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William W. Behrens Jr.
U.S. Navy

ENVIRONMENTAL CONSIDERATIONS IN NAVAL OPERATIONS

With its historic mission clearly defined as supporting the operational fleet, the Oceanographic Office of the U.S. Navy in recent years has expanded its efforts to also meet the growing challenge of working within a national program of studying the marine environment. This article summarily reviews past accomplishments of the Hydrographic Office, outlines projects currently under way, and forecasts future areas of research and concern for the United States in the oceans of the world.

A lecture delivered at the Naval War College

by

Rear Admiral William W. Behrens, Jr., U.S. Navy

The Oceanographer of the Navy

The products and services of U.S. Navy oceanographic effort are vital if the United States expects to exercise its leadership as a major maritime power. In addition to satisfying needed requirements of the fleet, our quest for knowledge about the sea and the total marine environment reveals fascinating information about a part of earth that is largely unknown. Much of this information is being shared with a world that is eager to learn more about the total human environment.

We are told that Alexander the Great, in his desire to learn more about the sea, commanded that a transparent underwater vehicle be built for his use in exploring that unfamiliar environment. Legend has it that he descended into the sea, close by the safety of familiar shores, and witnessed there a vision of underwater life and phenomena denied to most men of his time. Whether true or not, these accounts reveal something of the nature of man's abiding interest in the mysteries of the sea, so inaccessible until our time. It is only with the assistance of the fruits of modern technology that men have succeeded in entering this hostile environment, with sufficient comfort and security to make conclusive observations about its character.

Today man can dive beneath the surface of the sea in search of knowledge about the ocean depths without support from the surface. He has gone to the bottom of the deepest ocean trench and has lived safely on the ocean floor for more than 30 days. The ability to remain submerged for sustained periods has come about largely through the pioneering efforts of the U.S. Navy.

Modern navy oceanography is a study of the sea that calls upon many scientific disciplines. The diversity of its activities is in keeping with the three-dimensional configuration of today's naval operations above, across, and under the surface of the seas. Today all of us have a growing awareness of the complex interrelationships governing the sea, its surface, and the air above it. We recognize one geophysical system, supporting a delicate balance between a liquid and a gaseous sea. It is an environment of dynamic change, and when this change is measured accurately, scientists or technicians can predict environmental events vital to operatious—momeuts, hours, or even days ahead.

The Navy's oceanographic program is about 140 years old, dating from its inception with our Depot of Charts and Instruments. Lt. Matthew Fontaine Maury was appointed officer-in-charge of the depot in 1842, and it was through his foresight and persistent efforts during the early days of oceanography that a broad base of useful marine environmental knowledge was acquired. Maury's collection of worldwide data led to such developments as the "Wind and Current Charts of the North Atlantic" in 1847, originally prescuted as a series of six charts. By 1866 the Navy Hydrographic Office was authorized to carry out surveys and to print nautical charts and publications for the benefit and use of all navigators generally—a statutory requirement which governs the Oceanographic Office to this date.

The most significant events influencing the nature and origin of the present Navy oceanography organizational structure took place during the last decade. In 1959 the National Academy of Sciences issued a report which called for doubling the national effort in oceanography during the sixties. That same year the Navy developed its "Ten Year Program in Oceanography" based upon the report of the National Academy of Sciences. The Office of the Oceanographer of the Navy was established in 1966 to act as the Naval Oceanography Program Director for the Chief of Naval Operations. The Oceanographer is required to exercise centralized authority, direction, and control—including control of resonrces—in order to insure an integrated and effective naval oceanographic program.

For management purposes, the Navy's oceanographic program is divided into four major but closely interrelated efforts:

- *Ocean Science,* which conducts research into the physical, chemical, biological, and geological factors of the world's oceans and their boundaries;
- *Ocean Engineering and Development*, for the development of underwater equipment and techniques for working in the oceans;
- *Oceanographic Operations,* to provide data, techniques, charts, publications, and other services to meet specific fleet oceanographic needs, as well as satisfying the Navy's statutory requirements for ocean survey.
- And, *Environmental Prediction Services,* to provide accurate forecasts to the operating fleet about the constantly changing nature of its operating environment, the oceans, and the airspaces above them.

In the *Ocean Science* program we support considerable basic research through funding of major academic, nonprofit institutions and Navy in-house laboratory efforts. Although the scientific program investigates marine environmental phenomena of all kinds (some of which may seem pretty exotic to the layman), all of its work is directed toward solving naval problems. Nearly 90 percent of the science program is being directed to antisubmarine warfare, much in the field of underwater acoustics.

One example of the highly specialized investigations of underwater sound that is being conducted is a study of the deep scattering layer, an oceanic phenomenon which at times causes false bottom readings on sonar. The deep scattering layer can send back an echo that looks very much like a sonar trace of ocean floors at locations where we believe the ocean bottom is actually deeper. *Ocean Science* studies indicate that these readings come from masses of living organisms which reflect or refract sound waves. The layers migrate from one depth to another, moving upward during hours of darkness and deeper into the sea during daylight hours. Current speculation is that they follow masses of plankton on which they feed. If this can be substantiated and the organisms and their migration patterns identified, as well as how they interfere with acoustic operations, we will be able to predict their presence and make allowances for their effects.

Another phenomenon of great interest in our *Ocean Science* program is long-range acoustic propagation. Better information about this phenomenon will lead to improved underwater surveillance and detection. Long-range sound studies have shown the existence of ocean conditions which create a form of channel through which sound waves pass with far less distortion than through adjoining waters. Navy scientists are working to learn the nature of those phenomena in experiments. Results are still inconclusive but work continues. Our goal is to be able to predict the occurrence of this phenomenon and then exploit these sound transmission qualities with sensor arrays where practicable.

Physical oceanography, in the *Ocean Science* program, investigates physical and chemical processes taking place in the sea to establish a broad understanding of how those activities affect naval operations. We study ocean circulation, air-sea interactions, surface and internal waves, and how chemical processes and elements are distributed in the sea.

One field program, called "North Pacific Experiment" (NORPAX) is designed to study sea-surface temperature anomaly patterns across a great area of the North Pacific Ocean. For observing the ocean environment in experiments like NORPAX, instruments such as the large "Monster Buoy" are used as fixed data stations. This buoy can measure up to 100 individual meteorological and oceanographic parameters and then transmit this data over a distance of 2,500 miles to Navy processing centers.

The second major program area, the *Ocean Engineering and Development* program, seeks to provide equipment and techniques that will permit unrestricted travel for man in the oceans of the world. Existing programs will move man from 200 feet to 2,000 feet and vehicles from 2,000 feet to 20,000 feet, with improved capabilities for doing work. A serious limitation in the deep ocean has been our rather poor capability for rescuing personnel aboard disabled submarines. We now have a new development, still undergoing rigid testing, that promises significant improvement in our search and rescue efforts under water. The Deep Submergence Rescue Vehicle (DSRV) system will be able to rescue personnel from depths as great as the current hull collapse depths of our submarines in the ocean. The DSRV can be transported over long distance by aircraft, loaded onto a mother ship, and carried to the scene of the emergency where it descends to mate with the disabled craft. It is designed to operate in a totally dark environment and will be able to mate at up to 45-degree angles with the escape hatch of the disabled craft in a 1-knot current. The DSRV is capable of transporting 24 passengers, and we are confident that it will provide long-desired search and rescue techniques in the underwater operational areas. Besides the personnel rescue, we are developing equipment for the recovery of small objects from the ocean floor at depths up to 7,000 feet and salvage of objects as large as aircraft or large underwater craft at depths as great as 850 feet.

Our *Ocean Engineering and Development* program supports the project Deep Ocean Technology (DOT) which has as its objective the establishment of a broad-base technology for doing work in the deep ocean. The DOT project investigates requirements for deep ocean energy sources and materials for hydraulics and electronic systems, all of which would be capable of operation in the deep ocean. An experiment called SEACON investigates the sea floor in detail to determine how much weight and the types of structures it can support—what might have to be done to the site to make it suitable for underwater structures, as well as the kinds of tools that might be useful for major underwater construction. We are not working toward any specific structure, but to develop and test various small component structures and equipment that could be useful in understanding construction requirements in the deep ocean.

Our program activities are closely interrelated, even though they are divided into specific objective areas for ease of management. The work that is accomplished in one area is generally applicable to all other areas of the overall oceanography program. An illustration of this is the development and operation of the MIZAR, a most useful oceanographic ship which accommodates pure research in ocean characteristics, but also is capable of conducting search and recovery operations. The MIZAR is equipped with a center well for lowering a variety of instruments or recovery equipments into the ocean, without major interruptions from wave action that would affect over-the-side operations.

Recently added to the MIZAR is a unique instrument for search and recovery operations called the FISH. It is released through the well with a cable tether to locate and examine objects on the ocean floor. To accomplish these objectives it is equipped with side-looking sonar, magnetic sensors, depth sensors, newly developed strobe light illumination, and high-powered cameras. The FISH is capable of sensing its relation to MIZAR at all times, even though it ranges some distance away, and at the same time sensing its relative distance from all other objects, including the ocean floor. With this highly efficient instrument, MIZAR was able to locate and photograph the French submarine *Eurydice* that was lost off the coast of France in the Mediterranean. This same combination of ship and FISH also located and verified the secure condition of a scuttled hulk at the bottom of the Atlantic Ocean with its controversial cargo of nerve gas.

A third and major part of the oceanography program is *Oceanographic Operations* which supplies the fleet with daily information about the changing marine environment in which the Navy operates. This program exploits much of the research and development work in its role of supporting the tactical commanders at sea with their operational needs—weather reports and predictions, navigation aids, acoustic performance data, ice forecasting, and bottom survey information, to mention but a few.

Worldwide weather and oceanographic observations are reported to the Naval Weather Service Command over the Naval Environmental Data Network, as well as over the U.S. Air Force Automated Weather Network, and the World Meteorological Organization Collections System—now operated by the National Oceanic and Atmospheric Administration. Navy-originated data is supplied by reports from ships, submarines, merchant ships, aircraft, and Navy buoys at sea. The Naval Environmental Data Network extends from the Philippine Islands across the Pacific Ocean and from the United States to England and to Spain. This computer network provides a two-way communications link which is operated to collect data and to disseminate simultaneously products and services.

One of the widely publicized services from weather and oceanographic prediction is *Optimum Track Ship Routing.* The concept of weather routing for ships under the operational control of the Navy became operational in the Naval Weather Service in 1958. *Optimum Track Ship Routing* service for all types of U.S. fleet shipping and for the Military Sealift Command is now provided in the Atlantic by U.S. Fleet Weather Central, Norfolk, and in the Pacific by U.S. Fleet Weather Centrals, Alameda and Guam. Reports of results from the service show averages of 6 to 12 hours saved in Atlantic crossings, with savings of more than a day for Pacific crossings.

A valuable service developed by the Naval Oceanographic Office and now operated by the Naval Weather Service Command is the Anti-Submarine Warfare Environmental Prediction Services (ASWEPS) program, designed to assist ASW planning and tactical operations. The ASWEPS Fleet Weather Central, Norfolk, and the Fleet Numerical Weather Central, Monterey, provide synoptic analyses and environmental predictions to fleet operating forces in the North Atlantic, the North Pacific, and Mediterraucan theaters. Currently ASWEPS predictions are limited to areas in the Northern Hemisphere. A considerable variety of data received by the ASWEPS Fleet Weather Centrals and Facilities is processed by computers to produce the synoptic analyses and forecasts at Fleet Numerical Weather Central. These products are transmitted to major network centers where they are tailored for specific operational requirements and then disseminated to fleet users by radio teletype and facsimile. Reports come to the shipboard consumer as readings of layer depth, below layer gradient, sea-surface temperature, wave height, wind speed and direction, sonar effectiveness, jezebel effectiveness, and BT and sound velocity profiles. ASWEPS has proven to be highly effective, and we will continue to conduct the research necessary to improve future performance.

The Naval Oceanographic Office also has the responsibility of surveying the ocean bottom, and much that has been accomplished in this area has been done by the Sonar Array Survey System (SASS). This survey system is capable of surveying a wide swath of the ocean bottom in one pass at one-fourth the time required for conventional echo sounders. The entire complex turns out an accurate contour strip chart representing several miles of ocean bottom. Three of the ocean survey ships are presently equipped with and using SASS in a continuous, 270-day-a-year schedule.

While the ocean survey program produces a great deal of information which is retained by the Navy, it also provides a great deal of useful information to mariners everywhere. For example, the Navy was able to be of assistance to the fishing industry of Iceland which was experiencing difficulties in locating their catch. The bulk of the annual Icelandic fishing harvest is dependent upon the "herring run," migrating from Norway and stopping off at the east coast of Iceland when the herring reach the cold edge of the Greenland current. Because the cold current changed direction last year, the fish were diverted away from their normal feeding gronnds near Iceland. The U.S. Navy sent an ice patrol plane with a heat-measuring sensor to find the edge of the cold-water mass and the fish were located. Now there are plans to help Iceland develop its own capabilities for these searches, as well as for ice forecasting. While the U.S. Navy is not in the business of commercial fishing, this incident is an illustration of important nonmilitary benefits that can be made available to the world.

Many of the U.S. Navy's oceanographic efforts provide such "spin-off" to our own Nation's industries and national marine programs. Through the Navy's dissemination of a great amount of general knowledge about the sea and the ocean floor, our own fishing industry and petroleum indnstries often have been assisted. Thus, even though these responsibilities are not specifically included in the Navy's mission, they do contribute significantly to our national goal of understanding and utilizing the full potential of the sea.

Despite high levels of interest during the past decade, our national program in oceanography has been quite fragmented. Under his Federal reorganization plan, the President in October 1970 established the National Oceanic and Atmospheric Administration (NOAA) within the Department of Commerce. NOAA combines within its structure the Environmental Science Services Administration and the Marine Sport Fish program from the Department of the Interior; the Office of Sea Grants programs, from the National Science Foundation; elements of the U.S. Lake Survey program, from the Department of the Army; the National Oceanographic Data Center, Navy; the National Oceanographic Instrumentation Center, Navy; and the National Data Buoy project, from the Coast Guard in the Department of Transportation. To further consolidate all Federal activities in marine research, the Congress also is creating a National Advisory Committee on the Oceans.

Closely related to the President's establishment of NOAA is the creation of the Environmental Protection Agency. This agency will establish and enforce environmental protection standards and provide assistance to the Council on Environmental Quality, conducting research into factors of pollution. With a role to be played in protection of the human environment, it has become most important that the Navy's oceanography program be constantly coordinated with the efforts of these new Federal organizations, working closely with them to understand and use the marine environment for condncting our vitally important naval operations.

The mission of Navy oceanography increases in urgency as the Soviet Union displays its ever-increasing determination to match, or surpass, the U.S. Navy's long-held superiority on the world's oceans. While the Soviets did not establish their first oceanographic institnte until 1921, by the mid-1950's their effort exceeded that of any other country, and they are continuing to build ships and develop skills.

The current number of ships in the oceanography fleet of the Soviet Union is about the same as the United States total; but we believe their emphasis on military oceanography is stronger than our own. According to observations of U.S. scientists during exchange visits with the Soviets, it appears they do not have the same level of sophistication in either instrumentation or certain scientific skills. However, what they lack in sophistication they make up with sheer numbers of personnel and scope of data collection and analyses.

An area in which the Soviets have made truly great strides in oceanographic research is the Arctic, and for some compelling reasons. First of all, much of the Soviet power base is located in the Arctic, with many industrial centers and natural resources in that area. It is always a little surprising to realize that 99.5 percent of the population of the United States and Canada live south of 53 degrees north latitude, while 75 percent of the Soviet Union's 200 million citizens live north of that same latitude. As a matter of fact, 500,000 Russians live north of the Arctic Circle, compared to only 10,000 North Americans. There are numerous vital Soviet seaports along the Northern Sea Route that must be kept open to commercial ships as well as to their naval units. These are very important reasons for the Soviet Union to continue developing both economic and military capabilities for operating in the Arctic seas and for acquiring excellent oceanographic knowledge of that part of the world.

By comparison, the United States has had little more than scientific curiosity about the Arctic until the recent discovery of vast reserves of oil in the northern part of Alaska. A billion-dollar investment in oil leases by American oil companies has changed the prospect for economic development in these Arctic regions. Economic development there means increasing national responsibilities and, consequently, a related urgency for Navy oceanography to develop a better understanding of the Arctic environment.

Already Soviet nuclear submarines can, and do, operate with a great degree of freedom in the Arctic seas. They have an appreciable advantage in the Arctic which is derived from their experience and research and development efforts. This we must match and surpass. The Soviet Navy, made up of four major fleets, bases two of those fleets close to the outer edges of the Arctic. Operations from those bases give them the advantage of using the Arctic icecap as a cover for fleet movements, obviously further complicating the U.S. Navy's ASW problem.

The Soviets appear to have devoted about 70 percent of their extensive polar regions effort to research and development in the Arctic, while the United States has divided efforts about evenly between the Arctic and the Antarctic. They have developed icebreakers more rapidly than we and have progressed further in solving the problems of ice route transit. With such extensive effort in the Arctic, they may have developed techniques for mining the waters of the Northern Sea Routes and could effectively seal off those strategically important waters. And there is little doubt that they are capable of using the icecap as a cover for launch positions for strike missiles—only 2,500 to 3,000 miles from continental United States.

All of this is not to say that the U.S. Navy is without capabilities in the Arctic. We have an impressive record of accomplishments in the Arctic with aircraft, submarines, and surface units, including oceanographic activities. Nevertheless, we need much more environmental information, including better knowledge of sea ice physics; acoustic performance studies in the marginal sea ice zone, where acoustic problems seem to be greater than any place in the world; and bottom surveys

BIOGRAPHIC SUMMARY

Rear Adm. William W. Behrens, Jr., U.S. Navy, is a graduate of the U.S. Naval Academy (Class of 1944), holds a master's degree in international affairs from The George Washington University, and graduated from the National War College in 1964. As a junior officer in World War II, he served aboard the submarine U.S.S. *Sandlance* and U.S.S. *Picuda*—participating in six World War II submarine patrols for which he was awarded the Silver Star Medal. Rear Admiral Behrens organized and served as Director of the first Nuclear Power School in the Navy and later commanded the U.S.S. *Skipjack* (SSN 585) and the U.S.S. *Ethan Allen* (SSBN 608). As a rear admiral served as Commander 7th Fleet Amphibious Force/Amphibious Group 1, as Director of the Politico-Military Policy Division (OP-61) of the office of CNO, and in September of 1970 assumed his present duties as Oceanographer of the Navy.

of the Arctic basin, to mention but a few specifics. All of these problems must be dealt with in a total oceanographic effort that meets the needs of a complete and responsible strategy for worldwide naval operations.

Navy oceanography products and services to the fleet are the result of years of effort. Also, they are intimately linked to Navy-wide concepts of what the future has in store for us. Although our mission is clearly defined as supporting the operating fleet, we also have the urgent responsibility of working with and assisting wherever possible the national program for understanding the marine environment. Worldwide concern for man's relationship to his environment compels us to be alert to our own need for maintaining that environment. Our progress quickens as knowledge grows about the sea and points the way to new discoveries and greater services useful to the fleet.

Knowledge of the oceans is more than a matter of curiosity; our very survival may hinge on it.

John F. Kennedy, June 1963