

The Persian Gulf Expedition by the NOAA Ship MT. MITCHELL in 1992 was an unprecedented cruise conducted in conjunction with 140 scientists from 14 countries and 4 continents. The 28-year-old MT. MITCHELL was modified, upgraded and outfitted, with a very limited budget, on very short notice. The ship sailed halfway around the world and conducted complicated scientific operations in a politically and environmentally hazardous area with outstanding results.

The cruise was conducted as part of an international cooperative program developed by the United Nation's International Oceanographic Commission (IOC) to investigate the impact of the spill that was estimated at six to eight million barrels of crude oil. The investigation was conducted under the auspices of the Regional Organization for the Protection of the Marine Environment (ROPME), an organization that includes all Gulf countries except Iraq. The primary objectives of the cruise were designed to study the circulation patterns of the entire gulf, conduct shoreline and nearshore investigations in the most heavily oiled areas, conduct seafood quality and fisheries investigations, and conduct coral reef investigations.

Preparing the ship for this deployment involved a tremendous effort by shipboard and scientific personnel at NOAA's Atlantic Marine Center (AMC). Many modifications were made to the ship in a very short period of time, including fabrication and installation of customized deck hardware to secure scientific and storage vans, procurement and installation of Macintosh and IBM PCs, installation of an SCS, and the procurement and installation of a new suite of small boats. Continuous planning and flexibility were the primary keys to developing the operational efficiency and effectiveness needed to accommodate the varied projects.

This cruise involved a multitude of various operations, the breadth and scope of which are probably unprecedented in NOAA, and possibly in the global oceanographic community as a whole. According to the Chief Scientist of the cruise, basic factors such as personnel performance, logistics/support, data quantity, and data quality exceeded project objectives. A program of such importance normally requires several years to plan, but the ROPME team was able to make the initial commitment within a few months. AMC and the crew were able to outfit the



Persian Gulf & Gulf of Oman (ROPME Sea Area)

ship within 3 weeks of return from a shipyard period, and were able to keep the 28-year-old vessel operating halfway around the globe under arduous conditions. Of the 98 days the MT. MITCHELL spent at sea, only 2 days were lost because of mechanical problems. The Chief Scientist credited four critical groups with the success of the cruise: (1) the crew, NOAA Corps officers, and U.S. Public Health Service (USPHS) officers of the MT. MITCHELL; (2) the administrative and technical staff of AMC; (3) the NOAA and ROPME program and shore support personnel, and (4) the scientific complement of over 140 scientists from 14 countries.

The positive interaction and cooperation of so many nations, organizations, and individuals was phenomenal. The many professional and personal contacts made during the cruise will undoubtedly lead to many international, cooperative, followup projects and should serve to foster continuing efforts in the region for years to come.

Revitalized BALDRIGE Goes Around the World

The NOAA Ship MALCOLM BALDRIGE, one of the nation's most capable "blue water" oceanography vessels, is spending almost a full year on a series of research cruises that will take the ship to the Indian Ocean and around the world. Throughout 1995, a number of international research programs are focusing on the role of the Indian Ocean in climate and global change, and the biological and physical interaction of the oceans and the overlying atmosphere. NOAA scientists will be joined on the MALCOLM BALDRIGE by scientists from other nations and U.S. academic research institutions.

NOAA Ship MALCOLM BALDRIGE

For these cruises, the ship must acquire data that meets the most stringent requirements placed upon any oceanographic research vessel. It will conduct a full suite of physical and biological oceanographic programs studying the oceans and atmosphere, their interaction, and their effect on climate.

In preparation for the expedition, numerous upgrades to this 25-year-old ship were completed by AMC and the ship's crew in close cooperation with NOAA's AOML in Miami, Florida. Recent improvements to the ship, completed before the expedition, include installation of new Ship's Service Diesel Generators (SSDGs provide electrical power to the vessel), new water distilling equipment, upgrade of the deep-sea anchoring and coring winch, installation of a new state-of-the-art oceanographic winch, installation of a new shipboard SCS, significantly improved capability to transmit data and messages via satellite, and many routine repairs.

The ship will complete several major "lines" for the World Ocean Circulation Experiment (WOCE), which requires high precision sampling of the entire water column. The Radiatively Important Trace Species (RITS) program precisely samples the air and water columns for compounds such as nitrogen, carbon dioxide, ammonia and aerosols, and provides needed data to understand the ocean's role in global warming. The Global Ocean Ecosystems Dynamics (GLOBEC) program will conduct nutrient and biological productivity sampling in the Arabian Sea. The Ocean-Atmosphere Carbon Exchange Studies (OACES) compare the relative amount of carbon dioxide in the ocean and atmosphere to determine if

a specific ocean area is absorbing or emitting carbon dioxide, also necessary to understand the potential for global warming.

The ship will return to the United States across the Pacific, servicing deep-ocean oceanographic moorings of the Tropical Atmosphere Ocean (TAO) array of buoys, which extend from Indonesia to the Galapagos Islands. The TAO array provides "real-time" temperature, wind, and current data via satellite, which is essential to understand and predict the El Niño phenomenon.

Buoy Deployment and Retrieval Enhancements

The NOAA Ship DISCOVERER has implemented new procedures and techniques that increase the efficiency of deep ocean buoy deployment and retrieval. During the 1993 August – December Tropical Ocean Global Atmosphere (TOGA) cruise, 10 sea-days were saved as a result of these developments. At least 7 days were saved on the 1994 Spring – Summer cruise. It is estimated that the new procedures have resulted in approximately $250,000 of programmatic savings over 2 years.

Large improvements were attained by reengineering the methods for buoy deployments. The practice of using capstans was extremely slow and hard on equipment. By significantly reducing the number of blocks and rigging, the DISCOVERER formulated a method by which the nylon anchor line could be paid out in a free-wheeled method with no compromise of safety. Deployments are now accomplished in 75 percent less time than when the line was deployed using capstans.

DISCO to Increase Atmospheric Research Capabilities

The NOAA Ship DISCOVERER is a high-endurance oceanographic research platform with a broad range of equipment for collecting scientific data below and above the ocean's surface. The ship supports general oceanographic missions, atmospheric research, weather prediction, and global climate change research.

To improve forecasts of seasonal and interannual climate change caused by phenomena such as El Niño requires improved understanding of the coupled ocean-atmosphere system. Such naturally occurring events affect temperatures and precipitation over continental areas in ways that scientists are seeking to better understand and to predict. NOAA plans to install a comprehensive suite of atmospheric measurement equipment on DISCOVERER to meet the needs of programs involved in this work.

The ship currently has upper-air atmospheric sounding capability. The soundings, which include temperature, pressure, humidity, and wind observations are routinely collected on the ship and then relayed to shore facilities for incorporation into global atmospheric models.

Before the 1997 field year, NOAA is planning to install a 5-centimeter Doppler radar, a Doppler wind profiler, and atmospheric radiation measurement equipment on board the DISCOVERER. The Doppler radar will be used to study precipitation over the oceans, the wind profiler will be able to measure winds to an altitude of about 6 kilometers with very high resolution, and the radiation equipment will be used to assess the effect of clouds on solar radiation by providing a complete assessment of the various types of radiation reaching the ocean surface. In 1997, the study area will be in the region of the Inter-Tropical Convergence Zone in the eastern tropical Pacific.

When all of the capabilities of the above equipment are installed on the ship, the DISCOVERER will likely be the most advanced and complete research platform in the world for conducting atmospheric research over the oceans. These increased capabilities have the potential to provide valuable information for determining the effect of mankind's activities on the weather and to improve understanding of global climate change.

MILLER FREEMAN Does Double Duty

NOAA's fisheries research ship MILLER FREEMAN developed, engineered, and implemented an automated reconnaissance hydrographic surveying system during 1993-1994 that can be used as an ancillary dual function of the fishery acoustic survey system. The system utilizes a SIMRAD EK500 scientific sounder, the PC-based SEAPLOT chart software, and GPS. By collecting hydrographic data during fishery assessment transects through uncharted waters, the MILLER FREEMAN was and is able to add valuable hydrographic soundings to uncharted waters without impacting their fisheries assessment mission. To date, over 7,500 nautical miles of reconnaissance hydrography has been collected in uncharted areas of the southern Alaska peninsula, the Bering Sea, and the Russian continental shelves.

The SIMRAD EK500 scientific sounder is the key tool for hydro-acoustic assessment of major pelagic fishery resources of Alaska (pollack) and the northwest United States continental shelf (Pacific hake). To sample these fishery resources, scientists maintain assessment survey grids in excess of 20,000 miles per year in the Bering Sea and Gulf of Alaska. Along these grids, continuous acoustic profiles of the water column, the pelagic fish, and the bottom are collected. SEAPLOT software, controlled with GPS, maintains a track-record of the grid. Working together, NOAA Corps officers and scientists from the Alaska Fisheries Science Center have expanded this tool to provide reconnaissance hydrography along these transects and in transits between working grounds through uncharted waters. Operating with this dual mission, the MILLER FREEMAN is able to meet the fishery assessment mission of the Alaska Fisheries Science Center and to support the Nautical Charting Program with large amounts of high quality automated hydrographic data for use in large-scale charts. Both missions support the Alaska fishing and maritime industry by providing accurate assessments for fisheries management and expanding the charting of fishing grounds and offshore waters.

Trawling on NOAA Ship MILLER FREEMAN

This project demonstrates the professional commitment of NOAA personnel to enhance the multidisciplinary capabilities of the NOAA fleet. It also highlights the teamwork between the program and vessel personnel and the added value that NOAA ships and their crews bring in service to the nation.

Water Production in Polluted Waters

The NOAA fleet regulations prohibit potable water production within 12 miles of the entrances to harbors, rivers, inlets, and bays because of potential pollutants and the possibility of contamination of the vessel's potable water system. The crew of the NOAA Ship MT. MITCHELL developed and applied technology that enables NOAA vessels to produce potable water in silt-laden, polluted waters resulting in significant savings in fuel, labor, maintenance, and time required to complete operations in nearshore polluted waters. The addition of a back-flushable sediment filtration system prior to the reverse osmosis (RO) process decreases total sediments and solutes, allowing the RO units to

function in the seawater for which they are designed. This permits the ship to work in a nearshore environment with highly turbid, polluted waters.

The tests of the system were conducted by an Environmental Protection Agency (EPA) certified laboratory for those pollutants with designated maximum allowable standards as defined by the USPHS and Naval Preventative Medicine Service for safe drinking water including bacteria, metals, organic and inorganic compounds and hydrocarbons. The end product of the modification produced water in the test area that exceeded the standards for safe drinking water.

The system is relatively inexpensive and can be placed on vessels with RO units with little modification to existing vessel plumbing.

McARTHUR Sets a Rapid Pace

The first 3½ months of the NOAA Ship McARTHUR's 1995 field season were diverse and complicated. The 175-foot research ship successfully completed five primary projects and four ancillary projects. The following general summary of projects, participants, and investigations provides an overview of the scope of the work performed and shows the capabilities and flexibility of the vessel and crew.

These projects involved 13 different NOAA, federal, state, and local organizations in four states as well as the efforts of over 100 scientists and students. The projects included two Hake Larval Studies, a Monterey Bay National Marine Sanctuary Study, a Coos Bay South Slough National Estuarine Research Reserve Study, and a Washington Coastal Zone and Estuarine Plumes Study. The ancillary projects were synoptic weather observations, marine mammal observations, chart agent visits, and secchi disc surveys in the San Francisco Bay and Columbia River in support of NOS.

Many investigations were conducted during this deployment including Conductivity-Temperature-Depth (CTD) casts, Acoustic Doppler Current Profiler (ADCP) transects, bottom coring, sound velocity profiles, CHIRP seismic profiling, Remotely Operated Vehicle (ROV) surveys, side-scan sonar surveys, uniboom seismic reflection profiling, current meter mooring deployment and recovery, weather balloon launches, marine bird observations, scuba diving on nearshore submarine pinnacles, plankton tows using three types of nets, bottom trawls, sediment sampling, circulatory dye tracks, water clarity observations, and subsurface current mooring recovery.

The above information describes only the beginning of the year for the McARTHUR. At the time of this writing the ship has moved on to the next project of a long schedule that promises to result in a very efficient and productive field season in support of the nation's scientific community.

NOAA Ship McARTHUR

Fleet Management

Environmental Compliance Contributions

NOAA was one of the first organizations in the marine industry to initiate a shipboard hazardous materials and hazardous waste program to meet the requirements of the Resource Conservation and Recovery Act (RCRA), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and the Hazard Communication Standard. To comply with these laws and to provide standards for consistent and effective management of environmental issues throughout the fleet, NOAA developed and implemented the *NOAA Fleet Hazardous Materials and Hazardous Waste Manual.*

Because of their background in fleet engineering management and environmental issues, NOAA engineers have been asked to become involved in many environmental management projects. NOAA has become a member of federal working groups resulting in NOAA engineers contributing to numerous meetings and public hearings involving environmental compliance policy. For example, they are involved in policy development issues such as the regulation of ballast water on the Great Lakes, the control of shipboard incidental discharges as it relates to reauthorization of the Clean Water Act, and new international standards for control of airborne ship emissions. The extra effort described above is expended because of the potential impact of the environmental policy on the NOAA fleet. NOAA also has a responsibility to contribute to the development of rational and efficient national policies to protect the environment and preserve sustainable economic development.

NOAA has developed a much needed technical approach for achieving the regulatory goals of zero discharge of solid waste from ships. The NOAA approach identifies solutions using supportable engineering techniques and concepts. This new approach may eventually be used by others in government and industry. NOAA is also developing information pertaining to the latest technology associated with design, installation, and operation of equipment in all areas of shipboard pollution control. This, and all previously mentioned information, is disseminated to the NOAA fleet and fleet support activities, as well as other NOAA offices, through a recently established *Environmental Compliance Bulletin.*

Medical Care System and a Great White Shark

Since 1798, the U.S. Public Health Service (PHS) has had responsibility for health-care services for U.S. seafarers. Today, PHS commissioned officers, in a variety of health disciplines, continue this mission by providing care to the NOAA fleet. From pre-sailing medical clearance, which helps to ensure that individuals are fit for sea duty, to 24-hour-a-day physician consultation to all personnel on the ships, the NOAA health team provides the finest in maritime medicine.

Each ship has at least one crewmember trained to Department of Transportation Emergency Medical Technician (EMT) standards. In addition, a PHS Physician Assistant or Nurse Officer is assigned to all ships that are on extended cruises. Continuing education is available to assist providers in maintaining their skills. All providers are required to be certified by an appropriate agency for their category (state nursing board, national EMT registry, etc.). A comprehensive supply of medicines and equip-

ment allows many medical conditions to be treated on board with no time lost to mission objectives.

Physicians assigned to NOAA have training in diving, aviation, and occupational medicine. Sanitarians provide support in the areas of food and water protection, industrial hygiene, and disease transmission. The NOAA medical staff conducts physical examinations and tests necessary to monitor the health of fleet personnel who may be exposed to chemical, physical, or biological agents that could adversely affect their health. The NOAA medical staff conducts sanitation, industrial hygiene, radiation health, and environmental health inspections of ships of the NOAA fleet, ensuring a safe and healthful work environment.

The NOAA medical care system has been very effective over the years. Since 1980, the ships have worked 59,000 days at sea (DAS) with no fatalities other than those from natural causes.

The medical care system was put to an extreme test in 1994 aboard the NOAA Ship DISCOVERER in the South Pacific. Two crewmembers were injured, one critically, by a great white shark. The PHS nurse on board was able to stabilize the critically injured employee and keep her alive until the ship reached port at Easter Island almost 20 hours later. An emergency command post, set up at the Pacific Marine Center (PMC) in Seattle immediately after the attack, made arrangements to evacuate both individuals to critical-care facilities in Panama and then on to Seattle. The evacuation, which involved an Air Force KC 135, flight and orthopedic surgeons, and a support medical team, was carried out quickly and efficiently. Both individuals have recovered and continue to work for NOAA. Although tragic, the outcome of the emergency might have been much different had it not been for the preparation, training, and exemplary performance of the ship personnel and the staff of PMC.

The Right Boat for the Job

The hydrographic survey launches used by NOAA for the last 20 years were designed by NOAA engineers, specifically for NOAA's Coast Survey hydrographic surveying mission. The launches were designed with direct input from NOAA's experienced launch operators resulting in a boat that is well suited for a wide range of wind, current, and ocean bottom conditions. Sufficient speed, riding characteristics, electrical capacity, and air conditioning were included to allow daily use of sophisticated computerized hydrographic surveying equipment in some of the roughest conditions imaginable.

NOAA Survey Launch

A single standardized version of this flexible launch was built, thus minimizing design and logistical support costs. Twenty-two of the launches were built between 1975 and 1981. They were operational on all six NOAA hydrographic survey ships and for field parties. The Canadian Hydrographic Service subsequently built survey launches based on the same design.

These boats have been very productive, safe, and flexible platforms, which is reflected in the quality of the design. They are still the workhorses of the hydrographic surveying ships after 20 years of hard work in rough weather, along rocky shorelines. Office of NOAA Corps Operations (NC) recently started a cooperative Launch Modernization Program with Coast Survey to overhaul these

launches, improve their performance, and install state-of-the-art hydrographic survey systems. The original electrical power and air-conditioning systems have been replaced by modern systems. Designs for the installation of modern engines to increase speed and fuel efficiency have been completed. Acquisition efforts are underway to obtain modern shallow water multibeam sounding systems for these launches. With the above changes, these sturdy launches should continue to perform as safe and productive survey platforms across the NOAA fleet for another 20 years.

NOAA has continued efforts to improve its overall capabilities to collect hydrographic survey data. Concept design studies have recently been completed that describe new "Intermediate," "Fast Transit," and the more stable "Small Water Area Twin Hull" (SWATH) launches. These new launches are specifically designed to maximize survey productivity and cost efficiency in high-priority survey areas. NC is working with Coast Survey to obtain funding for these new launches through the FRAM Program.

Maintenance Improvements With SAMM

The Shipboard Automated Maintenance Management (SAMM) system has been implemented on the ships of the NOAA fleet. The system is designed to assist the ship and port engineers in managing maintenance and repair of the NOAA fleet. The system does this automatically by scheduling maintenance, outlining maintenance procedures, recording maintenance and repairs accomplished, and tracking spare parts. New modules being implemented will monitor lube oil analysis reports, equipment vibration readings, and thermographic images of electrical components to extend equipment overhaul periods, if possible, and predict impending failures. The SAMM system is a valuable new tool that should help increase the reliability of the fleet even during tight financial times by contributing to wise expenditure of maintenance funds and by predicting and avoiding costly equipment failures.

Centralized management of the NOAA fleet has allowed significant efficiencies in implementation and support of this system. The same software was implemented on all NOAA ships in a relatively short time. Centralized management and support for the fleet also facilitated interagency cooperation with the Navy's Military Sealift Command (MSC), which contributed significantly to this successful implementation.

Damage Control – Preparations and Results

NOAA ship damage and casualty control organization and procedures are important to NOAA because of the diverse nature of the missions, the configuration of the ships, the knowledge, skills, and abilities of those on board and the harsh working environment. This uniqueness makes it essential that NOAA centrally manage its damage and casualty control policies and procedures.

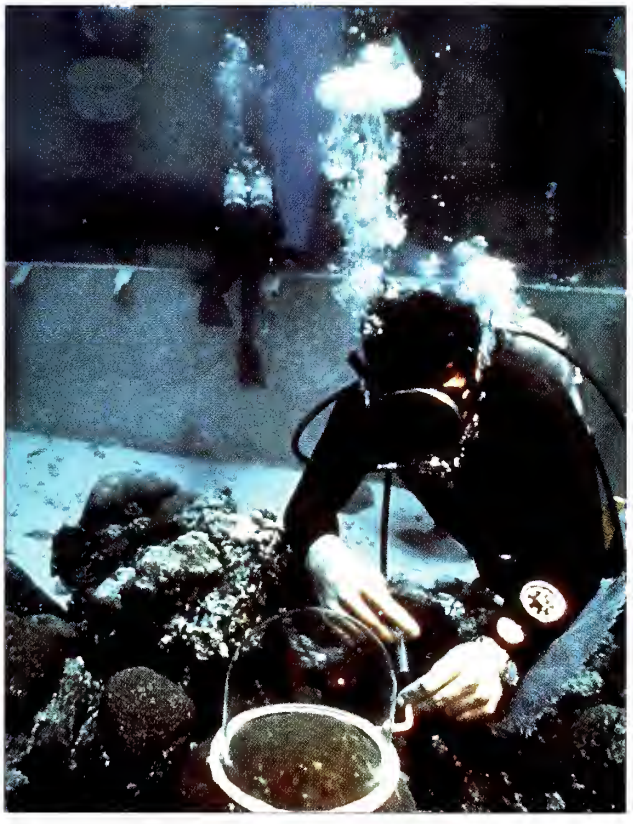
To address the issues unique to NOAA ship operations, a manual, *Damage and Casualty Control for Ships of the NOAA Fleet*, was developed including NOAA ship damage control diagrams. This manual is used in conjunction with formal hands-on training in fire fighting and damage control to prepare NOAA Corps officers and the ship's crew for sea duty. The manual contains important ship-specific information such as damage control diagrams, trim and stability information, system schematics and configurations, and the location of damage control equipment. The manual is used by officers and crew aboard NOAA ships to provide familiarity and consistency in damage control operations and procedures throughout the fleet. The manual provides practical and effective damage and casualty control information applicable to emergency situations that would most likely occur aboard NOAA vessels. The manual and training provide awareness and exposure to the skills, equipment, and procedures required for effective damage control, resulting in a long history of safe and efficient fleet performance. As a result of NOAA's damage control and casualty organization, the NOAA fleet has logged over 59,000 DAS since 1980 with no major equipment damage, fatalities, or serious injuries caused by fires or flooding incidents while at sea.

Dive Program

NOAA Diving – Safety and Numbers

NOAA has the largest complement of divers of any non-DOD Federal agency. NOAA divers work throughout the nation engaged in environmental assessment, on-site observation, surveys, installation and retrieval of underwater equipment, evaluation of instrumentation, and inspection, maintenance, and repair of ships. This wide variety of tasks reflects the broad range of NOAA's programs for management and protection of the Ocean and Coastal Zone.

The NOAA Diving Operations (NDO) Office supervises the activities of 314 divers, and has trained 1,961 divers since 1987. Of these divers, 35 percent were from agencies other than NOAA. Since 1989, NDO has logged over 51,000 dives with a 99.98 percent accident-free rate and no fatalities. The centralized management of NOAA's large, diverse diving program by experienced NOAA personnel has resulted in a quality, well respected, cost efficient, and safe operation that is key to many aspects of NOAA's overall mission. Because of the NOAA dive program's national reputation, the USCG is considering that NOAA assume USCG diver training responsibility, which is currently provided by the USN.



Operational Support by NOAA Divers

The NDO has centralized the management of diving equipment through the Standardized Equipment Program (SEP) at the NOAA Dive Center (NDC) in Seattle, Washington. NDC's procurement of standard equipment saves NOAA 45 percent per person, while maintenance and distribution of approved equipment ensures NOAA that divers are safely and adequately equipped while diving.

The SEP improved diver safety through equipment uniformity, in-house maintenance, and testing. All equipment is tested and inspected before issue to ensure that the equipment is within manufacturer's and SEP's specifications. In-house maintenance by factory-trained personnel guarantees that quality repairs are accomplished on all life-support equipment. Any items that cannot be repaired or fail annual testing are removed from the SEP equipment pool, and a ready stock of equipment is maintained at NDC to ensure rapid logistical support.

NOAA Diving Manual – Best Seller

The *NOAA Diving Manual* was written for use by NOAA scientists/divers to assist them in conducting various operations. Significant contributions to the preparation of this manual were provided by experienced NOAA personnel. Noted to be the largest seller in the Government Printing Office, the manual is a comprehensive reference specifically designed for the diving professional. The manual is used by government agencies and commercial groups. The diversity of the manual ranges from polluted water diving procedures to saturation and underwater habitat diving. The *NOAA Diving Manual* contains USN Air Decompression Tables as well as USN, Royal Navy, and COMEX Recompression Treatment Tables.

Aircraft

NOAA Hurricane Hunters and Atmospheric Research

NOAA's two WP-3D Orion aircraft are among the most advanced airborne environmental research platforms flying today. They are ideally suited for comprehensive atmospheric and oceanic research in the lower two-thirds of the troposphere. The NOAA P-3s are renowned for combining high accuracy of scientific measurement and rugged airworthiness during conditions of high turbulence and icing as well as intense precipitation.

During the hurricane season, the P-3s simultaneously conduct research and reconnaissance in tropical cyclones. The 1993 hurricane season heralded the first time that composite radar images of storms were transmitted directly via satellite to NOAA's National Hurricane Center (NHC), which gave forecasters a detailed look at hurricane structure from hundreds of miles out to sea. During Hurricane Emily, synoptic weather information developed with dropwindsondes from NOAA aircraft was instrumental in allowing NHC to improve forecasts by at least 20 percent, saving tens of millions of dollars in preparation and evacuation costs. During Emily, P-3 flight level winds and related radar data provided details of a much stronger storm than could be determined by standard satellite imagery.

During Hurricane Andrew, flight level and dropwindsonde information told the important part of the story, that the rapidly intensifying storm was heading straight toward south Florida. Important findings such as these are the result of demanding flight patterns, executed in winds that can exceed 150 knots, moderate hail, thunderstorms, as well as updrafts and downdrafts in excess of 35 knots.

NOAA P-3s also supported the Coastal Observation and Simulation with Topography (COAST) project in the Pacific Northwest during the winter storm season. The COAST program examines details of oceanic cyclones that are well offshore, as well as the complicated interaction of winter storms with mountainous terrain along the coast. Details of the mountain-storm interface are vital for fine-tuning forecast models of severe weather. Residents of the Pacific Northwest can expect significant qualitative improvements in their forecasts brought about by the 1994 COAST program.

The NOAA P-3s also explore midwestern supercells from Texas to South Dakota during the spring severe weather season. The P-3 radar capabilities are valuable in weather that is too severe for other mobile platforms to measure directly. Fixed ground-based radars can occasionally detect thunderstorms at optimal scanning range for quantitative measurements, but the aircraft's mobility ensures proper range for doppler scanning on the storm selected to be studied. Tornado chase vehicles, sponsored by the NOAA National Severe Storms Laboratory and midwestern university groups, make continuous use of the aircraft's communications link for positioning near the actual tornadoes.

NOAA WP-3D Orion

The P-3s also can be completely reconfigured to serve the needs of air chemists studying the processing of atmospheric ozone and the transport of pollutants from the lower boundary layer up into the free troposphere. A wide range of compounds must be accurately measured over long distances; the payload, range, and altitude characteristics of NOAA's P-3s blend together perfectly for this type of large-scale sampling.

The P-3s participate in a wide variety of NOAA, interagency, and international meteorological and oceanographic experiments on a worldwide basis. These aircraft give scientists a unique asset for the study of hurricanes and other severe storms, global climate change, air chemistry, pollution, Arctic ice formation, and many other environmental issues.

Cessna *Citation II* - Advanced Photogrammetry Platform

The NOAA Cessna *Citation II* is the world's most advanced photogrammetry platform. This jet has a side-by-side dual camera layout and a coupled GPS navigation system. It is used to collect aerial photography for NOAA's Coastal Mapping and Airport Obstructions programs.

The *Citation II* is a long-range, fast transit aircraft that can get to a field site quickly and perform its mission efficiently. The *Citation II* uses an on-board moving map display to help precisely navigate flight lines. A new kinematic GPS system has also been implemented that has increased positioning accuracy of the aircraft to better than +/- .5 meters. The range, speed, and accuracy of the system enables a dramatic increase in quality, productivity, and flexibility. As an example, in 1994, the *Citation II* completed coastal mapping and airport obstruction photography of Hawaii and several Pacific Islands. Projects such as this were not possible prior to the *Citation* because of limited operational capabilities of the aircraft.

The *Citation II* is also involved in several cooperative programs with state governments such as California and Massachusetts, and other federal agencies including the Federal Emergency Management Agency (FEMA) and the Department of State, assisting in maritime border decisions. Some of the recent decisions involved Japan and the United States, Niue and Tonga, and Micronesia and the Mariana Islands.

Testing and development is continuing on the *Citation II* toward implementation of a 12-channel multispectral scanner. When operational, the scanner can provide multispectral images that will aid natural resource managers in mapping and analyzing a broad range of environmental information such as the extent and health of wetlands and submerged aquatic vegetation.

NOAA's Cessna Citation II

Excellence in Aircraft Engineering Support

Much of the scientific instrumentation flown aboard NOAA aircraft is designed, built, assembled, and calibrated by the NOAA Aircraft Operations Center's (AOC's) Systems Engineering Division (SED). SED engineers and technicians, along with AOC fabrication specialists, devise airframe modifications to enable the mounting of sensors, cameras, radars, and other specialized equipment. AOC has pioneered many advances in airborne sensor systems and real-time data processing such as the use of forward- and aft-looking Doppler radar systems to map three-dimensional wind fields inside severe storms. Other examples of AOC pioneering work are the adaptations of C-band scatterometers and microwave radiometers for remote sensing in hurricanes.

During a 4-month period in the winter of 1992-93, a 28-person AOC team based on the Solomon Islands provided aircraft support for an intensive multinational program known as the Tropical Ocean and Global Atmosphere/Coupled Ocean-Atmosphere Response Experiment (TOGA/COARE). The TOGA/COARE experiment was designed to improve the ability to model the tropical ocean-atmosphere system and address questions of global climatic change. The program involved over 1,000 people from 19 countries, 14 ships, and 7 aircraft, including both NOAA P-3s. The P-3s flew more than 600 hours with no failures because of outstanding preparation and ground support provided by AOC.

NOAA Helicopters Support Multiple Surveying Missions

The operational characteristics of helicopters make them ideal platforms in the conduct of numerous NOAA survey missions. NOAA's helicopters are routinely reconfigured to optimize their capabilities in the performance of various survey missions.

NOAA, in cooperation with the U.S. Army Corps of Engineers, is integrating and testing a Scanning Hydrographic Operational Airborne Lidar Survey (SHOALS) system aboard a NOAA Bell 212 helicopter. This pulsed-laser hydrographic survey system will quickly and accurately measure water depths to 35 meters in clear water. The state-of-the-art system was flown in a test-and-demonstration mode for the first time in 1994.

The economy of the nation is heavily dependent on maritime commerce. Nautical trade, recreation, and tourism depend in turn on accurate nautical charts and surveys for safe navigation. Until now, charting has depended on survey vessels for water depth and bottom topography information.

The SHOALS system is expected to significantly increase shallow water hydrographic survey efficiency, resulting in quicker delivery of charting products. Both NOAA Bell 212 helicopters have been uniquely modified to accommodate the survey instrumentation.

NOAA helicopters are also instrumental in accomplishing missions in remote locations. NOAA helicopters are used regularly in conducting marine mammal surveys around the coastal United States and polar bear surveys in Alaska. A NOAA helicopter supported biological damage assessment surveys and cleanup operations following the Prince William Sound oil spill. NOAA's helicopters also transport scientific personnel and equipment to places otherwise inaccessible, and occasionally operate from ships at sea.

Helicopters Are Used in Many of NOAA's Field Operations

Twin Otter - Versatility and Capability

NOAA's DeHavilland *Twin Otters* have long been considered the most versatile platforms in the NOAA aircraft inventory. The marine mammal aerial surveys flown by the *Twin Otters* in support of the National Marine Fisheries Service (NMFS) have been essential for habitat protection and restoration programs. In the past several years the *Twin Otters* have flown missions on all coasts of the United States, including Alaska.

In June of 1995, one of the *Twin Otters* was modified extensively to support the Southern Oxidants Study. This project is a ground and aircraft-based experiment designed to investigate the emissions, transport, and eventual fate of tropospheric ozone and its precursors. The ultimate goal for the Air Research Laboratory is to increase the understanding of the mechanism of tropospheric ozone production. Data collected using the *Twin Otter* will

determine the magnitude and nature of pollutants in the survey area as well as the rate of removal of pollutant species and oxidation products at the earth's surface.

The sensors and instrumentation needed for this project required a total reconfiguration of the plane, which was done at NOAA's AOC. The airframe modifications included fabrication of an extended nose, removal of a fuel tank, addition of several air vents, and installation of data collection consoles that included extensive electrical wiring. Test flights for operational readiness and airworthiness were successfully conducted by AOC personnel.

The team of engineers and technicians at AOC have again exploited the versatility and capability of the DeHavilland *Twin Otter*. This modification will allow the *Twin Otter* to support air chemistry and atmospheric projects now and in the future.

DeHavilland Twin Otter

Water Conservation and Flood Control

Over 75 percent of Presidential disaster declarations result from flooding. Average annual flood losses total several billion dollars. Much of the flooding in the nation is due to spring snowmelt runoff. Observed snow water equivalent data are critical to operational flood forecast procedures.

The Gamma Snow survey mission, implemented by the National Weather Service (NWS), Office of Hydrology in 1978, uses light, twin-engine aircraft to quickly measure, by attenuation of gamma radiation, snow water equivalent along flight lines in selected basins each year. The data are disseminated by the National Weather Service, River Forecast Centers and are critical in issuing river and flood forecasts and in providing hydro-meteorological data and products to support water resources managers.

NOAA operates the Shrike Commander N51RF and Turbo Commander N53RF to measure about 1,700 10-mile-long tracklines in 25 states and 7 Canadian Provinces, covering virtually the entire snow belt of the United States and southern Canada. The huge expanses that can be measured in minutes using these airborne platforms would require days or weeks using ground-based measurements. The work is demanding, requiring precise navigation along tracklines while flying 500 feet above the ground, often in mountainous terrain.

Satellite information, which shows only the extent of snow cover, can provide some indication of the timing of flooding, but the aircraft-collected snow water equivalent data enables prediction of the extent of flooding. Knowing the amount of water in the snow cover helps the hydrologist provide flood warnings and forecasts weeks or months in advance of the snow melt, providing enough lead time to save lives and property. The snow survey mission contributes to warning and prediction services that saves $100's of millions annually.

These same aircraft support aeronautical Flight Edit and photogrammetry missions during the summer.

Air Navigation Safety

Air commerce is extremely important to the economy of the United States. The most basic information that air commerce requires is, "Where can I safely fly?" That information is produced by NOAA as air navigation charts. NOAA aircraft provide the quality photography and visual verification of information used in the production and maintenance of those charts. NOAA regularly operates three aircraft across the country for this purpose: the Cessna *Citation* (N52RF), the Turbo Commander (N53RF), and Shrike Commander (N47RF).

This work is coordinated with FAA and DOD and meets requirements of the FAA and DOD. The NOAA officer/pilots do the mission planning, flying, data collection, data processing, management, and data submission. Field work is highly weather-dependent and demanding, requiring long periods of travel, precise navigation, flexibility, and coordination of many details.

In the past 4 years, 946 new obstructions were found on 61 charts surveyed, which is an average of 15 new obstructions per chart. The program also checks the 230 FAA-designated Minimum Safe Altitude Warning areas that extend for 60 miles around each large airport. All obstructions within the designated areas are located and charted to provide the required critical information for flight safety.

There are, and will continue to be, significant returns on investments made by NOAA. Our products and services pervade the daily personal and business life of every American. Our research and technology development ensures a continuing national capacity to solve problems and respond to change.

No other agency working in the natural environment has NOAA's responsibility for the measurement, monitoring, and understanding of our atmospheric and marine systems. These are core activities of Government, including functions that have highly concentrated costs and widely dispersed benefits—such as providing weather warnings and climate forecasts.

The goals NOAA has set for the future will enhance opportunities for our citizens, the health of the U.S. economy, the protection of our environment, and the sustainable use of our natural resources.

Additional information can be obtained from:

Office of NOAA Corps Operations
National Oceanic and Atmospheric Administration
1315 East-West Highway
Silver Spring, MD 20910

Many NOAA offices have posted "Home Pages" on the Internet World Wide Web. The Office of NOAA Corps Operations' Home Page explains the supporting role of NOAA ships and aircraft in NOAA's mission. Each NOAA ship has a page with photographs, line drawings, detailed deck plans, and updated vital statistics. These pages are useful tools for scientists planning cruises aboard NOAA ships. The Aircraft Operations Center page has photographs of NOAA aircraft. The NOAA Commissioned Corps and its history are explained on another page.

Since going "on line" on July 3, 1995, the NC pages have acquired a number of links (hypertext-linked references from other home pages) including the University of Delaware's Oceanic Home Page and the Smithsonian's Ocean Planet Home Page. You can find the Office of NOAA Corps Operations' Home Page within NOAA's Home Page or directly at:

http://www.noaa.gov/nchome/