Oceanography in Virginia

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Dr. William J. Hargis, Jr., who authored this article, is one of the nation’s outstanding figures in the burgeoning field of oceanography. He is Director for the Virginia Institute of Marine Science at Gloucester Point, Virginia; Dean, School of Marine Science, The College of William and Mary; Chairman, Department of Marine Science, The University of Virginia.

No ivy-towered dweller, Dr. Hargis is easily conversant in his complicated field and his enthusiasm for a Science, which means increasingly more to all of us, is highly contagious. He’s a native of Russell County, Virginia, earned his A. B. and M. A. at the University of Richmond, went on to Florida State University to get his Ph.D. He has been actively engaged in research since 1950. He has been an educator in Biology, Chemistry and Marine Science since 1951.

His list of memberships in professional societies, service committees and his honors-fill almost a page. He is, for example, past president of the Atlantic Estuarine Research Society, Chairman of the Exploration of the Atlantic Shelf, a member of the Board of Trustees, Mariners Museum of Newport News, Va. and a fellow of the American Association for the Advancement of Science. He has been named by Governor Godwin as a representative for Virginia to important study groups related to pollution problems in the nation’s estuaries and to a Chesapeake Bay Study in connection with Chesapeake Bay Model. Author of 41 research publications and editor of 15 scientific translations, Dr. Hargis names sailing, powerboating, painting and photography as his principal hobbies.
Introduction

- Twice daily the ocean tide rises and falls in the 13 thousand square miles of the Virginia Sea and Chesapeake Bay. Along the 4,000 miles of shoreline, salt and fresh waters of Tidewater alternately cover and uncover rich shallows and marshlands - mixing fertility of soil and sea. Wildfowl, marsh animals, fish and shellfish are spawned in, sheltered or nourished by the enriched broth of the sea. Mineral deposits, fashioned by the ages, are hidden by the inconstant face of the ocean. By surf, beaches are built; under its turbulent roar, coasts are destroyed and highlands fall. Into the waters of the sea, wash the soil of misused land and others of the thousand wastes of man.

Houses, cities and factories rise along the shore. A newly christened ship slides silently down the ways. Upon the ocean a ship moves majestically, commerce or pleasure bent. Silent submarines angle slowly to stations below the sea's blue deck. Fishermen bring from the shallows of the Bay an abundant but varying harvest of crabs, clams, oysters and fish. From deeper shelf waters of the Virginian Sea, draggers scoop fish and scallops and other creatures. A sail shimmers over blue-green waters, while on shore recreationists and householders are refreshed or solaced by the sea.

Beaches and marsh, highlands and deeps, bottoms and shallows, fish and fowl, sea and sky all are of great aesthetic and economic value to the Commonwealth. Each year over 7 billions of dollars change hands in Maritime Virginia, much of it due directly to the marine environment, its resources and attractions.
The Newport News Shipbuilding and Dry Dock Company has conducted global exploration of submarine mineral deposits using its own research vessel PROSPECTOR. This is one of Virginia’s largest industry efforts in oceanography.

The early ocean explorer, Captain John Smith—who called that vast shallow area of ocean lying between Capes Cod and Hatteras the Virginian Sea, was among the first Europeans who recognized and publicized the New World’s marine resources. By his voyages, observations and writings, he urged their use. Later Virginians and Virginia-based explorers extended man’s knowledge of and dominion over the seas markedly. Among those who contributed notably are: Lt. John Mercer Brooke, Virginian and early geological oceanographer, and Admiral Richard E. Byrd, scientist and polar explorer. The worldwide scientific expedition led by Lt. Charles Wilkes, which preceded the renowned voyage of HMS CHALLENGER, fitted out and sailed from Hampton Roads in 1838.

Among the earliest proponents of marine research was Virginia’s Matthew Fontaine Maury. Maury, a primary founder of modern physical oceanography, recognized the potential importance of marine science or oceanography to man. Along with many other useful projects, he espoused the utility of properly oriented and conducted marine research. As often happens, the prophecy of Maury was far in advance of its realization. Oceanography in the United States languished from his day (the mid-1800’s) until very recent times. It is only since 1940 that its military importance has been strongly realized. Civilian oceanography did not de-
develop markedly until 1950. It may be safely estimated that 90 per cent of all the activity in marine science has taken place since World War II.

**What Is Oceanography?**

At this point it is well to consider what oceanography is. What is there about oceanography that makes it so important to man?

Oceanography or marine science or oceanology (for they are synonymous as used here) is the study of the oceans and their tributaries and their processes. It is not a basic discipline like physics, biology or chemistry but an interdisciplinary science like geology or meteorology—a science of a large natural system, the oceans.

Scientists interested in phenomena of the marine environment, in the oceans, their shallow seas and tributaries are called oceanographers. Because of the interdisciplinary nature of this field, oceanographers must be able to work in several areas or with specialists from other areas of science. Those interested in biological processes in the sea, or the interrelations between environment and marine life are called biological oceanographers. Marine fishery scientists are specialized biological oceanographers. Chemical oceanographers study the chemicals and the chemical processes in sea water. Geological oceanographers examine the interrelations between sea and sediments and sea and the shores and bottoms. Meteorological oceanographers study interactions between atmosphere and oceans, e.g., the relationships between wind and water. Physical oceanographers study the nature and movements of water masses, tides, currents and waves from the viewpoint of the water, itself. Together, all strive to understand and build a picture of that great mass of salt water that covers 71 per cent of our space ship—Earth. Thus, oceanography is a unified science—unified not because it is a basic discipline but because the sea, itself, is a single huge system of water, bottom, shore, air and marine life which must be considered as a whole.

Oceanographers are assisted and accompanied in their studies and subsequent practical activities by marine or ocean technologists of many types. Many kinds of applied scientists and engineers are involved in marrying scientific facts from oceanographic research with engineering principles to produce techniques to help society live with, use and preserve the resources of the sea.
Man has used the sea. As population and industry grow, distances shrink and communications increase, this dependence will increase. Because of the close relationship between the oceans and man and because of the utility of the bottoms, waters, shores, life and chemicals of the sea, oceanography clearly is closely coupled with society. Hence, basic research and applied research on the phenomena of the oceans will usually be put to use, quickly.

As predicted by Maury and others, the science of oceanography has proven of great use to the country in its development. It will be even more useful in the future. The great growth of activity in the field since World War II has been prompted by belated realization of this fact.

Virginia's Oceanographic Program

In the wake of interest produced by the National Academy of Science-National Research Council Report (by its Committee on Oceanography) entitled, "Oceanography 1960-1970", increasing activity has occurred in all areas of marine science. Many private and public institutions have established new programs or enlarged existing activities in the field. Of late, added stress has been placed on the more applied or practical aspects of marine science and to the need for coordinated efforts in the field.

In this scientific movement toward the sea, Virginia has been a leader. The historical, economic, social and political importance of Maritime Virginia (the 33 tidewater counties which contain 60 percent of the people, three of the largest urban complexes and much of the commerce and industry of the state) has prompted the General Assembly and executive offic-

ers of the Commonwealth to establish a major, state-supported coordinated program of research, service and education in marine science and engineering—the Virginia Institute of Marine Science. Under provisions of Chapter 9, Title 28 of the Code, sometimes called the "Oceanographic Law of Virginia," the duties and responsibilities of the program are as follows:

(a) to conduct studies and investigations of all phases of the seafood and commercial fishing and sport fishing industries;

(b) to consider means by which fisheries resources may be conserved, developed and replenished and to advise the Commission of Fisheries and other agencies and private groups on these matters;
(c) to conduct studies and investigations of problems pertaining to the other segments of the maritime economy;

(d) to conduct studies and investigations of marine pollution in cooperation with the State Water Control Board and the Department of Health and make the resulting data and possible corrective recommendations available to the appropriate agencies.

(e) to conduct hydrographic and biological studies of the Chesapeake Bay and the tributaries thereof and all the tidal waters of the Commonwealth and the contiguous waters of the Atlantic Ocean;

(f) to engage in research in the marine sciences and, with proper affiliation with one or more accredited institutions of higher learning, provide education therein;

(g) to make such special studies and investigations concerning the foregoing as it may be requested to do by the Governor.

The above studies shall include consideration of the seafood and other marine resources including the waters, bottoms, shorelines, tidal wetlands, beaches and all phenomena and problems related to marine waters and the means by which these marine resources might be conserved, developed and replenished.”
Dating to 1940, this charter wisely provides for basic and applied research, technological and engineering developments and for service to the principal users, managers and developers of the state's vast marine resources. It also provides for education in all relevant fields of oceanography and technology. In recent years, a mechanism has been developed to make the laboratories, equipment, ships and other resources of the Institute available to interested scientists and students in other institutions. Conversely, this arrangement provides a mechanism for encouraging others to work on the marine environment and problems of the Commonwealth.

Through VIMS, the General Assembly of Virginia has devoted fairly large amounts of money to oceanography. At this point, the Institute stands among the top ten of all marine institutions (and there are nearly a hundred in the nation) in total size, and among the first three or four in terms of total state-support. It is the largest in percentage of local support. Indications are that among state-supported oceanographic programs, Virginia has the largest on the East Coast (1967 Oceanology Yearbook).

Enlightened and controlled investment in marine science by the Commonwealth has resulted in increasing use of information about VIMS scientific personnel and graduate students working together conducting experiments in the James River Model. Research Assistant Jon Shidler adjusts water sampling apparatus from the model's Brown Shoal area. The James River's normal 13-hour tidal cycle is condensed to 15 minutes in the model, a considerable advantage to research scientists.
the marine environment and its resources in the public and private economic affairs of the Commonwealth. Health, welfare and aesthetics are also being served more actively. Marine scientists and engineers are regularly available for advice and consultation to local and state public management planning and development groups such as the Virginia Division of Industrial Development, the Division of Planning, the Department of Conservation and Economic Development, the Commission of Fisheries, the Water Control Board, the Department of Health, and other executive and legislative bodies. Service to industries of all types, especially to shipping, sport and commercial fishing interests, big water users, and waterfront developers has grown. Virginia's oceanographers also serve as advisors to state and interstate river basin development groups and fishery commissions.

**Education in Oceanography**

Within Virginia, training and educational opportunities in marine science are provided to advanced high school students, high school and college teachers and advanced undergraduates. Graduate courses leading to masters and doctors degrees in Biological Oceanography, General Oceanography and Marine Fisheries Biology are offered by the University of Virginia and the

Copper “roughness strips” are lowered, raised and bent in various directions to make circulation in the model conform with that of the actual James River. Docking, shipbuilding and ship repair and other man-made piers and basins are built to scale in the model. The James River Reserve Fleet was of such significance that it had to be duplicated in the model to verify river flow characteristics. The above view of Hampton Roads, looking seaward as duplicated in the model, is an example.
Scientists interested in the phenomena of the marine environment, in the oceans, their shallow seas and tributaries are called oceanographers. Bob Chew, a VIMS-William and Mary graduate student, does first-hand research on location at sea off the Virginia capes as he prepares to lower a water sampling device from the research vessel. Data collected by these young oceanographers help scientists understand salinity and temperature variations of Continental Shelf waters, and the inter-relations between ocean and Chesapeake Bay.

College of William and Mary in conjunction with the Virginia Institute of Marine Science. A minor in Ocean Engineering is available through the former. Electives and research courses in marine science or related fields also are offered at Virginia Polytechnic Institute and Old Dominion College in Norfolk. The latter anticipates development of oceanography graduate programs later. Several other institutions such as Hampton Institute and University of Richmond also have employed marine scientists to teach.

At this writing, the only oceanography courses leading to graduate degrees are those offered at VIMS through the University of Virginia and the College of William and Mary. Enrollment in these has grown markedly from about 6 in 1957 to 55 in 1967. Recently, many qualified applicants have been rejected due to lack of facilities.

Unfortunately, few Virginians have shown interest in the two educational programs. Of 150 applying in 1967, 18 were Virginians—11 of whom were ineligible. Hence, most of the applicants and successful enrollees to these programs are from elsewhere. This trend should and can be reversed by more emphasis on marine sciences at the pre-college and undergraduate levels. Adult education can focus additional attention on this field.

Activities to this end have been undertaken by VIMS; others should follow suit. Each year sees an increasing interest in marine science in Virginia and it is hoped that state and local public school systems and the community college programs will incorporate oceanography in the appropriate places in their curricula. All pre-college students and undergraduates
The VIMS research fleet includes R. V. LANGLEY, a converted 80-foot ferry, and the R. V. INVESTIGATOR, a 35-foot workboat. The LANGLEY is an excellent and stable floating research platform for work in the Chesapeake Bay and its tributaries. It is also used for shipboard research instruction in the VIMS academic programs and for visiting college groups.

And Virginians will be better prepared for education in the academic and research aspects of professional, post-graduate oceanography and engineering.

Oceanographic Research Facilities and Programs in Virginia

VIMS operates laboratories in two locations, the main one at Gloucester Point on the York and the Eastern Shore unit at Wachapreague. In addition, Virginia has built an hydraulic scale model of the tidal James in cooperation with the Norfolk District Engineer's Office and the Waterways Experiment Station of the U. S. Army Corps of Engineers. This excellent estuarine research and engineering facility is operated jointly by VIMS and the Corps. The new Chesapeake Bay Hydraulic Model to be built by the Corps will further enhance the scientific and practical oceanographic work of...
Virginia's marine scientists and engineers.

The Institute operates a fleet of three medium-sized (55'-90') vessels and a score of small ones.

Several other academic institutions in the state either have individuals or groups of scientists interested in oceanography and marine problems. Included are the School of Engineering and the Departments of Geology and Geography of the University of Virginia; the College of Engineering and the Departments of Geology and Biology and Forestry and Wildlife of Virginia Polytechnic Institute; the Departments of Biology, Chemistry and Geology, of the College of William and Mary; the Department of Biology of the University of Richmond; the Department of Biology at Virginia State College in Petersburg; the Department of Biology of Frederick College; various departments of the Medical College of Virginia, Madison and Longwood Colleges.

Some schools are developing separate facilities and programs in marine science. For example, Hampton Institute has expressed a desire to develop a departmental program and Old Dominion College of Norfolk has recently established an Institute of Oceanography with its own laboratory and boat. It is certain that others will be involved. This selected list of institutions which have persons with marine interests and capabilities is not exhaustive, but does indicate that there is considerable interest and capability in marine science.

Virginia has been a leader in the scientific movement toward the sea. The General Assembly and executive officers of the Commonwealth have established a major, state-supported coordinated program of research, service and education in marine science and engineering . . . the Virginia Institute of Marine Science. VIMS is located at Gloucester Point, on the banks of the York River across from historic Yorktown. A field laboratory at Wachapreague, gives Virginia's marine scientists constant access to seaside marshes, barrier beaches and the Atlantic.
and related activities throughout the academic institutions of the Commonwealth.

Private research institutions and industry have been active in developing programs relevant to the marine environment and its problems. The Virginia Institute of Scientific Research of Richmond has worked on corrosion chemistry. Woodard Research Corporation of Herndon, Virginia, conducts biological studies on a contract basis. Atlantic Research Corporation of Northern Virginia also does contract instrumentation and biomedical and microbiological development work. The two largest industry efforts in oceanography or related fields known to the author have been pursued by the Newport News Shipbuilding and Dry Dock Company, which has conducted global exploration of submarine mineral deposits using its own research vessel PROSPECTOR, and Reynolds International, Inc., whose program to develop and operate the deep submergence vehicle ALUMINAUT is widely known. There are undoubtedly other private and industrial capabilities in Virginia and Maryland. Near Annapolis, the Undersea Division of Westinghouse with its DEEPSTAR series of deep submersibles is another developer of engineering products for oceanography.

Considerable engineering and scientific talent in oceanography and related fields is present in the many federal establishments in the Commonwealth and nearby Washington and Maryland. Among those

The R. V. PATHFINDER, built in 1957 specifically for VIMS research activities, is used on projects in the bay and ocean. It is limited for offshore work by its relatively short length of 55 feet. VIMS scientists have, however, performed regular monthly cruises aboard her along the Continental Shelf from Cape Henlopen to Cape Hatteras, studying offshore distribution of planktonic forms, including fish eggs and larvae, and determining water circulation features of this important oceanic area.
in Virginia are the Naval Weapons laboratory at Dahlgren, and in Norfolk, the Land and Sea Interaction Laboratory (LASIL) and the Atlantic Ship Base, both of the Environmental Science Services Administration (ESSA). In addition, the U. S. Navy Weather Research Facility (Norfolk) and the Langley tow tank facility of the David Taylor Model Basin on the Peninsula are oriented toward marine research. Allied technical capabilities exist at NASA, Langley Field and NASA, Wallops Island. Cooperative research programs are underway or have been conducted between VIMS and both units of ESSA as well as with the Navy Weather Research Facility and NASA, Wallops.

Among the noteworthy non-military research and development projects that have been carried out in Virginia waters by Virginia-based institutions are the following studies (mostly drawn from VIMS' files):

1. Temperature and salinity distribution and circulation of Continental Shelf waters designed to develop better understanding of the factors involved and, if possible, capability of forecasting waves and currents. (The scientific and practical import of this project is obvious since military activities, boating, movement and survival of fishes, beach erosion and many other important features are directly dependent upon circulation of inshore oceanic waters.)

2. Circulation of tidal and estuarine waters of Chesapeake Bay and its tributaries. (Tidal and estuarine waters figure significantly in all maritime affairs. Hence, the significance of this work to industry and public welfare is clear.)

3. Chemistry of estuarine and shelf waters, with emphasis on the effect of man's activities on the natural environment.

4. Fate and role of radioactive particles in marine waters and sediments and organisms (significant because of the increasing use of nuclear energy in ship and electrical power plants).

5. Distribution and fate of pesticides in marine waters and organisms.

6. Primary productivity and over-fertilization of coastal waters.

7. Distribution and abundance of molluscs, crabs and finfishes in relation to natural and man-made factors and to fishing activities.

8. Effects of pollutants on fishery populations.

9. Search for unexploited or underexploited stocks of fishery organisms.

10. Development of techniques for mariculture of oysters, clams, and crabs and other species.

11. Processes involved in beach erosion.

12. Studies of sedimentation in estuarine and coastal waters.


15. Use of airborne and satellite radiometry and microwave photography in oceanographic studies.

These and other activities in the marine sciences and in public and private management of marine resources have begun to provide a research, development and management capability which will be useful in the future development of Virginia. As a result, Virginia is
in the best position that she ever has been to advise, secure or provide services on such practical problems as location of industrial plants; shoreline and water-use proposals; channel, dam and shoreline modification; beach erosion and nourishment; marina location; pollution abatement and avoidance in tidal waters; prediction and improvement of fishery stock; prevention of deterioration of the marine environment and other problems. In developing the various oceanographic capabilities in Virginia, especially those of VIMS, emphasis has been placed on making the results of research available and useful to the state, its industries and people. Obviously, people and industry put greatest demands on marine resources. Therefore, state-supported research should serve both science and the resource users.

The Future

It is clear that Virginia has many valuable marine resources. It is also clear that these resources are extremely useful and that they will be more widely used. As population and industry, both of which are attracted strongly to the marine environment, grow, competition and degradation will follow and the need for more careful management and use of the marine environment and its resources will increase.

In the future, Virginia must be able to 1) resolve conflicting use problems; 2) prevent degradation and destruction of the marine environment; 3) develop the ability to secure more food from the sea by controlled cropping of naturally produced or "wild" populations and by mariculture or "marine farming"—controlled production of marine organisms—first, for molluscs and perhaps algae, and later for crustaceans and finfish; 4) increase sportfishing yields; 5) use converted seawater to drink, process and cool; 6) increase other recreational areas and uses and restore the quality of the marine environment; 7) wisely set aside those areas of marsh, beach and water which must be preserved for all time; and 8) prevent or reduce destruction of life and property.

These demands will call for greater understanding of the processes and phenomena of the ocean and its tributaries and for development of greater technological and engineering capability. These aims will be accomplished if Virginia is able to continue to provide the capabilities of equipment, personnel and shore facilities which will permit improvement of research and engineering and if efforts are concentrated primarily on the phenomena and problems of the coastal and estuarine waters.

These objectives are clearly within the guidelines established by the General Assembly and Virginia and by the President's Advisory Committee and the National Academy of Sciences Committee on Oceanography. Existing programs and most of those planned for Virginia will contribute markedly to the further social and economic development of the Commonwealth as well as to increasing fundamental knowledge of the sea.

Because of these factors of population and industrial growth in Virginia and of the need for more food, water and minerals from the sea, its shores and floor and for wise placement of factory, farm, home and city, it is clear that further development of oceanography, marine technology and engineering by the Commonwealth and by the federal government and industry is warranted and necessary. It will be vital to the future for the General Assembly to continue to provide support and growth funds for the
State's marine science program as it has so wisely in the past. Important also will be increases in the investments of industry, academic institutions and the federal government in oceanography. For the immediate future, severe reductions in federal funds for oceanography appear imminent due to competition with Vietnam, foreign aid, poverty programs and other activities of the national government. However, as these pressures ease, the growth of oceanography and its service to man will undoubtedly rocket because development of ocean resources is vital to the future of the Nation and especially to Virginia.