

12-1-1981

## Virginia Institute of Marine Science Fortieth Annual Report for the Period Ending 30 June 1981

Virginia Institute of Marine Science

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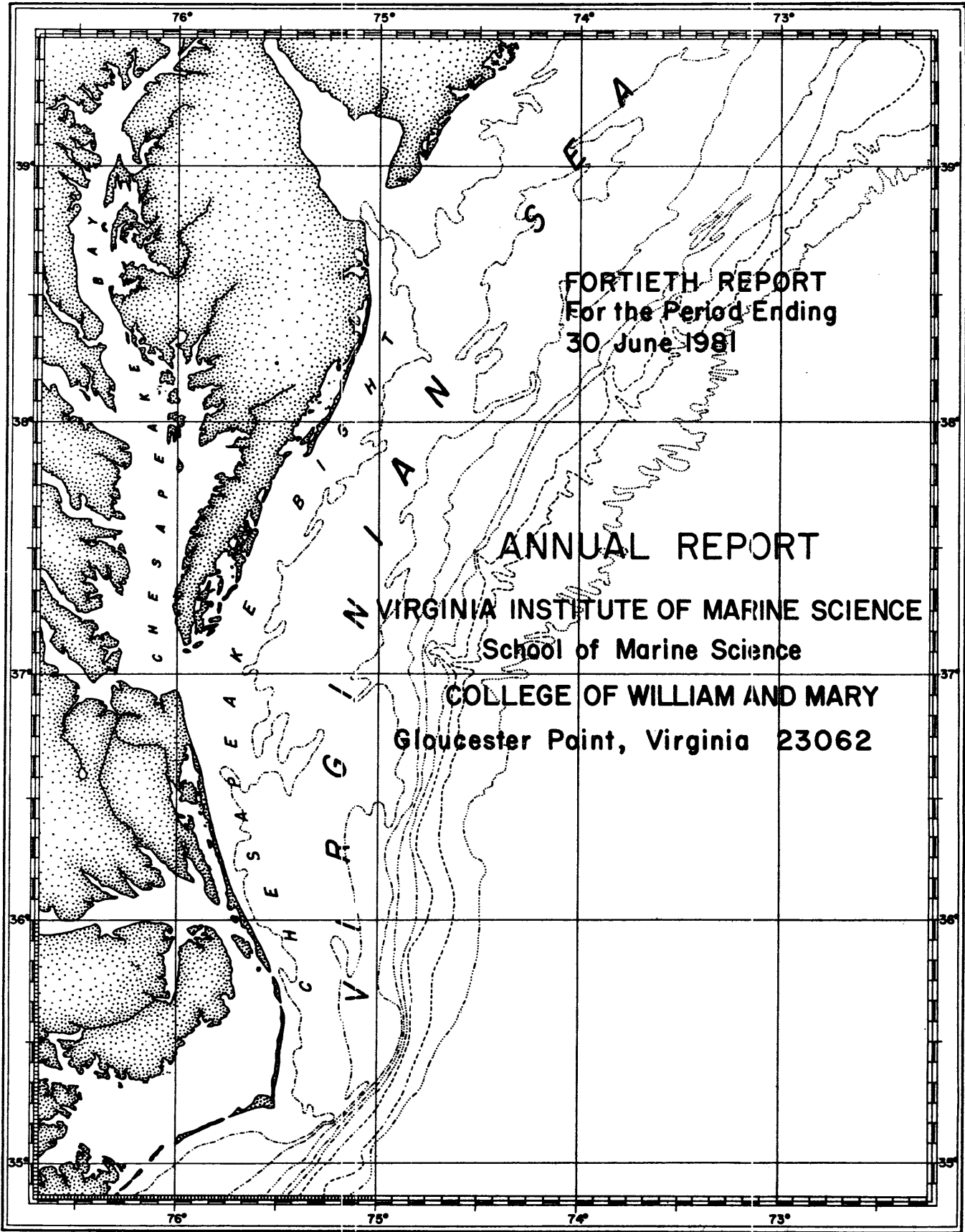
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FORTIETH REPORT  
For the Period Ending  
30 June 1981

ANNUAL REPORT  
VIRGINIA INSTITUTE OF MARINE SCIENCE  
School of Marine Science  
COLLEGE OF WILLIAM AND MARY  
Gloucester Point, Virginia 23062

FORTIETH  
ANNUAL REPORT  
For the Period Ending 30 June 1981

VIRGINIA INSTITUTE OF MARINE SCIENCE

School of Marine Science

COLLEGE OF WILLIAM AND MARY

Gloucester Point, Virginia 23062



CHARTERED 1693

THE COLLEGE OF WILLIAM AND MARY IN VIRGINIA

OFFICE OF THE PRESIDENT

WILLIAMSBURG, VIRGINIA 23185

November 30, 1981

The Honorable John N. Dalton  
Governor of Virginia  
State Capitol  
Richmond, Virginia 23219

Dear Governor Dalton:

I am pleased to submit to you the Fortieth Annual Report of the Virginia Institute of Marine Science, for the year ending June 30, 1981.

The fiscal year covered by this report is the second year of our stewardship of the Institute. The financial problems that came to us with the Institute are under firm control, and we have made our first payment towards reducing the deficit which we inherited.

While much effort has been expended on fiscal and administrative matters, the Institute has not neglected the research, advisory and education programs which have brought it national prominence.

The support of your administration continues to be an important element in our achievements, and is deeply appreciated.

Sincerely,

Thomas A. Graves, Jr.  
President

TAG:sw

Enclosure

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COLLEGE OF WILLIAM AND MARY

BOARD OF VISITORS

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Mr. T. C. Clarke . . . . . Vice Rector  
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George R. Healy . . . . . Vice President for  
Academic Affairs  
William J. Carter . . . . . Vice President for  
Business Affairs  
Duane A. Dittman . . . . . Vice President for  
University Advancement

VIRGINIA INSTITUTE OF MARINE SCIENCE  
School of Marine Science  
1980-81

Administration

William J. Hargis, Jr. . . . . Director of VIMS and  
Dean of the School  
of Marine Science  
Paul V. Koehly . . . . . Acting Associate  
Director for  
Financial Affairs  
and Administration  
Herbert M. Austin . . . . . Assistant Director  
and Head of Division  
of Fisheries Science  
and Services



Michael E. Bender . . . . .	Assistant Director and Head of Division of Environmental Science, Services and Engineering
Michael Castagna . . . . .	Assistant Director and Head of Division of the Eastern Shore
Maurice P. Lynch . . . . .	Assistant Director and Head of Division of Special Programs
Frank O. Perkins . . . . .	Assistant Director and Head of Division of Biological Oceanography
John M. Zeigler . . . . .	Assistant Director and Head of Division of Physical Science and Ocean Engineering

ADVISORY COMMITTEE

Mr. Morris H. Fine, Chairman

Mr. Harvey L. Bowen  
Mr. Carl P. Croasdale  
Mr. John M. DeMaria  
Mr. Frederick S. Gore

Mr. Felton S. Graham  
Rev. T. Wright Morris  
Mr. William P. St. Lawrence  
Mr. James E. Douglas, Jr.

## EXECUTIVE SUMMARY

Fiscal year 1980--81, the period of this report, was the second complete year for the Virginia Institute of Marine Science/School of Marine Science under the leadership of the College of William and Mary. Improvements, particularly in the realm of financial management, continued to be made to the administration of the Institute with the guidance and assistance of the College.

One of the most notable accomplishments of the Administrative Group was the placement of the Institute on an equal basis with other institutions of higher education with respect to indirect cost. VIMS is now permitted to retain 70% of all indirect cost recoveries for discretionary use. This is of immediate financial assistance, even though 50% of indirect cost recoveries are scheduled in the future to go towards the reduction of the deficit loan.

During the period of this report, severe reductions were made in Vessel Operations. Personnel were reduced from a high of 55 to five full-time and one part-time person. These extreme reductions were made possible by the disposal by sale or otherwise of several large, medium, and small vessels.

A great savings was also realized by changing to a much more capable computer at a lower cost. About \$20,000 per year was saved by this method.

The Business Office was reorganized during the period of this report, with an overall reduction of 10 persons. Other actions included:

- Hiring a Property Administrator.
- Automation of the accounting functions.
- The preparation of written guidance instructions for Business Office functions.

Although administrative procedures have been greatly improved, much remains to be done.

Academic programs of the School of Marine Science continued to produce highly employable, pragmatic marine scientists. During academic year 1980-1981, which falls entirely within the period of this report, 61 courses were offered by the faculty of the school. There were 17 Master of Science and seven Doctor of Philosophy degrees in Marine Science conferred. The excellence of the nationwide reputation of the School of Marine Science is attested to by the application of 169 potential students for graduate study, of whom 17 were enrolled. On 30 June 1981, there were 131 graduate level students enrolled at the School of Marine Science.

During the period of this report, the Virginia Institute of Marine Science continued the research, advisory and education (K through 12) programs and activities upon which its national reputation for excellence is founded and which are the activities mandated to the Institute by the Code of the Commonwealth. Support

for this work is derived not only from the General Fund of the Commonwealth, but also from the grants and contracts for such work won by the scientists of the Institute in open competition with other organizations.

The Scientific Group of the Institute is divided into six divisions, which are further divided into departments and, in some cases, into sections according to the specialized scientific needs of the particular division. These divisions, departments, and sections vary in size. The scientific staff of the Institute also provides the faculty of the School of Marine Science, permitting a far wider range of teaching disciplines than would be possible if the staff were maintained for instruction alone. The scientific divisions are as follows:

- Fisheries Science and Services
- Environmental Science, Services and Engineering
- Biological Oceanography
- Physical Science and Ocean Engineering
- Special Programs, and
- The Eastern Shore Laboratory at Wachapreague

The Scientific Group is supported in its endeavors by the Administrative Group, headed by the Associate Director for Financial Affairs and Administration.

During the period of this report, the Scientific Group was involved in some hundreds of projects, both internally and externally funded. Some of the more interesting were:

- A predictive model for croaker (Micropogonias undulatus) based upon winter temperature extremes.
- A monitoring program for the abundance and distribution of juvenile striped bass.
- Studies of both recreational and commercial shark fisheries.
- A study of the effects of the skin of sharks on their swimming efficiency.
- Assessment of eel pot catch efficiency.
- A study of the biology of and recreational fishery for the spotted sea trout (Cynoscion nebulosus).
- Studies of sea turtles in Virginia waters.
- A continuing assessment of the relationship between blue crabs (Callinectes sapidus) and climate.
- Studies of deep-sea red crabs (Geryon quinquedius) which supports a growing Virginia fishery.
- The impacts of an oil refinery on biological communities of the York River.
- Resource evaluation to determine the value of the Bay's major bottom habitats (mud, sand, seagrass beds, shallow and deep channels) to commercial fisheries species.
- A means for highway planners to evaluate the value of tidal non-vegetated wetlands.
- The ongoing development of a comprehensive plan for the management of the dredged material that would result from the dredging of Bay channels from 45 to 50 feet (13.7 to 15.2 m).

- A study of the effect that benthic infauna (invertebrates living in the bottom sediment) have on the distribution of toxic chemicals.
- Continuing research on the development of disease-resistant oysters.
- A study of artificial diets for oyster larvae.
- Studies of naturally-occurring bacteria from the Middle Atlantic Outer Continental Shelf that degrade petroleum.
- A paper describing the life cycle of a parasite that causes heavy mortalities in the summer flounder (Paralichtys dentatus).
- A continuing program to assess the impact of marinas on the bacteriological quality of surrounding waters to aid in the assessment of the usefulness of the fecal coliform buffer zone.
- The feasibility of oyster mariculture based on brewery wastes.
- A study of the response of marsh microbiota to petroleum.
- A survey of the striped bass spawning grounds in Virginia waters.
- An assessment of the effects of starvation on larval striped bass populations.
- Monitoring of the decreasing levels of Kepone in the James River.
- A program to determine the distribution and abundance of toxic organic chemicals in the Bay.
- Ecological studies of two power plants in Virginia and in Maryland respectively.

- The effects of industrial effluents on estuarine algae.
- A series of studies involving submerged aquatic vegetation (SAV).
- A long-term study of the ecological changes resulting from the dredging of a navigational access to Cabin Point Creek.
- An assessment of the ecological relevancy of time-of-the-year restrictions on dredging in Hampton Roads and the Elizabeth River.
- A continuing program to develop mathematical water quality models of all major and small coastal estuaries in Virginia for the State Water Control Board.
- A comprehensive study to design a mathematical model of Chesapeake Bay for the Environmental Protection Agency (EPA).
- A comparison of satellite data with predictions of our previously-developed Virginian Sea Wave Climate Model.
- Investigations into non-point-source water pollution.
- The development of low-cost beach erosion techniques.
- An assessment of the subaqueous sand resources of southern Chesapeake Bay.
- A study of trace metals in the suspended sediments and fluid mud of Chesapeake Bay.
- A satellite study of Chesapeake Bay discharge plume dynamics.
- A project to map the sensitivity of selected coastal areas to spilled oil.
- An assessment of swan damage to shallow water oyster beds in the Potomac River.

- The coordination of the shipment of Virginia seafood samples to New Orleans, Japan and the Netherlands.
- Participation in the U.S. Department of Agriculture (USDA) Food Show in Cairo, Egypt, representing Virginia seafood.
- An assessment of the market for hard clams (Mercenaria mercenaria).
- A study of the feasibility of the application of sail power to commercial fishing vessels.

These projects and many others are described in detail in the pages of the full report.



## VIRGINIA INSTITUTE OF MARINE SCIENCE/SCHOOL OF MARINE SCIENCE

### History

The Virginia Fisheries Laboratory (VFL), predecessor to the Virginia Institute of Marine Science (VIMS), was established in 1940, under the control of the College of William and Mary, funded jointly by the College and the Virginia Fisheries Commission. Education was carried out as part of the Department of Biology. In 1944, the VFL was "established and continued." In 1948, the laboratory was directed to conduct hydrographic and biological studies of the Chesapeake Bay and tributaries and all the tidal waters of the Commonwealth. A separate Department of Marine Science was established in the School of Arts and Sciences at William and Mary in 1959, with degrees being granted in Marine Science. In 1962, VIMS was established with a separate Board of Administration, and most of our current responsibilities were mandated in Title 28, Chapter 9, at that time. A small program in marine science was established with the University of Virginia, but it remained small and was gradually phased out by the Council of Higher Education. In 1972, the legislature assigned specific responsibilities for wetlands to VIMS. In 1979, the Institute was assigned as part of the College of William and Mary, along with its mandated responsibilities. The Board of Administration was dissolved. In 1980, specific responsibilities were added in the area of coastal erosion.

## Organization

The Virginia Institute of Marine Science (VIMS) is assigned as part of the College of William and Mary, and reports directly to the President of the College. The Institute also is the School of Marine Science (SMS) of the College, with most professional scientists of the Institute serving as faculty of the School.

The Institute is divided into two major groups, Administrative and Scientific, both reporting to the Dean/Director of VIMS/SMS. The Administrative group, headed by the Associate Director for Financial Affairs and Administration, is divided into five major departments.

They are:

Plant Development and Building Management

Aircraft

Business Office

Art, Drafting, Photo and Reproduction

Vessel Operations

Their titles are self-explanatory.

The Scientific group is divided into five major divisions, plus the Eastern Shore Laboratory at Wachapreague, each of which is headed by an assistant director. They are:

Biological Oceanography

Physical Science and Ocean Engineering

Environmental Science, Services and Engineering

## Fisheries Science and Services

### Special Programs

#### The Eastern Shore Laboratory (Wachapreague)

The divisions are further divided into departments and, in some cases, into sections. Divisions, departments and sections vary in size, according to their specialized needs.

The faculty of SMS is divided for the purposes of education into sub-faculties according to traditional academic disciplines. The sub-faculties are:

Biological Oceanography

Geology

Physical Oceanography

Marine Affairs

Fisheries

Chemistry

The faculty governs itself according to by-laws approved by the Board of Visitors of the College of William and Mary.

### Facilities

The principal laboratory and campus is located on about sixty acres at Gloucester Point on the York River, an important estuarine tributary of lower Chesapeake Bay not far from where the Bay mixes into the Atlantic Ocean. The Institute and School is admirably situated for research and teaching in marine and estuarine biology, chemistry, geology and physical oceanography and engineering. The

campus of the Eastern Shore Laboratory at Wachapreague provides access to the embayments, salt marshes, barrier beaches and coastal waters of Virginia's Eastern Shore. General research and mariculture laboratories are found there, as well as classroom and dormitory space.

An extensive complement of scientific equipment is available for research and academic purposes at VIMS. Included are a mass spectrometer, scanning and transmission electron microscopes, a sophisticated electronic computing center, a hydraulic flume, a Vibracorer system, and a ripple tank. A fleet of vessels supports both research and instruction and a DeHavilland Beaver aircraft is used for research and transport. The Marine Science Library contains some 28,000 volumes and 1500 serial titles. A hydraulic model of the James River, located at Vicksburg, Mississippi, and maintained under a cooperative arrangement with the U.S. Army Corps of Engineers, is available for research by qualified students as well as the scientists of the Institute.

## ACTIVITIES OF THE ADMINISTRATIVE GROUP

Fiscal year 1980-81 was the first year that indirect cost recoveries at the Institute were funded in accordance with the Appropriations Act. VIMS was permitted to retain 70% of all indirect cost recoveries for discretionary spending purposes in support of the research program. Although fifty percent (50%) of the indirect cost recoveries in the future are to go toward repayment of the deficit loan, VIMS benefited immediately as a result of this act. The fact that VIMS was placed on an equal basis with other universities and institutions of higher education with respect to indirect cost was a significant achievement brought about by the hard work of the Administration of the College of William and Mary and the Board of Visitors.

Based on the provisions of Section 4-4.03, Chapter 760 of the 1980-82 Appropriations Act, an additional \$1.8 million was appropriated to VIMS in general funds for the cost of Administrative and Support Services.

The very significant cost reductions occurred in Vessel Operations. The number of personnel was reduced from a high of about 55 to five full-time and one part-time personnel. The Virginian Sea, which was an underutilized and costly vessel, was returned to the Navy in March 1981; the Langley and several smaller craft were disposed of through surplus and one major item of vessel equipment was returned to

the vendor for a \$20,000 expenditure refund. This curtailed the major cash drain on the Institute.

Other savings were realized by changing computer systems. Net savings of about \$20,000 per year were realized, but perhaps of more importance was the increased processing capability obtained. The acquisition of the Prime 750 computer, and its benefits, are described under the Division of Special Programs in the Activities of the Virginia Institute of Marine Science.

The Business Office was reorganized. All personnel positions were reclassified based on the jobs being performed and new positions were established to accomplish functions that were necessary, but not being performed. Overall, there was a reduction of about 10 personnel. Some actions taken include:

- A Property Administrator was hired to establish a moveable property inventory and management system to assure control over and economical use of property. Federal auditors have previously disallowed 50% of the costs in this area because of lack of such control. In addition to improving our accounting posture, we anticipate that all scientists will benefit from knowing what property is available for their use, and where it is located.
- The accounting function was changed from a manually maintained general ledger to the automated system at William and Mary. Although the system is being improved continually, it has

provided administrators and scientists with reasonably accurate and up-to-date cost information for the first time in VIMS' history. Some of the direct benefits include improved cash flow, more timely billings, control over potential cost overruns and improved utilization of organization resources.

- The writing of instructions was initiated for all Business Office functions. This included drafting a manual by Sponsored Research Administration for the guidance of scientific personnel who prepare proposals for grants or contracts, and instructions for each of the areas of Central Supply operations, purchasing and travel.

Although all of the major reorganization plans were implemented during the year, improvement is still needed to achieve a more sophisticated level of operations; this process will continue.

## ACTIVITIES OF THE SCHOOL OF MARINE SCIENCE

The program of the School of Marine Science is primarily intended for the student who wishes to study Marine Science, or Oceanography, at the graduate level. The degrees offered are the Master of Arts and Doctor of Philosophy in Marine Science. Majors in Biological Oceanography (Marine Biology), General Oceanography (Physical, Chemical or Geological areas), Fisheries Oceanography (Marine Fisheries Science), and Marine Affairs are available at both levels. Within these general areas, study of several specialities may be undertaken. As examples, students may specialize in Marine Pollution Biology, Wetlands Ecology, or Benthic Ecology, among others.

Though the courses offered by the School are primarily for graduate students, advanced undergraduates (juniors and seniors) may participate in enrichment courses offered at the undergraduate level. Biology, Geology, Chemistry and Physics majors may enroll in suitable 500 level courses; similarly, they may work on a marine problem in their field of specialization. Consent of the Chairman of the student's major department is required to take problems courses in Marine Science.

As in most marine institutions, activities are accelerated during the summer. Qualified undergraduate students may take advanced training in Invertebrate Ecology, Physiology, and other subjects as scheduled. Additional faculty members are often added to the research and teaching staff at this time. In addition to the regular academic



courses offered, special summer research courses in Marine Science may be arranged.

Because the entire program is marine-oriented and the faculty is heavily engaged in research as well as teaching, students have an unusual opportunity to become intimately familiar with the field. This advantage is increased by the fact that the student's entire training program is carried out on the seacoast. Time is not lost in traveling from an inland campus to the sea and the sea itself is a constant classroom companion.

Approved marine science courses are offered at the main campus of the College of Williamsburg, but most are conducted on the campus of the School of Marine Science and the Virginia Institute of Marine Science at Gloucester Point. Accordingly, students commuting between campuses must schedule classes so as to allow time between them. Usually thirty minutes are required to make the passage.

#### Academic Year 1979-1980

Sixty courses were offered for curricula of School of Marine Science graduate students during the 1979-1980 school year. Sessions commenced July 23, 1979 (Second Term of Summer Session), August 30, 1979 (Fall Semester), January 14, 1980 (Second Semester), and June 2, 1980 (First Term of Summer Session).

Master of Arts in Marine Science degrees were conferred upon 19 students, while eight received Doctor of Philosophy in Marine Science degrees. There were 245 applications for graduate study during the

year, resulting in 17 new enrollees. A total of 131 student scientists were enrolled in the School on June 30, 1981.

## ACTIVITIES OF THE VIRGINIA INSTITUTE OF MARINE SCIENCE

The research, advisory and education (K-12) efforts of the Virginia Institute of Marine Science (VIMS) are inextricably entwined with the School of Marine Science. VIMS furnishes the faculty for the School from among its professionals. Funds raised by research activities support scientists, providing a far broader range of disciplines and expertise than could be justified on the basis of instruction alone. Further, graduate students in the School of Marine Science work on actual scientific projects under the tutelage of experienced professionals, developing and broadening their knowledge while receiving financial support from the project on which they are working. Often, too, the student becomes interested in some phase of the project, and the work forms part of the research required for a thesis or dissertation.

The Institute, through its advisory services and research, addresses the mandates assigned to it by the Code of the Commonwealth in Section 28.1-195 and elsewhere. Support for the work required by these mandates is derived from the general fund of the Commonwealth and the grants and contracts won by the scientists of the Institute in open competition with other organizations.

A discussion of these activities in some detail is given below, arranged under the scientific divisions that performed the work.

Appendix A lists all sponsored (externally funded) research conducted during the period of this report, together with the source of the funds and the amount of monies involved.

## DIRECTOR'S STAFF

There are two sub-units which, because of their unusual nature, have been carried as part of the Director's Staff, reporting directly to him. These are the Marine Environment and Resources Research and Management System (MERRMS) and the Office of Ocean and Coastal Law. Shortly before the end of this reporting period, these units were transferred to the Division of Special Programs. Their activities are discussed in the following paragraphs.

### Marine Environment and Resources Research and Management System (MERRMS)

The Marine Environment and Resources Research and Management System (MERRMS) is a unique information storage and retrieval system which was designed to assist and improve the transfer of raw and interpreted scientific data and information between managers and scientists and among the scientific disciplines. It serves as a point source of information within the Institute and provides an interpretive interface among scientists, managers and the general public. The system is continually updated and therefore grows constantly.

During this report period, information relative to the coastal and estuarine environments was received, interpreted and stored in a manner which facilitates rapid access. This is achieved through the use of such modern data handling techniques as microforms, random access slide displays and computer searches. The MERRMS document files, stored on standard 4" x 6" microfiche, are computer-retrievable

via author or subject as well as through keyword descriptors which are assigned to each entry.

By 1981, MERRMS holdings had grown to more than 10,000 publications, making it the most comprehensive information center of its type in the Chesapeake Bay region. These holdings include all VIMS publications and additional documents ranging from copies of hardcover books and technical publications to such "gray" literature entries as grant and contract reports, informal progress reports on research projects and newspaper clippings. Utilization of microfiche allows MERRMS to store publications not suitable for storage in a standard library format. Entries are selected primarily for relevance to the coastal zone, with an emphasis upon the area encompassed by the waters of the Commonwealth, including the western Atlantic and the Chesapeake Bay and its tributaries.

In an attempt to enhance the mechanisms through which scientific information is disseminated to the general public and regional planners, MERRMS provides local Planning District Commissions and other interested parties with periodic lists of MERRMS acquisitions and pertinent publications are provided to local planners free of charge. Through this program, local governmental officials are able to obtain a great deal of technical background material to which they might not otherwise have access.

Throughout this report period, MERRMS provided informational support and services to a variety of users including state and federal governmental agencies, educational institutions, consulting firms and

the general public. MERRMS provided microfilming services to numerous users within the VIMS community, including the Chesapeake Bay Bibliography, the National Aquaculture Information System and the Marine Education Materials System as well as general office records. The informational resources of MERRMS were utilized in a number of major Institute-wide interdisciplinary research projects.

The addition of the new terminal-oriented computer system at VIMS has significantly enhanced the accessibility of the MERRMS holdings. MERRMS has also been very active in several discussions and proposals concerning the feasibility of establishing a comprehensive Bay-wide information network. It is anticipated that MERRMS will be a focal point of this Chesapeake Bay Information Network should the project be implemented.

In June 1981, MERRMS was made part of the Division of Special Programs.

#### Department of Ocean and Coastal Law

The Department of Ocean and Coastal Law functioned in three roles--educational, research, and advisory service.

Since 1975, under funding from Sea Grant, the Department has carried out a cooperative, interdisciplinary educational program with the Marshall-Wythe School of Law of the College of William and Mary. The goal has been to produce scientists with a comprehension of law and institutions, and lawyers with an awareness of the natural environment and the nature of science. An average of one or two

classes each semester, including summer sessions, were offered to School of Marine Science and Law School students. An internship program among VIMS, the Marshall-Wythe School of Law and the Virginia Marine Resources Commission offered students a chance to work on "real world" problems to the benefit of both the Commission and the students. Over the years a number of symposia, publications, grants and employment opportunities as well as numerous courses were the fruits of this cooperation.

There were 23 students identified with the Marine Affairs Educational Program at both the masters and Ph.D. levels. This represented 21% of the VIMS student body. These students were employed throughout the Institute. A total of fourteen subfaculty and associate subfaculty members were affiliated with the program. Graduates from the Marine Affairs Program were demonstrated to be eminently employable.

The Department was normally involved in a number of major contracted research projects, and continuously solicited external support for proposed research projects. For example, the Department was under contract with the Senate False Cape Subcommittee of the General Assembly investigating the problem of public access to shoreline areas in Virginia. The Department is also in the process of carrying out an investigation regarding dredge spoil disposal and artificial islands.

The Department of Ocean and Coastal Law responded to a great diversity of requests for information at a rate of over ten per month.

Each of these normally require a great deal of literature research as well as research into case, statutory and regulatory law. Many requests were related to proposal writing and research activities of other departments of the Institute.

Furthermore, the Department was involved in a number of advisory roles--most notably the Federal Register Service, an information service summarizing such documents as the Federal Register, Environmental Law Reporter, Pollution Control Guide, etc. This Service had a circulation of approximately 100, both in and out of house. It was both a means of providing important current information and of maintaining a competitive edge in grant seeking and research activities.

The majority of the Department's functions required a working understanding of both science and law; the Department maintained a research specialist and three graduate students especially trained in this field. We also had in our employ a junior scientist currently on a special internship with the National Advisory Committee on Oceans and Atmosphere (NACOA).

In June of 1981, the Department of Ocean and Coastal Law was made part of the Division of Special Programs.



## DIVISION OF FISHERIES SCIENCE AND SERVICES

The focus of VIMS' fisheries research is to advance the state of knowledge of the relationships between basic oceanic processes and the abundance and availability, distribution, recruitment and mortality of fish, shellfish, and crustaceans in the Virginia waters of the Chesapeake Bay, its tributaries and the waters of the Virginian Sea. Improvement of our understanding of these relationships will permit more accurate stock distribution and abundance forecasts. Data and information are also provided to state, regional, national and international regulatory and management agencies including the Virginia Marine Resources Commission (VMRC), the Potomac River Fisheries Commission (PRFC), the Atlantic States Marine Fisheries Commission (ASMFC), the Middle Atlantic Fisheries Management Council (MAFMC), the Food and Agriculture Organization (FAO) of the United Nations and others.

During the period of this report, research in the Division Office focused on long term environmental variations and their impact on yearly fluctuations in abundance and distribution of coastal living marine resources, and the distribution of marine mammals.

Funding from the National Marine Fisheries Service (NMFS) supplemented state funds for the climate and fisheries research, and provided all funding for the marine mammal research. The climate-fisheries studies have produced a predictive computer model for the Atlantic croaker (Microponias undulatus) based upon winter temperature extremes. Current research includes extending the

croaker-climate studies to include an examination of the continental shelf environment during spawning and subsequent transport into the Bay.

Information was developed on the distribution and abundance of the bottlenose dolphin (Tursiops truncatus) off the Virginia Capes for the summers of 1980 and 1981, and information was collected cooperatively with the U.S. National Museum on strandings of all marine mammals from Chincoteague to Cape Hatteras.

#### Ichthyology Department

The Department's long-term seasonal trawl surveys in the lower Bay and major tributaries were continued during the period of this report. Efficiency has been improved by combining trips with the crab survey cruises where possible. These data are used to define and monitor fish communities within the estuaries and to identify and delineate nursery grounds. They form the basis for predictions and forecast models of year-class abundance of important species. Several Master's Theses and Ph.D. dissertations continue to utilize these data as well. A major effort was initiated during 1980 to automate the trawl survey data holdings making them more available to VIMS scientists and outside users working on population dynamics, stock trends, and effects of climate variations, and to improve the timeliness and accessibility of the year-class predictions.

The unprecedented drought of 1980-81 was monitored by Institute scientists using data from the juvenile fish surveys. Species not

normally collected were taken from Virginia's rivers, and species normally taken were found far upriver of their normal range due to increased salinities caused by the lack of freshwater inflow.

Departmental personnel, in cooperation with associate faculty member Dr. Weinstein from Virginia Commonwealth University, continued studies of the community structure and function of fishes in the Bay's eel grass beds and tidal creeks. Areas addressed include the processes of recruitment and emigration from fish nursery areas, the relative benefits of different nursery habitats from the trophic and refuge standpoints, the effects of major predators which may frequent these habitats, biomass estimates of the components of the fish community, the sources of the production consumed by the fish populations, and ultimately, the levels of secondary production by the fishes.

VIMS' long-term studies on the Commonwealth's valuable anadromous (marine species that spawn in freshwater) fish stocks continued, supported by the National Marine Fisheries Service (NMFS) under Public Law 89-304. Catch effort statistics for the alosine (herring-like) fisheries were collected for the James, York, Rappahannock and Potomac rivers. Virginia river herring landings of 630 metric tons (694 tons), 965 MT (1064 tons), 766 MT (844 tons) and 537 MT (592 tons) in the years 1977-1980 were the lowest recorded over the last 15 years. These extremely low landings are a continuation of a decline that began in 1970. The decline is attributed to heavy exploitation of

river herring in the late 1960's and early 1970's by foreign fleets and recurring poor recruitment in the last decade.

VIMS scientists, after analyzing the alosine fishery, recommended that the federal-state Regional Fishery Management Councils work with the U.S. Secretary of Commerce to reduce the foreign fleet's offshore river herring by-catch allocation to 100 MT (110 t) or less beginning in 1981. They also recommended that a contingency management plan for river herring be formulated by the Virginia Marine Resources Commission (VMRC) that would provide for increased escapement from the fishery until the advent of strong recruitment. These data were presented, and were partially responsible for the decision by the Atlantic States Marine Fisheries Commission (ASMFC) to initiate an interstate fisheries management plan for shad and river herring during 1982.

Additional research included a study of the utilization of Pohick and Dogue creeks in Fairfax County by anadromous fishes. Both creeks were confirmed as Alosa spawning grounds in the late 1960's. The U.S. Department of Agriculture (USDA) Soil Conservation Service is progressing with plans to construct an impoundment on Pohick Creek and on South Run, a tributary to that creek, above the site of the past spawning ground confirmation. Thus, a new study was warranted. Dogue Creek, presently known to be a spawning site for alewives, was included for comparative purposes.

The results of this investigation indicate that environmental conditions in Pohick Creek have been altered since the last survey.

Supporting evidence for this conclusion is: (1) the failure to detect alewives in Pohick Creek in extensive gill net sets or by visual observation, while alewives were present in Dogue Creek; (2) avoidance of Pohick Creek by dip netters; (3) the failure to catch any species of fish in Pohick Creek, while resident species were present in Dogue Creek; and (4) the extremely high levels of total chlorine residuals in Pohick Creek.

The suspected cause for the apparent absence of ichthyofauna in the surveyed area of Pohick Creek is the high chlorine levels in the sewage plant outfall. Total chlorine residuals in the creek ranged from 1 to 2 milligrams per liter (mg/l). These findings were similar to monthly mean values for chlorine measured in the treated effluent before release, and suggests that the water in the creek consists predominantly of the treated sewage effluent.

Based on visual evaluations of the physical and hydrological features of Pohick Creek and South Run, it was concluded that impoundments on Pohick Creek and South Run would reduce the availability of spawning grounds, but to what extent is unknown. If the chlorine problem is rectified, upstream passage facilities for anadromous fishes should be included in impoundment construction. The construction of passage facilities would not be warranted if high chlorine levels in Pohick Creek persist and are acceptable (in a regulatory sense) to a degree that is toxic to early life stages of Alosa or results in stream avoidance.

The recent decline (1973-1980) in the striped bass (Morone saxatilis) or rockfish stocks along the east coast prompted Congress to pass the Chafee Emergency Striped Bass Amendment to the Anadromous Fish Act. VIMS fisheries scientists are federally funded through 1982 to develop a monitoring program for the abundance and distribution of young of the year bass in Virginia's rivers. Initial efforts during 1980 focused on the York, Rappahannock, and James rivers and preliminary results suggest that all rivers support spawning but at levels well below those of the 1960-1970's. Preliminary results for 1981 suggest that these low stock levels continue.

During the summer of 1980, a juvenile striped bass seining program was initiated to assess the relative abundance of young-of-the-year striped bass in three Virginia rivers. Specific objectives of the program are to:

- Measure the 1980 relative abundance of zero age-class striped bass in the James, York and Rappahannock rivers.
- Identify relationships between the abundance of juvenile striped bass, cohabitant species and environmental conditions at the time of collection.
- Develop a striped bass data retrieval and forecasting system.
- Standardize beach seining techniques.

Field sampling was conducted triweekly from July 1 through October 24, 1980. Thirty fixed sampling stations were sampled by beach seine in each of five sampling periods and corresponded (with

few exceptions) to stations that were sampled during the 1967-1974 VIMS striped bass seine survey.

All specimens collected were identified to species and enumerated. All striped bass were measured to the nearest millimeter (mm) fork and total length and were released on site. Up to 25 specimens of each additional (non-target) species were measured to the nearest mm fork length (FL). Prior to each sampling, spatial, temporal, and physiocochemical data were also recorded.

A total of 322 juvenile striped bass were collected during the 1980 field program. The overall mean catch per unit of effort (CPUE, catch per seine sweep) was 1.82 fish and ranged from a high of 3.77 in early July to a low of 1.1 in mid-September. The Rappahannock River had the lowest mean CPUE of the three river systems; the York River system (York, Mattaponi and Pamunkey rivers) had an intermediate CPUE; and the James River system (James and Chickahominy rivers) had the highest.

Catch data for 1980 were compared to data from 1968, 1970 and 1972 (intermediate, strong, and poor year classes, respectively). Overall, the relative abundance of striped bass in 1980 was somewhat higher than the poor 1972 year class, but was much less than the strong 1970 year class. 1980 catches in the York and Rappahannock rivers were lower than in 1968, 1970 and 1972. The James, Mattaponi and Pamunkey rivers had a higher CPUE in 1980 than in 1972. Of all rivers included in the comparison, the James River appears to have made the best recovery from the 1972 low point.

No striped bass less than 30 mm (1.8 inch) FL were collected. The dominant size class overall was 50-59 mm (2.0-2.3 in.) FL, and the majority of fish were from 40 to 80 mm (1.6-3.1 in.) FL. No obvious differences in the size distribution of juveniles were observed among the rivers sampled. Since samples from month to month were not equally spaced and were not taken in a short time period, i.e. a few days, accurate estimates of monthly growth increments cannot be made from these data. However, examination of the modal size class progression from month to month suggests an "order of magnitude" estimate of about 10 to 15 mm (.4 to .6 in.) growth per month.

A stepwise multiple regression analysis of catch data was performed to identify the major factors affecting the relative abundance of juvenile striped bass. Salinity, wind direction, wind velocity and a dummy variable for the James River system (James and Chickahominy rivers) were the only independent variables found to explain a significant portion of the variation in abundance. The equation predicts a higher abundance of juveniles at lower salinities, with all else held constant. Winds from the west and northwest of low velocity produced a higher abundance than those from other quadrants or of a higher velocity. The dummy variable for the James River drainage was positively related to abundance. Thus, a significantly greater abundance was found in this river system than in the other two systems, after removing the effects of other independent variables in the equation.



Within the range of values observed, water temperature, dissolved oxygen, cloud cover and tide stage did not explain a significant portion of the variation in juvenile abundance. Likewise, after removing the effects of the significant independent variables, no significant differences in abundance were found between fishing gears or sampling months.

Studies supported by Sea Grant on the potential for both recreational and commercial shark fisheries continued. During the period of this report, indications were very encouraging with regard to the development of both. Reported landings of spiny dogfish (Squalus acanthias), presently the major target species of the commercial fishery, tripled those of the previous year and were over eight times higher than in any other recent year at 290,753 kg (641,000 lbs). Landings of other species, although still small at 11,340 kg (25,000 lbs), were more than double those of the previous year and five times that of any other recent year. The sport fishery appears to be enjoying similar expansion; the number of entrants in local shark tournaments was up approximately 50% and tackle store owners have reported sharp increases in shark-related sales. Progress towards the goals of the project have thus far been very satisfactory. Field sampling efforts have been highly successful and have largely exceeded expectations. Approximately 1,500 spiny dogfish have been collected to date from National Marine Fisheries Service (NMFS) Groundfish Survey Cruises and local trawlers. The specimens have been examined for reproductive state, age-length and stomach contents. Laboratory analyses of stomach contents are complete. Most age

analysis (aging) has been completed. Reproductive data were taken in the field.

Virtually the entire proposed longline sampling pattern was successfully completed in 1980 and thus far in 1981, including several additional sets of longlines. The only significant deviation was cancellation of the April cruises, when it was deemed more fruitful to have project personnel participate in the NMFS spring groundfish survey. Over 600 sharks have been collected during the longline operations. Reproductive tracts were examined and large, identifiable food items measured in the field, but aging, identification and measurement of small food items still await laboratory processing, pending the completion of the spiny dogfish material.

A preliminary analyses of historical distributional information has been summarized in a publication produced by the project and distributed to the public by the Institute's Sea Grant office under the title "A Preliminary Evaluation of the Potential for a Shark Fishery in Virginia." This and other information distributed concerning the project has evoked an excellent response, including numerous local and wire service newspaper articles, several local television and national radio interviews and prominent coverage in a local television documentary show. This exposure has been very gratifying since one of the major goals of the project is to increase public awareness of sharks as a potential resource.

Project personnel were invited to serve as weighmasters at the largest local shark tournament, sponsored by the Virginia Beach

Sharkers Club. All sharks landed "were donated to science" and were dissected by project personnel. This resulted in the collection of additional valuable biological information as well as increasing awareness of project goals within the sportfishing community. The tournament sponsors have agreed to collaborate in writing a section on shark angling methods for inclusion in our planned shark sportfishing publication.

The cooperative tagging program between our project and the NMFS Gamefish Laboratory at Narragansett, RI, was reviewed and enlarged. NMFS has agreed to supply tags (including payment of rewards) for the tagging of juvenile sandbar sharks (Carcharinus milberti) within the Bay. Almost 100 young sandbars have been tagged to date. The results of this study should provide a validation of techniques and also provide insights into the migrations and ultimate fate of the substantial Bay nursery populations. Sandbar sharks constitute the Commonwealth's second largest potential commercial resource after spiny dogfish.

Another highly interesting area of shark research was initiated with support from the National Aeronautics and Space Administration (NASA) on the effect of the placoid scales in shark skin on the swimming energetics of sharks. The surface structure and geometric arrangement of scales in some sharks may act to reduce turbulent flow, thus reducing drag and improving swimming efficiency. Department scientists have collected skin samples from several species of sharks that live in different habitats. These samples are being examined

with the VIMS scanning electron microscope to define scale surface structure and to determine whether surface structure is correlated with shark size, habitat, or both.

During fiscal year 1980-81, the department's Sea Grant funded butterflyfish (Peprilus triacanthus) project collected additional specimens from scientific and commercial sources, primarily from offshore trawl fisheries and inshore pound net fisheries. In the laboratory, specimens were examined and length, weight, sex, maturity and fecundity were recorded. These data have been added to those previously compiled. This information will be utilized to establish basic life history curves (e.g., length-weight, age-length, etc.) for Virginia butterflyfish. Seasonal distribution data for butterflyfish in Chesapeake Bay has been compiled based on commercial pound net catches and on larval occurrence data from Institute plankton surveys. Continued contact with commercial fishermen has been maintained in order to monitor utilization of butterflyfish, as well as the species composition of nominal butterflyfish catches--which may comprise species other than Peprilus triacanthus.

Department scientists are also directing a Sea Grant study of eel pot catch efficiency. Objectives of this study are to collect, analyze and synthesize information on the relative efficiency of eel pots and provide this information to industry, management agencies and other interested parties.

Five types of eel pots are being compared:

- standard mesh (1" x 1/2"), galvanized, cylindrical.
- small mesh (1/2" x 1/2"), galvanized, cylindrical.
- standard mesh, galvanized, square.
- standard mesh, vinyl coated, square.
- small mesh, vinyl coated, square.

Pots are randomly set in a line in water of approximately the same depth and within the same vicinity. Salinity, dissolved oxygen, and temperature measurements are taken for each trip out to the fished area. Total length, maximum girth, and weights are taken for all eels (Anguilla rostrata). A subsample of eels are aged and sex-determined. Data will be compiled by season, diel period, and station location. It will be analyzed to determine catch efficiency and spatial and temporal trends in the data. The field work stage of this project has just been completed, but data analysis has not yet begun.

During fiscal year 1980, department scientists continued their study of community organization among bottom fish species dwelling from the edge of the outer continental shelf to the abyssal plain. This study, funded by the National Science Foundation (NSF), focused on comparison of catch data from the temperate study region (Norfolk Canyon-Middle Atlantic Bight) and the tropical study region (vicinity of the Bahama Islands). Analyses centered on description of the taxonomic composition of the two fish faunas, numerical classification of collection sites and species groups, quantification of biomass and numerical abundance, identification of dominant fish species, and

comparison of trends in species diversity along the depth gradient sampled. New computer programs were established to facilitate listing of cluster format data and analysis of rarefied species diversity data; these computer programs should also prove to be of general utility to other VIMS projects utilizing cluster format data.

A sampling cruise to the tropical study region was conducted during August-September 1980 aboard the R/V Columbus Iselin. Several VIMS staff and students participated in this cruise as well as invited deep-sea specialists from the Smithsonian Institution and Denmark.

The deep-sea project supported one graduate student and provided specimens and data central to the dissertation research of three additional students. As a result of the project, several manuscripts concerning the life history, ecology and systematics of bottom fishes have been published or submitted for publication by VIMS staff members and students. Additional contributions to regional faunal series have been submitted; these in part utilized life history and distributional data resulting from the deep-sea project.

In addition to the studies on juvenile fishes (including grey sea trout (Cynoscion regalis), croaker (Micropogonias undulatus), spot (Leiostomus xanthurus), and summer flounder (Paralichthys dentatus)) and those on striped bass (Morone saxatilis) and sharks noted above, VIMS continued its special study on the biology and the recreational fishery for spotted sea trout (Cynoscion nebulosus). This study is funded by the Sport Fishing Institute (SFI). Analyses include age-growth data and reproductive biology. Fish collected in

Chesapeake Bay ranged in age from 0 to 15 years; females were found to grow larger than males. Male fish matured in their second year but most females matured at age three. Spotted sea trout seem to have two spawning peaks during the summer in Chesapeake Bay.

Twenty-two years of spotted sea trout citation data (2,445 entries) from the Virginia Saltwater Fishing Tournament were analyzed using the Statistical Analysis System (SAS and SASGRAPH). In general, the period of 1972-1976 was the best recent spotted sea trout fishing years in the Bay; catches have been much lower since that time. The Chesapeake Bay Bridge Tunnel and Piankatank River were historically the best areas for catching spotted sea trout. In the past several years, however, the Ware and North rivers have produced many citation-size spotted sea trout in May. Parkers Island and Nassawadox Creek on the Eastern Shore have produced the most summertime spotted sea trout recently, while Hungars Creek (Eastern Shore), Lynnhaven River and the Bridge Tunnel have produced the most fish in the fall. Peeler crabs, "sting ray" grubs and "mirrolures" are the most effective baits or lures.

"Speckled Trout" Catch Information sheets were distributed to fishing clubs, marinas, and individual anglers, requesting that lengths, weights, capture location and date, and a scale sample from each spotted sea trout caught be recorded on the form. Only 82 of these forms were returned. Most of the fish recorded were caught at Hungers Creek in the late summer and fall on "mirrolures" or in the Ware and North rivers in May on crabs. Scale samples from each

returned form were aged. Fish ranged from 1-12 years of age with only two fish under age 4, thus indicating spotted sea trout are not fully recruited into the recreational fishery until 4 years of age.

The loggerhead sea turtle (Caretta caretta) is considered threatened under the Federal Endangered Species Act of 1973 and is listed as endangered by the State of Virginia. Department scientists continued their studies of sea turtles in Virginia in 1980-81. Historically, the loggerhead has been reported nesting on Virginia's beaches. The suitability and seclusion of the Barrier Islands of the Eastern Shore and the coast south of the heavily developed Virginia Beach area increased the probability of nesting occurring and going unreported. In order to ascertain the use of Virginia's beaches by nesting loggerheads, 15 weekly aerial surveys of the Atlantic coastline were made from May through August 1980 with funding support from a special grant from the City of Danville, Virginia, through the Environmental Protection Agency.

The majority of the surveys were made in the VIMS DeHavilland Beaver aircraft which is ideally suited for low level, low speed observations.

No nesting tracks were observed by air during the survey period. There is a possibility that nesting occurred and the evidence was swept from the beach by wind or tide, but the likelihood that major nesting trends were thus hidden is remote. It is most probable that only sporadic nesting occurs here although the waters of the Chesapeake Bay and those around the Barrier Islands support a large



population of juvenile loggerhead and Atlantic ridley (Lepidochelys kempi) sea turtles, and adult loggerheads congregate along the shore.

Records of only 14 documented nestings were found, all of which occurred since 1970. Also, during this period, four turtles were found on the beach and tracks of another eight turtles were observed.

The lack of documented turtle nests and the results of the summer beach survey leads us to believe that Virginia's shores do not support any large loggerhead rookery and occasional nesting females found here are extralimital to the normal breeding range of the species.

The sex of loggerhead hatchlings is determined by the temperature of incubation of the eggs; lower temperatures produce all males and higher temperatures all females. This, coupled with the supposed return of nesting females to the beach where they were born, means that eggs incubated on Virginia's beach may be producing all or nearly all males due to generally lower sand temperatures. If so, few if any females would survive to maturity to return to Virginia and nest. Water and air temperatures along the coast drop rapidly in the fall, reaching levels that will kill sea turtle hatchlings. In order to escape falling temperatures, the hatchlings would have to swim very long distances to reach the warmer waters of the Gulf Stream or the Southeastern Coast. During this swim, the hatchlings would be exposed to predators and lack of food as well as falling temperatures. Rafts of Sargassum along the shores of natal beaches, the normal refuge used by sea turtle hatchlings, does not occur except spottily in Virginia's waters. Therefore, production of predominately male hatchlings, the

lack of refugia for protection from predators and food concentration, and the fall race against lowering temperatures probably prevents the establishment of a permanent sea turtle rookery here.

Sea turtle mortality studies initiated in 1979 were again funded by the National Marine Fisheries Service (NMFS) and expanded during this period. These new studies include pathology and sex determination of stranded turtles, incidental catch and pound net mortality, a co-operative tagging program with Virginia watermen, a public stranding response network, and the sonic and radio tracking of sea turtles in Chesapeake Bay.

Based on our research and success in documenting turtle strandings, VIMS was named the regional center for sea turtle stranding reports as part of a national stranding network. Principal findings of this project show that the Chesapeake Bay is an important seasonal foraging area for loggerhead sea turtles. Subadult loggerheads are the predominant group and occur in the Bay and its tributaries to salinities lower than 50‰ seawater. Forty-three ridley (Lepidochelys kempii) and seven leatherbacks (Dermodochelys coriacea) were also found in the Bay from 1979 through 1981. Ridley sea turtles are probably more common in Virginia than indicated by records.

In each study year, turtles entered the Bay in May and were most abundant in June. In 1979 and 1980, turtles were absent from the study region by mid-November. In 1979, 185 carcasses were stranded in the Bay area. Totals for 1980 and 1981 (to date) included 333 and 119 strandings, respectively. Loggerheads comprised 81% of total

carcasses in 1979 and 1980, while ridley and leatherbacks amounted to 5%. In 1981, 20 out of 163 turtles, or 12% of the preliminary total were ridleys. Incidental capture, boat damages, and mutilation were among the major identified causes of mortality. Histopathological findings for six loggerheads examined in 1980 included drowning and verminous or bacterial infections in their diagnoses.

In 1980, over 284 sea turtles were found alive in pound nets. Of these, 75 were tagged and released from nets in the Bay. Six recaptured loggerheads showed an average length of stay 92 days between tagging and final recapture in the area. Forty-four turtles were tagged and released in 1981.

Pound net incidental turtle catch occurs in two forms, including possible death from entanglement in hedging mesh, and confinement alive in the head of the net. Both capture types require additional study and management consideration in order to protect these endangered creatures. On-going and future tracking of turtle movements within and around pound nets may yield practical methods of eliminating inadvertent mortality.

As in the past, VIMS scientists served as advisors to the Virginia Marine Resources Commission rendering advice on several problems including trawl net mesh size regulations, fish size limits, and seasonal otter trawl regulations within the territorial sea.

Dr. Merriner continued to serve as chairman of the State/Federal Scientific and Statistics Committee on Menhaden. This committee

formulated a Fishery Management Plan for Atlantic menhaden. Final report preparation and production was carried out in the Ichthyology Department at VIMS with National Marine Fisheries Service funding. Dr. Musick served as chairman of the State/Federal Scientific and Statistics Committee on Summer Flounder (Paralichthys dentatus). This committee is completing work on a Fishery Management Plan for summer flounder. This is the most important species in Virginia's valuable trawler landings and supports a large recreational fishing industry on the seaside of the Eastern Shore.

#### Ichthyology Museum

Student curators in the VIMS regional Ichthyology Museum continued curation of this valuable collection. In 1980-81, several hundred specimens were sent out as loans, gifts or trades to scientists at other institutions around the world. VIMS curators lectured about the fish collection and about the biology of fishes to visiting groups, ranging from high school students to recreational fishing clubs. In addition, curators responded to numerous queries regarding identification of fishes, collection and distribution data and taxonomic data.

#### Crustaceology Department

Studies on crustaceans concentrated on understanding the ecological relationships between the blue crab (Callinectes sapidus) and its climatological environment. Additional studies and monitoring programs have:

- Provided data for effective effective harvesting, utilization and management of the blue crab (Callinectes sapidus);
- Described biological characteristics of large crustaceans of potential commercial importance on the continental shelf and slope; and
- Provided continuing annual estimates of recruitment to the Virginia blue crab fishery from results of the juvenile monitoring surveys.

Estimates of abundance of juvenile crabs less than one year old are made yearly from May through November by trawl surveys in Virginia's major rivers. Surveys have been made in the York River since 1956, in the James since 1964 and in the Rappahannock since 1968. The historical data on numbers and sizes of juvenile crabs have been compared to trends in commercial landings, providing the basis for predictions of the commercial catch. These predictions are based on the fact that the commercial catch from September of one year through August of the next are based on the hatch of the year previous. That is, the commercial catch from September 1980 through August of 1981 is based on the hatch of 1979.

We have evidence that large fluctuations in the basic supply of crabs are caused by unusual climatic and environmental conditions during the first eight months of life of a crab. The variables that affect an early stage in the life history of the blue crab are several; they include:

- the quality of the water in the area of the Chesapeake Bay most suitable for egg production, hatching, growth and survival of larvae.
- the retention of the larvae and juvenile crabs within the Bay, or their transportation through the Bay mouth to the continental shelf and possibly return of juveniles to the Bay.
- the transportation of juveniles to the nursery grounds in the tributaries.
- the quality of the environment in the tributaries during the juvenile crab stage.

Preliminary analyses funded by the National Marine Fisheries Service (NMFS) indicate that water temperature and salinity, and water transport are among the most important variables affecting crab survival. These preliminary results, and the correct forecast of a large 1980 year class due in part to the unprecedented drought, suggest that our conceptual model is valid.

Collections of crustaceans obtained in prior years during demersal (bottom) trawling operations on ships-of-opportunity on the outer continental shelf are still being processed by departmental staff and students. Data were obtained on various aspects of the biology of some potential commercial species including rock crab (Cancer irroratus), jonah crab (C. borealis), deep-sea red crab (Geryon quinquedius), and other decapods (portunids, galatheids and shrimp). These offshore crustacean collections formed the basis for

two master's theses and a doctoral dissertation. They also constitute the basis of a Virginia crustacean reference collection.

A commercial fishery for red crabs is developing at the edge of the continental shelf, on the slope and in the canyons off Virginia. Fishing with wooden traps by Virginia vessels began in 1978 and was conducted in a narrowly restricted range around a mean depth of 300 fathoms (549 m), and a narrow range of temperatures, 4-5°C (39.2-41°F). In 1979, we measured different body parts, obtained body weights and recorded shell color from about 600 crabs. A number of gonads were collected to determine the size at which the crabs attain sexual maturity. These data, which will permit an evaluation of the growth and reproductive potential of the species, are currently being analyzed.

#### Malacology Department

The main thrust of work during the period of this report was to analyze and publish data collected over the past 35 years. It may be useful to list the types of data available in VIMS files from those years of studies. Some records cannot be published beyond short summaries but may become very useful to subsequent investigators.

Annual oyster setting records were obtained for 22 years (1946-1967) along with population counts and observations of fouling organisms on public oyster beds statewide. Activities of the oyster disease caused by Perkinsus marinus (Dermo) were monitored for 31 years (1950 to 1981). These records were compiled and interpreted in

VIMS Data Report No. 16 in the winter of 1980-81. These records supplement five published reports on Dermo.

A major effort over the last three years has been the compilation of mortality and incidence records for the disease of oysters caused by Minchinia costalis, commonly known as Seaside Disease or SSO. This disease is primarily restricted to seaside of the Eastern Shore of Virginia; it is scarce north of the Delmarva Peninsula. Because no one else has studied this disease extensively and because much effort has been expended at the VIMS Eastern Shore Laboratory at Wachapreague collecting samples for this study, it is important to assemble the data and analyze it. The period covered was from 1960 to 1981. Tens of thousands of live oysters and gapers (dead oysters) were sampled and sectioned into permanent slides for disease diagnoses. These represent only a part of 170,000 oysters processed into stained slides for diagnoses of Minchinia nelsoni (MSX) and SSO. Three major papers have been published on Seaside Disease since we discovered it in 1960.

Unpublished data collected over 22 years on two minor parasites of oysters are being assembled. The small soft crabs that live inside oysters and rob them of food are called pea crabs or oyster crabs. Weighing of oysters has revealed that tiny (2 mm or 1/12 inch) crabs, invading oysters in large numbers in September and October, cause oysters to cease growing. The incidence of pea crabs over the years and information on their life cycle are being prepared for publication.



The second parasite is a microscopic flatworm called Bucephalus, meaning ox-headed, after Alexander the Great's war horse. This flatworm destroys the gonads of oysters and follows a complicated life cycle involving needlefish and garfish as alternate hosts. Data on host-parasite relations are being collected.

The major current field effort in 1980-81 was to continue to monitor Minchinia nelsoni (MSX). For 23 years, trays of susceptible James River oysters have been examined every two to four weeks in the major rivers of Virginia to monitor MSX activity. Extraordinary weather in 1980-81 has threatened to permit MSX to spread upstream far beyond its normal range due to the drought, which has increased salinity. The unprecedented winter-spring drought, with river runoff down to about half normal volumes, caused very high salinities in Virginia's oyster-growing regions. In normal years, low salinity is the primary barrier to the spread of MSX as well as other diseases and parasites over most Virginia beds.

In June 1981, a meeting of oyster biologists was held at VIMS to assess the status of MSX. Both New Jersey and Virginia (VIMS) have small stocks of brood oysters that are resistant to the disease but, unfortunately, hatcheries to produce resistant progeny are not yet economic along the Atlantic coast. Hence, the brood stocks produced by 17 years of intensive selection at VIMS cannot be currently utilized.

## Department of Applied Biology

During the period of this report the Department carried out three major continuing research projects.

A long-range study was continued on the weekly levels of oyster spatfall on strings of shells placed at about 60 representative locations throughout the Chesapeake Bay tributaries in Virginia. This study, begun in 1947, shows the season when oyster larvae attach to shells in the greatest numbers. The results of this program are widely used by commercial growers and by agencies of the Commonwealth of Virginia in their shellfish-growing programs.

A second long-term program monitors, each fall, the condition of the public oyster rocks in the state. It is conducted by taking half-bushel samples of bottom material from representative bars with an oyster dredge. This material is carefully examined for numbers of live and dead oysters, numbers of oyster shells, and for evidence of predation by organisms such as oyster drills.

The two preceding programs have enabled scientists to detect long-term changes in oyster populations. For example, our spatfall monitoring program has shown, since 1960, an approximated 80% decline in number of spat setting each year on natural cultch in the lower James River. The cause or causes of this decline are still not clear, but it is now the subject of an on-going research program to determine whether natural conditions or man's activities are primarily responsible.

The results of the preceding programs are published annually by the Institute and the distributed through the Sea Grant program to about 2,500 persons.

A third continuing program measures oyster meat quality at about 12 locations throughout the Commonwealth. These measurements are expressed as index numbers. Oyster meat quality indices tell growers when and where to expect the highest yields of meats per bushel of oysters. It tells scientists which areas produce the fattest oysters. If oysters in any region have consistently low quality it may be due to adverse environmental conditions such as oyster diseases, or the absence of suitable food in the water. If they are fat (high index numbers) it indicates that oyster diseases are absent and there is an optimal amount of food.

Sponsored research during the 1980-81 fiscal year has consisted of completion of a four-year study entitled: "The Present and Potential Productivity of the Baylor Grounds in Virginia." This work was funded by Sea Grant. The completed study consists of two volumes. They show in over 50 charts the locations of most of the state's public oyster growing areas, their extent, shore lines, bottom type, average salinity, incidence of predators and diseases, and the suggested best use. Copies of this publication are available at cost from the Office of Sea Grant at VIMS.

In addition to the preceding programs, the Department of Applied Biology advises several State and Federal agencies concerning shellfish growing areas in relation to such projects as canal dredging, highway construction (bridges), docks and marinas.

## DIVISION OF BIOLOGICAL OCEANOGRAPHY

The Division of Biological Oceanography includes four departments: Invertebrate Ecology, Marine Culture and Aquatic Toxicology, Microbiology-Pathology, and Planktology. Research, graduate education, and advisory activities within the Division are varied, but center primarily on the lower trophic levels of the food web: phytoplankton, zooplankton, benthic (bottom) invertebrates, and the recycling activities of bacteria. Work during the period of this report is described below.

### Department of Invertebrate Ecology

Research in this department is concentrated on benthic invertebrates, their community structure and changes in populations due to manmade alterations to the environment.

Four students completed their Masters degrees working on various aspects of the Bay and continental shelf ecology.

Their studies included:

- An examination of the effects of the barrier presented by the thermal front between the waters of the Gulf Stream and northern water to the distribution of benthic invertebrates around Cape Hatteras.
- Recolonization experiments on azoic (without life) sediments.
- The impacts of an oil refinery on the biological communities of the York River, and

- The feeding ecology and population dynamics of continental shelf amphipods.

Long-term monitoring of various invertebrate communities of the Bay was continued in order to follow their natural population dynamics. This gives a reference point from which to assess the impacts of man's activities, since natural systems are inherently variable. Our monitoring program has produced the longest and most complete record of invertebrate communities in the United States. We have documented changes caused by major natural disturbances, such as Hurricane Agnes, and are presently evaluating the effects of drought.

A program of resource evaluation was started to determine the value of the Bay's major bottom habitats (mud, sand, seagrass beds, shallow and deep channels) to commercial fisheries species since most of the major fisheries species in the Bay rely on the bottom for trophic (food) support. Invertebrates are the key link between the Bay's fisheries yield and its high primary productivity. The more productive a bottom is of key invertebrate species, the higher the resource value of that bottom.

Several studies were conducted to collect data for the formation of management strategies for our aquatic resources. The trophic support and shelter provided by seagrass beds to fisheries species was evaluated to see if the beds should be protected and replenished. The effects benthic infauna (invertebrates living in the bottom sediments) have on the distribution of toxic chemicals in the sediments was

determined in order to predict where toxicants would finally reside in the Bay. Through their activities, the benthos are able to rework sediments and thus can enhance the reintroduction of toxic chemicals into the water column where they have the potential to contaminate the food chain.

A habitat evaluation method was also developed to provide highway planners and managers a means of evaluating tidal nonvegetated wetlands for highway design. The method is based on the primary productivity and biomass of invertebrate populations. Various construction site alternatives can thus be compared and the least environmentally disruptive right of way chosen.

We have been involved in developing comprehensive plans for management of the dredged material that would result from the dredging of the Bay channels from 45 feet to 50 feet (13.7 to 15.2 m). Items of concern are the possible effects on salinity patterns which could influence the distribution of oyster disease and predators, impacts on benthic communities from disposal operations, and alterations to the resource value of impacted bottoms. Other support was provided in evaluating permits for wetlands, fill acquisition, and sand mining.

#### Department of Marine Culture and Aquatic Toxicology

The appointment of Dr. Morris Roberts as department head expanded the original Department of Marine Culture to include research on toxicology. All research projects within the department are at least partially supported by external funding.

Research continued on the development of disease resistant strains of the American oyster (Crassostrea virginica). Four families of oysters which appeared to have significant resistance to "Dermo" (Perkinsus marinus) were inbred and further tested for resistance. Seemingly resistant oysters from wild populations were selected to establish additional families of resistant oysters. At least one of these families is derived from an MSX (Minchinia nelsoni) resistant family previously established through research at VIMS.

In studies of artificial diets for oyster larvae, it was demonstrated that microcapsules (3-80  $\mu\text{m}^3$  in diameter) are ingested by oyster larvae if presented in appropriate concentrations. This provides a method to introduce chemically formulated diets to oyster larvae for evaluation of nutritive value. It will also provide an experimental tool to determine which amino acids and lipid fractions are essential to oyster larvae; i.e. cannot be synthesized by the larvae from simpler precursors. Initial studies with the microcapsules, while not producing growth and survival equal to control larvae fed the standard algal diet, have been encouraging.

A microencapsulated diet would be valuable for use in an oyster hatchery. It can be mass produced with rigid quality control to insure consistency in formulation and in a form which can be stored for extended periods to be available when needed. It would replace the need to carefully schedule the continuous production of algae to insure availability when the oyster larvae require it. The algae cultures also are quite variable in quality. The biggest benefit of

the use of a microencapsulated diet would be a reduction in the cost of food for oyster larvae.

A project was completed in conjunction with researchers at the Chesapeake Biological Laboratory (CBL) comparing the sensitivity of pairs of closely related estuarine species of algae, mysids, copepods, and fishes to three toxic substances. The latter two groups were tested at CBL. One species in each pair is stipulated as the test species of choice by the Environmental Protection Agency (EPA) whereas the other species is often more representative of the fauna in the Chesapeake Bay and its tributaries. In simultaneous paired tests with these species, only small differences in sensitivity were noted between related species whereas there were large differences in sensitivity among the broader taxonomic categories. The project was funded by EPA.

#### Department of Microbiology-Pathology

During the period of this report, a student completed research for a dissertation entitled "Petroleum Degradation by Naturally Occurring Populations of Marine Bacteria from Middle Atlantic Outer Continental Shelf Waters". This research provided valuable information on the patterns and rates of petroleum hydrocarbon degradation by marine bacteria.

Bacteriology personnel and students conducted other research on the activities of bacteria that degrade pollutant petroleum hydrocarbons in marine environments, public health bacteriology and



pollution bacteriology. Studies continued to assess the effects of the estuarine environment on the viability of the fecal coliform indicator Escherichia coli and the enteric pathogen Salmonella sp. Studies to evaluate standard and proposed methods for enumeration of fecal coliforms continued.

Bacteriology personnel also continued baseline monitoring of microbial populations of the lower York River for long-term assessment of changes in water quality, as well as general ecological studies. Refinement of an existing direct counting technique by epifluorescence microscopy yielded an extremely powerful technique for enumeration of microbial populations.

Research was also continued on the development of methodology for determining rates of chitin degradation in marine environments utilizing naturally synthesized radiolabeled chitin.

Parasitology personnel continued their study of parasites and disease organisms in Chesapeake Bay area fishes. This is an integrated program incorporating parasite investigations using both state and external monies as well as student research funds to produce an overview of the kinds and numbers of parasites in local fishes. Such information can be valuable in understanding fish kills, fluctuations in fish populations, indicating pathogens that might become pathogenic under culture conditions, and providing a list of parasites that could be used as biological tags for fish populations.

Systematic studies of marine leeches continued. Some of these annelid worms serve as vectors of blood parasites of fishes.

Literature on monogenetic trematodes and important skin and gill parasites of fishes continued to be added to the Parasitology library. A large work dealing with the host specificity of these interesting parasites will be published in the Institute's Special Papers in Marine Science series before the end of the year.

Parasitological research, supported mainly by Sea Grant funds, on the life cycle, ecology, and pathology of blood parasites (hemoflagellates), was beginning to yield results. A paper describing the life cycle of the most important hemoflagellate in the Chesapeake Bay system was accepted for publication. This parasite causes heavy mortalities in small summer flounder (Paralichthys dentatus) that remain in the estuaries during the colder period of the year. It may be a major factor in summer flounder population fluctuations. A paper describing the biology of this hemoflagellate is in press and another dealing with the pathology it causes is in preparation.

Another Sea Grant sponsored project examined the distribution and effects of two protozoan parasites found on the gills of many commercially important local fishes. Both parasites are notorious pathogens in other areas of the world and might pose problems to Virginia-based mariculture operations or stressed fish populations.

A project funded by Sea Grant to assess the impact of marinas on the bacteriological quality of the surrounding waters continued into

its second year. The project is investigating the usefulness of the concept of the fecal coliform buffer zone around marinas, with its attendant impacts on marina permitting and shellfish harvesting.

Funding was received from Sea Grant and Anheuser Busch Corporation for a graduate student to conduct research on the feasibility of oyster mariculture based on the recycling of brewery wastes by microorganisms.

A final report describing the responses of selected marsh microbiota to controlled oil pollution was completed and sent to the American Petroleum Institute (API), which funded the study, for editing. Another final report was submitted to the Bureau of Land Management (BLM) describing changes in levels of petroleum-degrading bacteria in oil-treated and untreated sediments placed in situ on the Middle Atlantic continental shelf. BLM funded the work.

Bacteriology personnel participated in two National Oceanographic and Atmospheric Administration-National Marine Fisheries Service-National Aeronautics and Space Administration (NOAA-NMSF-NASA) sponsored cruises to describe the extent and effects of Chesapeake Bay discharge plume waters on contiguous shelf waters as expressed through microbial populations.

Department personnel continued their advisory/educational activities related to sanitary microbiology and the significance of the fecal coliform indicator concept to shellfishing and shellfish processing in Virginia. Assistance and technical advice on oyster

depuration (self cleaning) was made available to both state government and persons in private industry. As part of Microbiology-Pathology's ongoing disease diagnostic program, Parasitology personnel furnished technique and advisory services on parasite and disease problems to Institute scientists, graduate students, and persons outside VIMS. An apparent increase in the number of disease problems in confined populations of fishes was noted. Continued work on diagnosis and control of fish diseases will be useful in view of future mariculture ventures.

#### Department of Planktology

Departmental activities included continuation of research on zooplankton populations from the Chesapeake Bay and Middle Atlantic Bight and cruises in Chesapeake Bay for the long-term Lower Bay Zooplankton Monitoring Program (LBZMP). They also surveyed distribution and abundance of striped bass eggs and larvae in the James River and initiated a study, in cooperation with Maryland's Chesapeake Biological Laboratory (CBL), to assess starvation in striped bass larvae. We entered the final phases of a flume study of the efficiency of pumps in collecting zooplankton and developed a proposal for research on larval migration into Oregon Inlet, N.C., and another on systematics of certain fish larvae.

Two Masters theses were completed in this fiscal year, one on the hyperiid amphipods obtained from zooplankton collections of the Bureau of Land Management (BLM)-VIMS surveys of 1975-1976, and the other on

the nutritional ecology of the chaetognath Sagitta tenuis. This arrow worm is a prominent planktonic predator on the summer-fall zooplankton of Chesapeake Bay. Graduate student research still in progress includes studies of offshore decapod larvae, gammarid amphipods and the vertical distribution of zooplankton in the lower Chesapeake Bay. These studies have been funded under both state and externally funded research projects and are integrated with departmental research goals.

The Lower Bay Zooplankton Monitoring Program (LBZMP) is totally funded by the Commonwealth and is the only such project carried out by the Department of Planktology. Goals of the program are to provide a long-term assessment of the abundance of zooplankton (including decapod crustacean larvae, and fish eggs and larvae), to document their occurrence and to gather the baseline data needed to reasonably evaluate future perturbations. The program was initiated in early 1978 and is continuing.

Collections of zooplankton in the lower Chesapeake Bay were completed in four monitoring cruises made during July, August, March, and June. This year's collections are of particular value in view of the exceptionally high salinity caused by the continuing East Coast drought.

Outside funding for research was obtained during this fiscal year from four sources: National Marine Fisheries Service (striped bass egg and larvae survey), U.S. Fish and Wildlife Service (larval starvation study), Martin Marietta Corporation (zooplankton pump

efficiency study) and the Army Corps of Engineers, Norfolk (identification of fish larvae).

Results of the 1980 survey of the York River striped bass spawning grounds were presented at a special session of the Northeast Fish and Wildlife Conference in Virginia Beach, Virginia on April 20, 1981. The survey showed that eggs were present in the Pamunkey from the initiation of sampling on April 16 until May 16; in the Mattaponi River, eggs were found until May 9. Maximum abundance in both rivers occurred in the latter part of April just above the upriver extent of salt water.

Reduced federal funding for 1981 eliminated original plans for continued monitoring of the York River system, but did allow a new survey of the James and Chickahominy rivers in the spring months of 1981.

A new study was initiated late in the fiscal year that will complement Maryland efforts at assessing the importance of starvation in decimating striped bass larval populations. Our efforts will provide a comparison of larvae from the Rappahannock River with Maryland collections of Potomac River larvae.

A study utilizing VIMS' flume (Physical Oceanography Department) examined the efficiency of pumping systems under various flow regimes and orientations of intake nozzles. The study employed both passive plastic particles and live zooplankton as test subjects. Results will

be used in evaluating zooplankton catches obtained by pumping in power plant studies.

Proposals were developed for research on the migration of larvae into Oregon Inlet, North Carolina, the site of a proposed inlet stabilization jetty, and for a systematic, worldwide study of fish larvae in the pearlfish family (Carapodidae sp.). Corps of Engineers funding for the former has been delayed for a year; the systematic study of Family Carapodidae is being submitted to the National Science Foundation for possible funding.

## DIVISION OF ENVIRONMENTAL SCIENCES, SERVICES AND ENGINEERING

There are three departments within the Division of Environmental Sciences, Services and Engineering at the Institute: the Department of Ecology-Pollution, the Department of Environmental Physiology and the Department of Wetlands Ecology and Environmental Impact Assessment. In addition to the projects conducted within these departments over the past year, the Division Office has been responsible for coordinating the Institute's Kepone research program, conducting fate and effects studies with crude oils, providing information on the fate and effects of pollutants to the Attorney General's Office and the Virginia Marine Resources Commission (VMRC), and planning Chesapeake Bay model tests for the Hampton Roads channel deepening projects.

### Department of Ecology-Pollution

The staff of this department continued to be heavily involved with the scientific assessment of Kepone in the James River. Previous investigations have yielded a wealth of information on this substance in water, sediments and biota. We have a basic understanding of the routes and rates of Kepone movement in the system. Now, after almost five years, the natural cleansing ability of the estuary is reducing the amount of Kepone in the top layer of the bottom sediments by depositing new, clean sediments on the contaminated ones. By monitoring this process and determining the resulting changes in the concentration of Kepone in fish, crabs and oysters, we will be able to



refine our ability to understand and predict the impact of persistent organic chemicals on estuarine waters and biota.

For the past three years, this department has been developing an analytical program to determine the distribution and abundance of toxic organic chemicals in the Chesapeake Bay. This program is being funded by the Environmental Protection Agency (EPA). In the past, most monitoring programs were designed to determine only the presence and concentration of a pre-selected set of compounds. For instance, one may have only looked for the DDT family of pesticides; in such a case, no other compounds were sought, and therefore none were noted. This type of program has the obvious major pitfall of missing many potentially dangerous compounds because they were not pre-selected. Now, with better instrumentation, computerized data systems and more knowledge of organic analytical chemistry, a different approach can be taken. Rather than search for a few compounds and ignore the remainder, we can now determine a great many and ignore only a few. The system will continue to be upgraded as new advances in technology appear.

Department personnel completed a two-year survey of the main stem of the Chesapeake Bay utilizing the above method. Hundreds of compounds have been identified and many more are in the process. Our studies are now being directed into the tributaries of the Bay centering on the two "hot spots"--the Elizabeth River and Baltimore Harbor. We believe that the data generated in this program will

assist the localities and the states to better control the pollution of Chesapeake Bay.

The major emphasis of the Biology Section of the Department of Ecology-Pollution continues to be on the study of the functional ecology of shallow water ecosystems. External funding has continued to support research projects in seagrass ecosystems, coral reefs, estuarine plankton, estuarine eutrophication and power plant effects. During the period of this report, emphasis in the seagrass studies has changed to include studies of light as a controlling factor in seagrass distribution. The plankton studies have obtained funds to develop an automated system for plankton enumeration, while the estuarine eutrophication project formed part of a nutrient dynamics survey of Chesapeake Bay.

In collaboration with the Department of Marine Culture and Toxicology, we are extending our analysis of the constituents of the algae used as food for oyster larvae to the development of an artificial encapsulated food for the larvae. This Sea Grant financed project has shown success in encapsulating lipids and fatty acids which can be eaten and digested by oyster larvae. If ultimately successful, this project will be extremely beneficial in the mariculture of oysters.

In the past year, studies of the ecological consequences of two power plants on Chesapeake Bay tributaries were brought to a close with the completion of their final reports. The Surry plant on the James River and the C. P. Crane plant on the Gunpowder River in

Maryland both discharge heated water into a zone of transition between fresh and saline water. At Surry the discharged water mixes rapidly with the main stem of the James River, and elevated temperatures are detectable only within a small mixing zone. Most of the biological effects relate to the transport of organisms suspended in the cooling waters from the intake area through the plant to the discharge area. At C. P. Crane on the other hand, the heated effluent enters a system of shallow creeks within which there is a gradual decline in temperature, and at least five types of modifications of the resident invertebrate populations may be attributed to the plant. The latter findings have prompted Maryland state officials to plan for a long term monitoring program at C. P. Crane to assess year-to-year changes in its effects, and to examine possible alternative discharge locations.

A hydrographic and phytoplankton monitoring study of the York River was expanded from a summer program, as it was when initiated in 1974, to a year-round effort in 1980-81. The salinity patterns resulting from the persistent drought conditions of this period were documented, with particular attention devoted to dissolved oxygen conditions in the deeper waters. This study is continuing.

The interaction of several Air Force fuels and fuel component mixtures with clays and sediments is also being investigated by this department. This project is funded by the United State Air Force Engineering and Services Center to provide data on the adsorption of hydrocarbons from fuels on mineral matter from aqueous solutions.

There is little literature information on this subject at present. Results of this study will permit better prediction of the effects of accidental fuel releases in subaqueous environments. Adsorption of fuels is being measured and the data presented as adsorption isotherms. The effects of temperature, salinity, pH and sediment organic carbon content on fuel adsorption are being measured by adsorption equilibrations with these variables controlled. The work is part of a comprehensive study of toxicity, transport behavior, sinks, and degradation of USAF fuels.

Fuel on water aging experiments simulating oil spill conditions are being run with exposure to sunlight in the presence and absence of sediments. Decomposition products of the oil will be identified if detected.

#### Department of Environmental Physiology

During the 1980-1981 reporting period, the Department of Environmental Physiology continued its work in radiobiology, studies of red waters and jellyfish as well as other research. These projects are discussed below.

The analytical facilities for undertaking experimentation with radioactive isotopes were maintained during this period. Five research projects, two marine science classes and several thesis projects utilized the radiobiology laboratory.

The staff continues to insure that the Institute operates its radioisotope facilities in conformity with its license and the regulations of the United States Nuclear Regulatory Commission.

Department scientists developed technical comments for the Commonwealth of Virginia on the potential effects of effluents released from the Three Mile Island - Unit 2 into the Susquehanna River and Chesapeake Bay.

In cooperation with the Department of Invertebrate Ecology, the effects of industrial waste effluents on selected species of estuarine algae were studied. This project, funded by the U.S. Environmental Protection Agency (EPA) through the Chesapeake Research Consortium (CRC), employs the use of radioactive carbon as a tracer for measuring the rates of photosynthetic production by selected estuarine algal species.

Limited field observations were again made on the abundance of Chesapeake Bay jellyfish. High populations of the stinging nettle (Chrysaora quinquecirrha) and moderate abundances of the moon jelly (Aurelia aurita) were observed during the summer of 1980, a period of very high temperatures and humidity and low rainfall. Great numbers of jellyfishes were found in the Bay proper, but their numbers diminished by the end of July. The autumn jellyfish Rhopilema verilli was not seen during 1980 nor were the offshore venomous Lion's mane (Cyanea capillata) observed on the Eastern Shore. No random captures of the venomous Pelagia noctiluca were made in the continental shelf waters of Virginia. However, several small populations of the

non-venomous winter form of the Lion's mane (Cyanea capillata) were noted in the waters of mid-Chesapeake Bay and Piankatank River during the early spring of 1981.

The sighting of extensive Red Water formations caused by the organism Cochlodinium heterolabatum in the summer of 1980 followed a spring period of low dissolved oxygen in the York River. The Cochlodinium bloom persisted into the early autumn. This condition, which occurred during high water temperature and high salinity conditions, contrasted significantly with the same period of 1979 when extensive Red Water formations did not occur. However, similarities were noted with the Red Water formations during the summers of 1975, 1976, 1977 and 1978.

Studies of the diurnal (daily) oxygen metabolism of an oligohaline (low salinity) Chesapeake Bay sub-estuary was undertaken during 1979, funded by the Department of Natural Resources of the State of Maryland. The effects of industrial waste heat loading on the planktonic community were evaluated during the late summer and winter seasons. The magnitude of diurnal responses was measured during a series of field observations undertaken with tight synchrony of diurnal and tidal cycles.

In cooperation with the Department of Microbiology-Pathology, the bacterial biomass and heterotrophic potential in the waters of the Chesapeake Bay discharge plume and the contiguous continental shelf were measured under contract with the National Marine Fisheries Service (NMFS) of the National Oceanic and Atmospheric Administration.

Viable count, direct count, and heterotrophic potential were correlated with hydrographic variables using Kendall's Tau non-parametric statistic. Microbial indicators were positively and significantly correlated with chlorophyll and temperature, and negatively correlated with depth and salinity.

Department of Wetlands Ecology and Environmental Impact Assessment

During this report period, the Department participated in the education, research and advisory functions of the Institute/School of Marine Science through five program areas:

- Shoreline Permit and Advisory Activities
- Wetland Inventories
- Education
- Research, and
- Coastal Primary Sand Dune Management and Guideline  
Development

Each is discussed below.

Wetland personnel processed 527 shoreline alteration permit applications during the reporting period. Each permit involved a site visit, a written report and in some cases a follow-up visit prior to permit issuance. In addition, staff members were in daily communication regarding permits and related matters with four federal agencies (Fish and Wildlife Service, Environmental Protection Agency, National Marine Fisheries Service, and the Army Corps of Engineers); the primary state agencies involved (Water Control Board, Marine

Resources Commission), and the local wetlands boards. Permit assessments increased 15% over the last reporting period. Much of this increase reflects the technical and scientific assistance of staff members under the Coastal Primary Sand Dune Protection Act that was added to the Wetlands Act on July 1, 1980 by the General Assembly.

Wetland personnel coordinated Institute comments on 15 environmental impact statements during this period. More than 40 presentations were made by staff members, including wetlands workshops, conferences, seminars, talks to elected officials and input to public hearings.

Under a federally funded technical service contract, department scientists are involved in detailed studies of certain shoreline activities, some of which require permits, and some of which do not. Under this contract, the Army Corps of Engineers (C of E), the National Marine Fishery Service (NMFS) and the Environmental Protection Agency (EPA) require us to investigate shoreline activities that are of particular environmental concern. A number of the sites require the use of aerial photography provided by the Remote Sensing Section of the Department of Geological Oceanography.

Wetlands staff are required to attend the following meetings in order to supply technical advice to federal, state and local management agencies:



- Monthly Joint Permit Processing Meetings at Fort Norfolk, with the Environmental Protection Agency (EPA), State Water Control Board (SWCB), State Health Department (SHD), Corps of Engineers (C of E), Marine Resources Commission (MRC), National Marine Fisheries Service (NMFS), and the Fish and Wildlife Service (FWS).
- Monthly meetings of the MRC.
- Bi-monthly meetings concerning federal dredge projects with all federal and state regulatory and advisory agencies involved with dredging.
- Monthly meetings of local wetland boards.

Staff members also have a very close working relationship with state and federal regulatory and advisory agencies on a daily basis.

All field work for the Tidal Marsh Inventory program was completed in October 1978, but data reduction and report preparation continues. The following inventories were published during this reporting period:

James City County  
Isle of Wight County  
Surry County  
Middlesex County

The following county inventories were reprinted due to demand after being out of print for several years:

Mathews County

Lancaster County

King George County

Four staff members of the Department are on the faculty of the School of Marine Science, and taught five different courses in marine science during this fiscal year. They also serve as advisors, committee members and major professors for a number of graduate students at the School of Marine Science, as well as at other universities and institutes.

In addition to the structured graduate school activities discussed above, staff members lecture and offer seminars and other programs to community college students, secondary school students, civic organizations and other interested groups.

Wetlands workshops (three to seven hours each) are also given to local wetlands boards. Workshop sessions have increased during this fiscal year because of the recently legislated Coastal Primary Sand Dune Protection Act. This Act has increased the responsibilities of the Wetlands Boards because in addition to wetlands, the board members must consider coastal dunes as well when making decisions involving shoreline activities.

A major effort was directed toward drafting and reviewing the publication "Coastal Primary Sand Dune Guidelines." Staff members worked closely with personnel from Virginia Marine Resources Commission (VMRC) on this document. The publication was developed as a guideline

for the permitting of activities which encroach into coastal primary sand dunes.

Department scientists continued a long-term project designed to document the ecological changes which occur as the result of dredging a new navigational access into Cabin Point Creek, a tributary of Lower Machodoc Creek in Westmoreland County. The previous connection was a narrow shallow tidal creek which meandered across the end of a prograding (building outward) sand spit. This has been replaced by a channel 40 feet wide and four feet deep with stone jetties on either side, dredged through the sand.

The research effort has been concentrated on four main aspects of this system. These are:

- Beach processes
- Tide and current regimes
- Water quality, and
- Wetlands

This first year's research involved obtaining baseline information on the creek system prior to the dredging. This included regular slack water sampling surveys, beach profiles, tide range and current measurements and quadrat samplings of wetlands vegetation. The second year's work has continued in all of these areas during the course of the construction of the new channel. The third and fourth years of work will document the changes which occur in this creek

system after completion of the project. The project is being funded by the National Marine Fisheries Service (NMFS).

In a study financed by the Corps of Engineers, department scientists assessed the ecological relevancy of time-of-year restrictions on dredging in Hampton Roads and the Elizabeth River. Under this policy, dredging has been prohibited during certain times of the year to protect finfish and shellfish during critical periods in their life cycles. Recent research indicated that these restrictions might not be necessary in the Hampton Roads area because of the type of dredging and disposal operations usually employed and the proximity of the dredged channels.

VIMS proposed a multi-disciplinary approach to solving the problem which included studies of:

- Distribution and abundance of finfishes in the Hampton Roads area.
- Distribution and abundance of clams and oysters in Hampton Roads and the Lower James River.
- Finfish spawning activity in the study area.
- A physical model of the distribution of the dredge-induced turbidity plume.
- Dredge monitoring in the field to calibrate the model.
- A study of surface and bottom currents in the Hampton Roads area, and
- Summary of dredging effects from the literature.

Based on the information generated during the contract, it was determined that, in general, the type of dredging in question did not generate suspended sediment levels high enough to adversely impact the majority of estuarine organisms present in the study area. Oyster eggs and larvae, though, could possibly be affected by suspended solids levels near the maximum generated by the dredge cutterhead. The results of the field monitoring and turbidity model, however, indicated that within a few hundred meters downcurrent of the cutterhead, suspended solids levels were again at background levels. When the resource areas were compared with the area projected to be impacted by the dredging operation it was found that very few oyster bars would be affected by routine maintenance dredging in the study area.

In a study funded by the Environmental Protection Agency (EPA), various aspects of the biology of eelgrass (Zostera marina) were investigated. The study consisted of a number of sub-projects.

During the past decade, eelgrass beds have experienced considerable decline in the lower Bay. In one sub-project, seasonal changes in the standing crop of existing eelgrass beds were studied including the distribution and growth of seedlings, an important component of the revegetation process. Anthesis (flowering) and seed production in eelgrass beds were also investigated to determine the sequence of the flowering events and to determine how the pattern here compares with other areas along the east coast. Aspects of the seed germination of eelgrass were studied using both field and laboratory

experiments as well as the growth of seedlings under laboratory conditions of increased nutrient enrichment.

Because of the lack of natural revegetation in many denuded areas and significant interest by the public and management agencies in restoring beds of eelgrass, methods for the transplantation of eelgrass were developed. The growth and survival of the transplants were studied including various factors which may have been implicated in increased or decreased success. Natural revegetation of an area in an existing bed of eelgrass that was denuded by a boat propeller, a common occurrence in eelgrass beds, was studied and compared to the transplanted sites.

A part of this study was to continue investigations into the distribution and abundance of submerged aquatic vegetation (SAV) in Virginia by use of aerial photography. The study was to complement earlier work done in 1978, by comparing the status of SAV in 1980 with that of 1978 and to develop a continuing data base for use in the management of Virginia's shorelines. In addition, historical patterns of SAV abundance in the Chesapeake Bay were investigated as well as comparisons of SAV changes in the Bay with other areas along the Atlantic Coast.

In addition, we worked to prepare a synthesis paper on the distribution and abundance of SAV in the entire Bay. This was a review of all existing data on SAV in the Bay, data from the EPA program, trends from the east coast of the U.S., and world-wide trends. A scientific summary will be the final document.

Department scientists also conducted an investigation on the role of grazers, primarily a small snail, on the periphyton of eelgrass. Our work involved a laboratory effort assessing the impact that the snail had on reducing epiphytic growth and the ultimate effect on the growth of eelgrass. This work was particularly relevant in that we felt that the loss of grazers from eelgrass in 1973 may have had important implications in the decline of eelgrass in the 1970's.

In a related project funded by the U.S. Fish and Wildlife Service (FWS), we provided aerial photographs of the shoreline and SAV of major parts of the upper Bay in Maryland waters. Also, these funds allowed us to photograph the lower Bay grass beds.

Other relevant research included: (1) light-photosynthesis studies in lower Chesapeake Bay seagrass communities, (2) submarine optical properties of lower Chesapeake Bay waters, (3) SAV epiphytic primary production and community metabolism, (4) preliminary investigations of community metabolism in tropical seagrass ecosystems (Mexico), (5) benthic flux processes in the coastal Georgia Bight, and (6) computer simulation development and analysis for seagrass ecosystems in Chesapeake Bay.

As indicated by the titles of these projects, the majority of studies are directed at environmental control and regulation of primary production in seagrass ecosystems.

## DIVISION OF PHYSICAL SCIENCE AND OCEAN ENGINEERING

The principal goals of the division's research program are to understand the basic geological and physical processes of the marine environment and to develop and apply procedures to improve the planning for and management of the Commonwealth's coastal, estuarine and continental shelf resources. These goals are approached through separate and integrated studies of the three departments in the Division: Physical Oceanography and Hydraulics, Estuarine Processes, and Geological Oceanography. Much of the research activity reported herein crosses departmental lines, and in many cases divisional lines as well. This is essential to an holistic approach to the problems facing the Commonwealth; VIMS is unique in this attribute among Virginia institutions.

The programs are described below.

### Department of Physical Oceanography and Hydraulics

By definition, an estuary is an embayment on a coast wherein salty marine waters mix with the fresh waters carried by rivers to the sea. Since the fresh water is lighter than the salt water it tends to override the latter; the process results in a very complicated circulation pattern. This estuarine circulation, in turn, controls in large measure the ecological characteristics of the embayment. The upriver limit of oyster grounds, that of their predators and pathogens, and the finfish spawning and nursery grounds are among the features controlled by the average characteristics of estuarine



circulation. The estuarine circulation itself is controlled by the magnitude and timing of fresh water input from the river and the tides which propagate from the continental shelf into the Bay and its tributaries.

Estuarine circulation also controls the distribution of drifting life forms such as plankton and larval life stages. Further, circulation is very significant in the transport and dilution of various pollutants introduced into the system.

Given this extreme importance, major emphasis by the department is placed on understanding and predicting the elements of estuarine circulation.

Each of the major Virginia tributaries is periodically monitored along its longitudinal axis to determine the vertical distribution of salinity, dissolved oxygen, and nutrients. These data, as well as being essential to understanding the circulation process, are intrinsically important to verifying whether various "models" reflect actual conditions. Finally, the monitoring data allow a statement of the "condition of the river" so that fisheries scientists can make near term predictions and plan surveys. We have been monitoring the major tributaries of the Commonwealth in this fashion for many years.

Considerable attention over the last decade has been devoted to the formulation of numerical circulation models to predict flow and salinity regimes for specified conditions.

Under the Cooperative State Agencies (CSA) program, a joint venture with the Virginia State Water Control Board, VIMS is developing mathematical water quality models for all major and small coastal tributaries of all Virginia estuaries. These estuaries are the James, York, Rappahannock, Great Wicomico, Piankatank, Poquoson, Back, Chickahominy, Pagan, Nansemond, Elizabeth, and Potomac rivers; Lynnhaven and Chincoteague bays, and the Parker Creek and Little Creek embayments. During the period of this report, efforts have been made to apply ecosystem models to eight Potomac River embayments, to expand their dimensions and to improve their prediction accuracy. The water quality monitoring program has been expanded to cover all nutrient data. All CSA models are being calibrated and validated to include nonpoint source pollutants.

A mathematical water quality model developed by department scientists was used by the City of Virginia Beach to evaluate the effect of a proposed channel on water quality in the Eastern Branch of Lynnhaven Bay. The model projection runs were made with nonpoint pollutant inputs prepared from the first storm event of the design storm sequence of the "Hampton Roads 208" study. The model used in this study was a tidal-prism model, in which mixing and dilution caused by freshwater inflow and tidal exchange were simulated.

An intensive hydrographical and water quality survey has been conducted for Little Hunting Creek. This information is being used to develop a predictive water quality ecosystem model to evaluate

creek conditions and aid in the formation of a consistent improvement program.

For the Hampton Roads 208 study, several different water quality models were developed. Both point and nonpoint sources of pollution were included. The estuaries modelled were the Pagan, Nansemond, Elizabeth, James, York, Back and Poquoson rivers, Little Creek and Lynnhaven Bay. This study was done to assess the present and future water quality conditions and to develop a wastewater management plan to assist in planning future development within the Hampton Roads area.

A study to develop a mathematical model plan for improving the water quality in the Potomac embayments is currently underway. This project is funded by the State Water Control Board.

A comprehensive study was initiated for the Environmental Protection Agency (EPA) to design a mathematical model to address the analysis of hydrodynamic circulation and water quality distribution of Chesapeake Bay. The model will be able to reliably predict realistic future conditions when the Bay is subject to various waste loadings. The model being developed is two-dimensional in the horizontal plane and depth-averaged for flow velocity and water quality parameters.

Kepone transport in the James River estuary is being modelled. Field studies have demonstrated that the major portion of Kepone is adsorbed to the sediment particles. The model is thus formulated as a two-phase process; the dissolved phase and the adsorbed phase.

With funds from the U.S. Navy, a field study to measure currents in the vicinity of Pier 12 at the Norfolk Naval Base was completed. These data will be used in a model formulated by another contractor to determine the origin and deposition rate of hydroids and bryozoans which cause fouling of the cooling systems of Navy ships.

State law requires that a zone surrounding marina sites be condemned for the taking of shellfish. With funding from Sea Grant, a modelling system is being prepared to assist in the estimation of mixing zones near marina sites. The ultimate objective is to develop a system for regulatory agencies to use in setting the limits of condemnation zones more realistically. Other divisions at the Institute are also working on supporting portions of this project.

Water motions on the continental shelf and slope are important to the regional fisheries of the Middle Atlantic area. Further, these water motions modify the movement of water and entrained materials entering or leaving the Bay. The study of these phenomena are therefore essential to prediction and understanding of the Bay itself; the entire interaction zone should be considered as part of the Bay system. Three studies on this subject were completed or initiated during the period of this report, all with external funding.

A comparison of satellite data measured by SEASAT Side Aperature Radar (SAR) with the predictions of the Virginian Sea Wave Climate Model (VIMS-NASA) is being made with funding by the National Oceanic and Atmospheric Administration (NOAA). This comparison will determine

the usefulness of the satellite data for wave train analysis on the continental shelf, show areas of significant differences between wave patterns predicted by the model with those measured by the satellite and evaluate the future of SEASAT SAR data for prediction of wave climate along the coast. Regions currently under study are the Cape Hatteras and southeast Long Island areas. Comparison between waves generated by a distant hurricane and the model applied to the Cape Hatteras area has demonstrated a correspondence in parts of the region. Deviations, perhaps due to currents, are being evaluated.

Regular advice was given to the State Water Control Board on the application of water quality models to particular cases. In addition, advisory work was performed for the Public Health Department, the Hampton Roads Sanitation District, the Marine Resources Commission, and to several localities and to their consultants.

#### Department of Estuarine Processes

As previously discussed, estuarine circulation provides the answer to the ultimate disposition of pollutants introduced into the system. A corollary question, of great importance to the Commonwealth, is how much, and what is the character of, the pollutants which enter the estuarine system from "nonpoint sources." This term refers to runoff from the land, which carries pollutants into our rivers and estuaries. The research includes not only the impact of runoff on estuarine water quality, but also the processes which control the amount and quality of the runoff. If managers are

to address this problem, they must know how these systems behave, how the coastal zone differs from other parts of the Commonwealth, and what methods are most effective in controlling this type of water pollution.

This is the principal area of study of the Department of Estuarine Processes.

A number of small research projects have been underway in the department. These include studies of silica levels in the major estuaries of Chesapeake Bay, a time series analysis of water temperature records taken over many years at the VIMS pier, development of a water quality index to assess the effect of waste discharges, assessment of the impacts of increased levels of nutrients in estuarine waters, and the editing of papers presented at an international conference held in Williamsburg in May of 1979.

The department also operated the Nutrient Analysis Laboratory which performed over 24,000 separate analyses on water samples during the year. This lab provides water quality analyses as an important service to other departments of the Institute.

Studies being conducted in the Lynnhaven Bay basin, with funding from the Hampton Roads Water Quality Agency (HRWQA), have as their primary goal comparison of alternate methods of controlling stormwater runoff. A number of factors affect the quantity and quality of runoff including land use, slope of the land, soil characteristics, amount of paved area and the amount and intensity of rainfall. Given this

complex system, data must be interpreted with care. For example, two residential neighborhoods in the Lynnhaven area were studied; one had typical curbs and gutters while the other had grassy swales or ditches to convey the runoff away from the streets. The water in the ditches tended to be more polluted than that in the gutters. However, the grassy areas allowed a portion of the runoff to percolate into the soils, thereby reducing the volume of runoff. In fact, the loading rates, expressed on an acre basis, were lower for the area with grassy swales. Stated somewhat differently, more sediment, nitrogen and phosphorus will leave an acre of land with curbs and gutters than leaves an acre of land with grassy swales, if all other factors (rainfall, density of housing, etc.) are more or less equal.

A similar conclusion was drawn from Environmental Protection Agency (EPA) supported studies of the Ware River basin in Gloucester County. There, a farm field with light sandy soils yielded runoff with high concentrations of nutrients and sediments. However, these soils allowed most of the rain to enter the ground so that runoff was observed only a few times during the year. Thus, fewer pounds of pollutants left an acre of this farmland than was observed at a similar farm with heavier, poorly drained soils. The highest loading rate (pounds of pollutant per acre per year) observed in this study was at a residential site. This agrees well with observations made elsewhere that show that the amount of pollutants leaving an area increases as the amount of impervious cover (paving, roof tops, sidewalks, etc.) increases.

It is obvious that runoff having high concentrations of nutrients and suspended sediments must have some effect on the waters which receive these flows, but the extent and severity of these impacts are poorly documented. New surveys of water quality in Lynnhaven Bay were made in the fall of 1980 to gather just this type of data. The data are being used to calibrate a mathematical model of water quality formulated by the Department of Physical Oceanography and Hydraulics which will be used to test different strategies for controlling nonpoint source pollution.

Data from wet weather surveys on the Ware River indicate that pollutant levels do increase following rains of half an inch or more. Stormwater impacts were most observable at the freshwater-saltwater interface. Dissolved oxygen levels decreased immediately following the rain, presumably because organic matter carried with the runoff was decaying in the estuary consuming the oxygen. Nutrient levels increased, resulting in increased algal growth; chlorophyll levels peaked shortly after the rain stopped. Nutrient levels also have been found to increase during extended hot and dry periods, which is believed to be due to the release of nutrients from bottom sediments.

Dr. Neilson, department head, served on an advisory board in Maryland which directs state funded research dealing with the impacts of power plants. He also chaired a panel on Marine Energy at the North and Mid-Atlantic Regional Conference on Ocean Pollution Research, Development and Monitoring held in New Hampshire in 1980.



Department scientists have been working with other state and local agencies on matters relating to dredging, nonpoint source pollution control and water quality problems. Two specific items which have demanded a great deal of attention are an assessment of water quality problems in the Chowan River and development of plans to clarify technical issues and eliminate algal blooms, and an evaluation of the shellfish growing waters of the Commonwealth. Both of these projects are on-going, and no conclusions have been reached as yet.

#### Department of Geological Oceanography

The principal research areas in the department are estuarine sedimentation processes, coastal and shore erosion processes, and application of remote sensing to marine resource research and management.

Three new state-supported programs originated from recommendations of the legislature's Coastal Erosion Abatement Commission. Funds were provided for a dedicated technical advisor to the newly formed Commission for the Conservation and Development of Public Beaches. In addition, funds were allocated to staff a research program focusing on low cost erosion control techniques. Finally, the first year of a two-year study assessing the subaqueous sand resources in the southernmost Chesapeake Bay was completed. Significant sand deposits for beach nourishment were located.

Also, the Legislature acted to establish a Commonwealth Data Base and VIMS was selected to provide the state with a central facility for satellite mapping of coastal resources and land use patterns.

A comprehensive report was completed on the results of an interinstitutional study of the Rappahannock estuary's response to high freshwater flow. Also completed was the editing of a special journal volume on results reported at an international meeting examining continental boundary-shelf exchanges.

Because of the characteristics of estuarine circulation, the Chesapeake Bay and its tributary estuaries act as traps for sediment introduced from the rivers and shore erosion. Thus, sedimentation is a major problem leading to shoaling of shipping channels and siltation of oyster grounds. In addition, many industrial wastes become bound to the sediments, causing them to act as a reservoir of pollutants. Two major sediment studies funded by EPA were brought to completion or near completion. The first addressed the distribution of sediments in the Virginia portion of Chesapeake Bay, and the patterns and magnitude of sediment deposition in the Bay. The deposition patterns suggest that fine sand and silt is carried from the Bay mouth to considerable distances up Bay, much further than heretofore thought.

The second study examined the trace metals in the suspended sediment and bottom fluid mud in the Bay. The highest concentrations of trace metal in fluid mud were found in the Baltimore-Susquehanna River zone with decreasing concentrations seaward. Trace metals on

the surface of suspended sediments exhibit maximum concentration in the central Bay; this is attributed to bioaccumulation of wastes from distant sources.

A new sediment analysis system, Fourier grain shape analysis, has been implemented with Sea Grant funds to aid in the differentiation of sediment types based on their grain shapes. Shape characteristics of detrital quartz particles in the fine size range are now being quantified through use of the harmonic amplitudes obtained in a closed Fourier series representation of magnified grain images. The method requires input from a microprocessor-controlled video imaging system which was developed jointly with members of the Numerical Analysis and Information Services Department of the Institute. It is presently being used in a study of bottom sediments in lower Chesapeake Bay and its tributaries that seeks to identify sediment sources and determine their distribution and mixing characteristics on the basis of Fourier shape attributes.

The fringes of the tidal lagoons and small embayments along the edges of the Bay and its tributaries have become increasingly attractive to residential developers, since such systems offer all the advantages of shoreside living without the risk of erosion which exists along more exposed coastlines. This led to a study of small tidal inlets, which was undertaken with funding from Sea Grant. The results indicate that some of the empirical relationships found for large oceanic inlets do not hold for smaller inlets, which is useful and important to the design of stable inlet channels.

Under the leadership of the Virginia Soil and Water Conservation Commission, we have completed the first year of a multiyear program investigating the merits of using marsh grasses to inhibit shoreline erosion. Our role is to monitor and evaluate the success of demonstration plantings at the initial thirteen sites. The objective of the program is to determine what range of shoreline conditions are amenable to treatment with marsh grass.

Land-bound researchers have, over the last two decades, learned to use and appreciate the capability of remote sensing from satellites. Previous mention was made of the Commonwealth's use of LANDSAT information. Two additional studies were undertaken using satellite imagery.

In the first, department personnel took part in the SEASAT satellite wave climate study discussed under the Physical Oceanography and Hydraulics Department.

The second satellite study, funded by the National Oceanographic and Atmospheric Administration (NOAA), is an analysis of Chesapeake Bay plume dynamics using LANDSAT images. In this project, Bay waters moving through the Chesapeake Bay mouth and out onto the continental shelf are studied under different wind and tide conditions. Over 90 images obtained by LANDSAT over the last eight years are available. Preliminary results show that the plume hugs the Virginia/North Carolina shore except when southern winds move it more toward the east. This information will be used by the National Marine Fisheries

Service (NMFS) to better understand the tie between Bay waters and continental shelf fish populations. This will ultimately improve our nation's management of shelf fisheries.

During the last year, advice and consultation were provided to the Marine Resources Commission, the Soil and Water Conservation Commission, and the Public Beach Commission on matters relating to beach erosion and sand dune characteristics. Consultations regarding Kepone and estuarine sedimentation were provided to the State Water Control Board (SWCB) and to the Secretary of Commerce and Resources. Service was given to the Baltimore District of the U.S. Army Corps of Engineers and to Virginia executive agencies on channel deepening projects. Continuing advice on technical matters has been provided to the Coastal Erosion Abatement Commission.

## DIVISION OF SPECIAL PROGRAMS

The Division of Special Programs coordinates interdisciplinary, multidisciplinary and interinstitutional projects involving personnel from other divisions within the Institute and from other institutions.

Examples of the programs coordinated through the Division are Sea Grant, Coastal Zone Management (liaison only, now that Virginia is not participating in the federal program), and various projects conducted through the Chesapeake Research Consortium. The results of the projects conducted under the auspices of these programs are reported elsewhere in this document by the Divisions conducting the research.

Some special projects, discussed below, are conducted by personnel assigned to this Division.

The Division also administers the programs of the Computer Center (Department of Numerical Analysis and Information Systems), the Department of Advisory Services, the Institute Library and the Reports Center (Word Processing).

At the end of the period of this report, the Marine Environment and Resources Research and Management System (MERRMS) and the Office of Ocean and Coastal Law, both of which had previously reported to the Director's Office, were transferrred to this Division.

### Special Projects Department

The Chesapeake Bay Use Ethic Project, which was begun during the previous fiscal year, continued to be coordinated at VIMS under

funding from the Citizens Program for the Chesapeake Bay (CPCB). Draft papers prepared by ten humanities scholars from various disciplines underwent extensive peer review. The general public was also given the opportunity to review and comment at a series of workshops conducted in Virginia and Maryland. With the revisions of the papers recently completed, the final report for the project is scheduled for publication in August 1981.

The Division began work on another project sponsored by CPCB this year. The Chesapeake Bay Information project is funded by the National Science Foundation "Science for Citizens" Program. This program will study the need for and feasibility of a center or network to enhance the use of available information by citizens and government managers in policy-making for the Chesapeake Bay. Personnel in the Division are responsible for one of the major tasks, a Survey of Information Sources on the Chesapeake Bay. The results of the survey will be published early in the next fiscal year.

Work also continued on the Chesapeake Research Exchange (CREX) project sponsored by the Chesapeake Research Consortium. This computer-based system is being developed to maintain up-to-date information on current research activities dealing with the Chesapeake Bay. The focus of this year's effort has been to design and initiate an information gathering/reporting system for a test population of ongoing research projects in Virginia and Maryland.

Another special project which the department began last year is the mapping of the sensitivity of selected coastal areas to spilled

oil. This work is closely related to a Sea Grant project which is discussed below. The mapping project is funded by the National Oceanographic and Atmospheric Administration (NOAA) Hazardous Materials Response Program. Special priority areas to be mapped have been designated by the U.S. Coast Guard and representatives of the states of Maryland, Virginia and North Carolina. These priority areas will be classified according to an environmental sensitivity index that was originally developed by the Research Planning Institute, Inc. of South Carolina, but modified for use in the Mid-Atlantic region by VIMS. Approximately 120 maps and a final report will be completed during the next fiscal year.

The interest of the department in hazardous materials was given a new focus this year. The NOAA Hazardous Materials (HAZMAT) Response Program working through the Sea Grant Program is funding the development of a scientific support coordination plan by department personnel for response to hazardous material spills in Maryland, Virginia and North Carolina. HAZMAT, which is based in Boulder, Colorado, provides scientific support coordinators (SSC's) to the Coast Guard to assist them in mitigating adverse environmental impacts resulting from oil and hazardous materials spills, among other things.

Department personnel participated in training sessions in Buffalo, New York; Tampa, Florida; Norfolk, Virginia; Bangor, Maine; and Seattle, Washington. Some of these training sessions related to health and safety considerations for SSC's during spill response. Others involved testing the response skills of SSC's through the use of hypothetical spills. The spill exercise held in Tampa was a major



effort and received much attention from NOAA, the Coast Guard and state and local officials in Florida. An article on the drill, and the role of VIMS personnel in that event, was published in the spring issue of the NOAA magazine.

To facilitate the coordination of the various groups the SSC works with, a monthly "SSC Newsletter" was begun by personnel from this department. Response to the newsletter has been extremely favorable.

As required by the contract, an SSC is provided to the local area Coast Guard during oil and hazardous materials spills. For the period from January to June, the principal investigator, who is the designated local SSC, responded to 13 spill notifications. Of this total, six were within Virginia waters, one in Maryland and six in North Carolina.

#### Advisory Services Department

Marine Advisory Services is the department of the Institute responsible for the transfer of technical information to coastal resource users and managers in understandable formats. The department provides advice and technical assistance to the general public as well as federal, regional, state and local agencies concerned with marine-related matters. In addition, the program strives to encourage wise use of the marine environment and its resources, while improving awareness of and appreciation for the marine environment through formal (K-12) and informal education programs. Besides insuring that research results get into the hands of those needing the information,

we also identify problems encountered by users of the marine environment. Appropriate responses to these problems are then undertaken. This may involve the development of a research project, a publication, a workshop, a seminar, an individual response or whatever may be required.

Sections of the department work in the speciality areas of commercial fishing, marine trades and recreation/tourism, resource economics, marine education, erosion control and communications/publications. Approximately 60 percent of the department's funding came from the U.S. Department of Commerce's National Sea Grant Program, with the remainder provided by the Commonwealth. The program was responsible for well over two dozen seminars, workshops, conferences and short courses during the year. An equal number of displays and exhibits were conducted throughout the Chesapeake Bay region, as well as the inland areas of Virginia, reaching an estimated 275,000 citizens, educators, students, marine business operators and resource managers.

The communications/publications element of Advisory Services disseminated radio spots and coordinated 24 television talk show appearances and radio interviews. In addition, the communicators produced the quarterly "Marine Resources Bulletin," the "Commercial Fisheries Newsletter" and a new series entitled "Tide Graphs." Special announcements on topics such as energy tax credits, seminars and workshops were issued under the marine advisory "FOCUS" logo. The "Fishery Flash" series was continued on specific topics of interest to the fishing community. Six new seafood promotional brochures on

species of interest to local commercial and sport fishermen were produced. Several Marine Resource Advisory pamphlets were distributed to oyster growers and management agencies concerning possible new outbreaks of oyster diseases and predators resulting from unusually high salinities (due to the continuing drought) in Chesapeake Bay tributaries. Finally, a number of major technical and education series publications were produced and distributed.

Department personnel devoted themselves to local, regional, national and international projects. Frequently, projects that begin as a result of local problem-solving needs produces information of regional or even national significance. Examples include the recently completed study on the economic feasibility of crab meal drying plants now being applied throughout the Chesapeake Bay region as well as in other areas of the country; the Marine Education Materials System used extensively nationally and now internationally as well; the Advisory Services annually sponsored Hard Clam Culture Workshop and Course (conducted by the Eastern Shore Division) which has drawn participants from 24 states and eight foreign countries; externally funded trade missions to Nigeria, the Netherlands and Egypt resulting in export increases for Virginia fishing firms; reports on waterfront festivals which are in demand throughout the U.S. and in Canada; the convening of parasitologists from the mid-Atlantic region to solve a parasite problem with eel shipments exported to Denmark and the coordination of a vessel guarantee program from New York through Virginia which allows fishing vessels to test experimental gear and electronics.

The maturity and effectiveness of VIMS Marine Advisory Services program were recognized this year by the National Sea Grant Office in Washington, D.C. when the Advisory Services staff was asked to make a presentation on the VIMS program before National Oceanic and Atmospheric Administration (NOAA) officials as part of a national review of Sea Grant's Human Resources Division, which is responsible for 33 Marine Advisory Services Programs established across the Nation and in the Trust Territories.

Brief mention of specific activities and accomplishments in each major element of the Marine Advisory Services program follows.

#### Marine Education

The marine education program continued to expand its efforts to "educate educators", i.e. to assist teachers in the development of the professional competency and knowledge needed to implement marine education in Virginia's schools. Approximately 800 teachers were reached through ten "seashops" held throughout Virginia and in several other states. In addition, field trips and individual assistance were offered science teachers at all grade levels. A special Boating Safety Workshop for Educators was held in cooperation with Virginia's Boating Advisory Committee. Three two-day mini courses on marine life were taught by VIMS staff for the Virginia Resource Use Education Council's Environmental Education Course at Longwood, William and Mary and Virginia State College. Continuing education credit units were awarded 80 oyster inspectors of the Virginia Marine Resources

Commission who attended the department's marine education course entitled "Virginia Fisheries: Environmental Issues."

The Marine Education Center added several teaching aids to its resources which are available for loan to educators, civic groups, etc. These include films, slide sets, cassettes, records, filmstrips, and transparencies. Requests for use of these materials were regularly filled for requestors from all over the country and even overseas. The Center also houses the nationally known Marine Education Materials System (MEMS) for use by educators in "marinating" their curriculum. The department acquired a portable computer terminal capable of linking to the Center via telephone. This permitted on-the-spot computer searches of the system for teachers at demonstrations, encouraging them to take advantage of the microfiched materials in the system, which were produced at the Institute by the Marine Environment and Resources Research and Management System (MERRMS). In the U.S., 23 distribution centers now exist for MEMS, plus one in Australia and another in Trinidad, with the materials for these centers being updated regularly by VIMS.

Special marine education programs for gifted students were offered weekly at three Gloucester County schools. A slide presentation and a publication on this curriculum were developed for presentations to educators. Work continued on marine education programs for handicapped students with student groups visiting VIMS for field trips and a kit of marine "touchables" produced for mailing to such groups. Work is also underway to reproduce more of the Marine

Education Center's written materials in formats usable by visually and hearing impaired students.

In the area of nontraditional and continuing education, close relations were maintained with science museums and other out-reach education programs such as exhibits and science fairs. The successful "Oceanography for Landlubbers" series at VIMS provided interested local citizens with monthly lectures and demonstrations on such subjects as erosion control, fisheries, wetlands, geology of the area, underwater archaeology, and estuarine ecology. A statewide marine poster contest was co-sponsored with the Cousteau Society as part of the heavily attended Ocean Science Day activities associated with Norfolk's Harborfest. Two one-week marine studies summer camp sessions were conducted in cooperation with the Virginia Wildlife Federation, and a leadership training field session was conducted with Virginia's 4-H program. Over two dozen displays and exhibits were coordinated, reaching an estimated 275,000 persons with information on the Commonwealth's marine environment. Exhibits were presented at communities in Virginia's coastal region and inland areas, as well as in Washington, D.C. and Baltimore.

The marine education program enabled approximately 500 students to get out on Virginia's marine waters through its cruise program. In addition, students, educators and interested citizens were reached through regular columns in the National Marine Education Association's Journal Current, Virginia Wildlife magazine's "Marine Education" column and the "Wavelet" series in VIMS' "Marine Resources Bulletin." The Marine Education Center continues to serve as the information

distribution point for the National Marine Education Association and the Association's Mid-Atlantic chapter.

### Commercial Fisheries

With the loss to private industry of the fishery specialist working on offshore fisheries, a new specialist was hired whose primary expertise is in bay and inshore fisheries, especially crabs. Advisory Services maintained its interaction with the offshore fishery through the department head's activities in coordinating exporting opportunities for Virginia fishery firms and the vessel guarantee program sponsored by the Mid-Atlantic Fisheries Development Foundation. The latter program allowed trawler captains from Virginia, New Jersey and New York to experiment with fishing gear otherwise unavailable to them. Since his arrival in the spring, the new specialist has prepared a fish promotional brochure on soft crabs; helped an individual design and set up a soft crab shedding operation; and assisted in an assessment of swan damage to shallow water oyster beds in the lower Potomac which helped oyster growers in obtaining relief for approximately \$70,000 in losses.

Threats to oysters from diseases and predators associated with unusually high salinity levels in Bay tributaries were addressed in special Marine Advisory publications and "Fishery Flashes" sent out to oyster growers and resource management agency representatives. This information aids decision-making for those planting seed and harvesting market size oysters and should help reduce losses from possible expanding infestations of MSX (Minchinia nelsoni) and Dermo

(Perkinsus marinus). The commercial fisheries specialist provides the content of the "Commercial Fisheries Newsletter," distributed quarterly, and is coordinating Virginia's first Commercial Fisherman's Forum to be held in early winter.

The Marine Advisory Services export marketing program made considerable progress during the year. Building on contacts made during the 1980 trade mission to Nigeria and the Netherlands funded by the Coastal Plains Regional Commission and the Gulf and South Atlantic Fishery Development Foundation, the department coordinated shipments of Virginia seafood samples to trade shows in Japan, New Orleans and the Netherlands. This was the first export activity for many of the participating seafood producers. As a follow-up, a seafood exporting workshop was convened in Williamsburg in cooperation with the Virginia Seafood Council.

This year, Advisory Services participated in the U.S. Department of Agriculture (USDA) Food Show in Cairo, Egypt, coordinating shipments of frozen seafood samples and representing regional interests at the show and in meetings with Egyptian officials. These activities, again funded by the Gulf and South Atlantic Foundation, resulted in many tons of Virginia seafood entering the export market. Following the Cairo food show, a publication listing seafood buyer contacts was prepared and released to the fishing industry. An article on what was learned at the show was published in Seafood America magazine.



At the end of the reporting period, the department head attended an International Workshop on Management of National Fishery Development Programs conducted by England's highly respected White Fish Authority. The fishing firm management techniques learned there will be transferred to Virginia and regional fishermen.

#### Marine Resource Economics

The resource economist cuts across all elements of Advisory Services as he interacts with all the other specialists, bringing his expertise to bear on complex resource management problems. Such interaction has resulted in testimony to the General Assembly on price flexibility of hard clams (Mercenaria mercenaria) with references to the possible introduction of mechanical clam harvesting techniques to Virginia, a publication on marketing and production economics of crab wastes and a published report to the Governor's Boating Advisory Committee concerning the economic significance of recreational boating in Virginia. In addition, work is underway on developing a partial budget analysis for a sail-assisted fishing boat to compare expected fuel savings with the costs of outfitting a boat with sails.

A special thrust of the resource economics program has been providing workshops as well as one-on-one sessions for fishermen concerning bookkeeping, loan sources, terms and preparation assistance, and tax management. Workshops were presented at the East Coast Commercial Fish Expo in Baltimore, and at the Rappahannock Community College in Warsaw to 200 watermen. In an effort to make Virginia's financial community more familiar with methods of operation

and investment opportunities in the fishing industry, a highly successful Venture Capital Seminar was co-sponsored with the Virginia Bankers Association. Special "FOCUS" announcements on energy tax credits and pending IRS public hearings were prepared and distributed to the fishing industry as well as presented at the East Coast Commercial Fish Expo seminar.

Research efforts included work on the economic impact of recreational boating in Virginia, landings and value for Virginia commercial fisheries by county, economics of Chesapeake Bay fisheries, the economic feasibility of crab meal processing plants and an analysis of the hard clam market. The latter project is being expanded at the request of the Legislature and the Commonwealth's marine management agencies into a biological/economic study of Virginia's hard clam industry.

The resource economics specialist made numerous presentations at fishery industry meetings. Some of the groups requesting presentations were the National Blue Crab Industry Association in Atlantic City; the Conference on Seafood Waste Management in Orlando, Florida; the Crab By-Products and Scrap Conference in Virginia Beach; the Fish Expo 1980 in Boston; the Virginia Seafood Council Annual Meeting in Williamsburg and the Mid-Atlantic Fisheries Development Foundation Annual Meeting in Baltimore.

#### Marine Trades and Recreation

The marine recreation specialist continued his close relationship with marine trades, boating, sportfishing, diving and beach user

interests. Involvement with waterfront festivals was expanded by considering these festivals as mechanisms for enhancing urban waterfront redevelopment. A special project studying fuel savings attributed to sail-assisted power on a fishing vessel was coordinated.

The marine boating industry was aided by release of a publication describing the economic significance of Virginia's coastal marina industry. This information was also presented at a marine recreation seminar during the Marine Technological Society "Oceans '80" conference in Washington, D.C. The industry was also presented a preliminary report assessing the economic impact of the total recreational boating field in Virginia. Plans were completed for sponsoring a marina/boatyard management seminar at the annual meeting of the Virginia Association of Marine Industries. The specialist continued coordinating a multidisciplinary study (previously discussed) on marina pollution with bacteriologists and a physical oceanographer from other divisions of the Institute. A summary of this work appeared in the national Sea Grant publication Sea Grant Today. Work was begun on a project to assess the impact on marine resources posed by the marina pollution-shellfish industry conflict in Virginia.

An advisory chart of fish havens (reefs, wrecks and obstructions) off Cape Henry was published in cooperation with the Marine Resources Commission Artificial Reef Program. A layman's guide to oystering, clamming and crabbing was published in cooperation with the Commission of Outdoor Recreation. Research efforts in recreational fishing resulted in completion of a master's thesis on Virginia's charter and

head boat fishery. A comprehensive advisory publication was published on the socioeconomic and catch impacts of this major fishing activity. A preliminary study of the economic significance of the Cape Charles black drum (Pogonias cromis) fishery was initiated with the resource economist.

The Chesapeake Boating Weather Guide, published in conjunction with the National Weather Service, exhausted its first printing of 2,000 copies and had to be reprinted. Boat owners, Coast Guard Auxiliary Flotillas, U.S. Power Squadrons and citizens continue requesting this publication in large numbers and a third printing is imminent. A publication on dangerous marine animals of the Mid-Atlantic region has also proven popular and is being used as a guide for several lifeguard services at Chincoteague and Yorktown.

In the area of recreational fishing, water survival lectures were given to fishing clubs and other interested public groups. A package containing advisory publications on sportfish, boating weather, dangerous marine animals, etc., was given to each of 25 participants in the Peninsula Salt Water Sport Fisherman's Association annual fishing course. Cold water survival lectures and demonstrations were continued for boat users. Approximately 250 persons were reached with this life-saving information at such programs as the East Coast Commercial Fish Expo, sailing clubs' meetings, Coast Guard Auxiliary Flotilla meetings and Ocean Science Day during Norfolk's Harborfest. Radio interviews and appearances on television talk shows were also made on this topic.

The recreation specialist continued to serve on the Governor's Boating Advisory Committee. In addition, he was appointed to serve on the Marine Resources Commission's Sport Fishery Advisory Panel and serves as VIMS coordinator for the Institute sponsored Sea Explorer Troop.

The growth in sport diving activity and the resulting need for improved communications among divers and dive service operations were addressed by holding Virginia's first Sport Diving Workshop. This workshop drew over 100 divers and dive shop operators, some coming from North Carolina and Maryland. Focusing on diving medicine, safety and needed improvements in communication, the workshop was a great success.

The information gap concerning waterfront festivals as a mechanism to stimulate urban waterfront redevelopment was partially filled by the Norfolk Harborfest '79 study and the National Conference on Waterfront Festivals held in Virginia Beach. This work resulted in requests for presentations at Delaware's Third Governor's Conference on Tourism and Recreation and the Waterfront Revival Conference in Bellingham, Washington. Over 100 copies of the Delaware conference paper have been requested by communities across the country and in Canada. Advisory Services presented an excellent, highly praised exhibit at both Norfolk's Harborfest and the Washington, D.C. Potomac River Awakening Festival.

A special research and documentary effort on the application of sail power to fishing vessels has resulted in VIMS Advisory Services

receiving national news coverage. Demonstration runs were made aboard the Norfolk Rebel during Washington's Potomac Awakening Festival with representatives of Nautilus Press, Sea Technology magazine, Science 81 magazine and National Geographic magazine. Follow-up articles will be published in these publications when Advisory Services completes preliminary sea trial data for the vessel.

A video production on dangerous marine animals was produced for use by school systems and, it is hoped, cable TV or educational TV networks. A sportfishing forecast presentation was made before a group of outdoor writers at a fishing show which received wide coverage in the writers' newspaper columns. Commonwealth Magazine cited VIMS Advisory Services work and conference on waterfront festivals in an article on Virginia festivals. Sea Grant Today published an article prepared by our communicator on VIMS waterfront festival conference. The recreation specialist and communicator teamed up to produce a Virginia Wildlife magazine waterfowl photo "centerfold" on hunting and preparing surf scoter.

#### Shoreline Erosion

The VIMS shoreline erosion advisory program has taken on new dimensions. Largely as a result of research and advisory work on erosion conducted in the geology department at VIMS, the Commonwealth's Shoreline Erosion Abatement Commission was formed. The Commission subsequently recommended expansion of the Institute's erosion advisory services in conjunction with the U.S. Department of Agriculture (USDA) Soil Conservation Service. Three new advisory

agents were hired by the Virginia Soil and Water Conservation Shoreline Erosion Advisory Service and oriented to Virginia's problems by the Institute's erosion specialist.

Presently, the specialist supports the advisory agents with research activities involving stabilizing shorelines using transplanted marsh vegetation. An ongoing Vegetative Erosion Control Project is a joint effort among VIMS, the USDA Soil Conservation Service and the Virginia Soil and Water Conservation Commission. Twelve shoreline sites throughout Virginia's major tributaries, are under study to demonstrate the feasibility of this erosion abatement technique that could reduce landowners cost to \$5-\$8 per linear foot. Experimentation is continuing with ways to stabilize transplanted marsh vegetation on the shoreline during its critical first year of growth. Discarded tires are being considered as a means of reducing the effect of wave action on the unstable transplants, either by using them as a floating breakwater or securing them in place on the eroding lower bank face and beach.

The VIMS erosion program produced a comprehensive and very popular publication on shoreline erosion in Virginia. This publication explains how erosion occurs, where it can be expected to be most severe and demonstrates effective practical ways to reduce erosion rates. Our erosion specialist appeared on several radio and television talk shows discussing erosion problems.

## Numerical Analysis and Informations Systems Department

The primary event of the year was without question the selection, acquisition, and installation of a new computer at the Institute. The machine selected was a PRIME 750, which met and even exceeded the specifications laid out in the Request for Proposal issued by the Department of Management Analysis and Systems Development in Richmond. The Request was developed at the Institute to specify a machine appropriate to the scientific needs of the research taking place at VIMS. The system is expected to meet the needs of the Institute for years since there is room for expansion in the machine's configuration.

The primary method by which scientists access the computer is by means of terminals (usually video) consisting of keyboard (typewriter style) for input and a TV type screen for output. There are at present about 30 terminals attached to the computer and expansion capability exists for a total of 96. This means that a considerable number of users can be doing work on the computer simultaneously in a process known as "time-sharing". Furthermore, because a user receives the computer's response immediately at his terminal instead of having to wait hours for printed output, a large portion of the work can proceed much faster. This is known as "interactive" computing. The advent of time-sharing and interactive computing greatly enhances the productivity of those who work with computers. This was one of the primary reasons for obtaining a new computer at the Institute.



The new computer became operational on March 30, 1981. Since that time Computer Center personnel have been giving a number of courses and sessions to familiarize Institute members with the capabilities of the machine.

In addition to providing computing service for the Institute, the department maintains and updates a number of data files. It is planned eventually to enable access to these data files in a simple fashion from any terminal connected to the computer system. This has already been achieved for the Marine Educational Materials System (MEMS) and the mailing labels system. Future plans call for similar treatment of the VIMS hydrological data file.

With funding from Sea Grant, a tidal prediction system has been developed which produces output in the form of a calendar with a superimposed plot of the tidal variation throughout each month. This format of information has been well received by the general public and each quarter VIMS issues a set of tidal plots for Hampton Roads and Wachapreague. These plots are available upon request through the Advisory Services department.

The advent of the new computer has made it possible to produce graphs and other types of plots to illustrate the results of Institute studies. Such computer generated plots are produced directly from the data stored in the machine and with little effort plots may be obtained which would have required many man-hours of work by both scientists and draftsmen. The staff of the Computer Center has

devoted a considerable amount of effort to make the programs available which enable such plotting to be done.

In summary, the final three months of the year have seen a quantum jump in computing capabilities at the Institute. All members of the department are delighted with this improvement and intend to realize the potential of the new system to its utmost to provide the Institute with computing services commensurate with the state of the art.

#### Library of Marine Science

The Library began the period of this report with the loss of two staff members, the Chesapeake Bay bibliographer and the Library secretary, due to Institute cutbacks. These staff reductions necessitated shifts in duties and Library service objectives.

The Library continued to develop its collection, observing an even more strict acquisition policy. Twelve hundred monographs and bound periodical volumes were added to the Library holdings.

We processed 590 requests by Institute/School of Marine Science personnel for interlibrary loans of photocopies and were able to supply 142 of the 204 requests made by other libraries for materials in our collection.

We have begun arrangements for joining the OCLC network via the College of William and Mary's membership in the Southeastern Library Network (SOLINET). OCLC is a bibliographic utility which will enable us to electronically locate and request interlibrary loan material.

This will replace the TWX network supplied by the Virginia State Library, and greatly improve efficiency. OCLC will also provide a more efficient and ultimately more economical means of book cataloging and catalog card production.

Computerized literature searching through Lockheed's DIALOG system increased as more scientists and students learned the value of the service. Thirty searches were performed, triple the number run in the previous year. Several students taking the scientific writing course had the opportunity to design a literature search for their thesis topics during the section on library research methods, which was taught by the Librarian. Attendance at a two-day refresher course, "Online Update '80," helped polish the Assistant Librarian's online search skills.

A proposal to Sea Grant for producing a union list of serials in marine science libraries was funded. In spite of a late start due to budget considerations, the project is progressing well. The grant supports a Library Assistant who began in April. She has nearly completed the first phase of the project, which is an inventory of the VIMS serial holdings. Concurrently, we are developing a computer program for compiling the union lists.

The fifth volume of the Chesapeake Bay Bibliography, a supplement to the complete data base, was published in April. No entries have been made since July 1980 when the bibliographer's position was terminated. However, all incoming library materials have been

screened as before for relevant Chesapeake Bay entries and records kept to insure their future addition to the system.

The 1976 VIMS Contributions were printed and sent on exchange to 150 marine institutions around the world. We answered frequent telephone reference queries from people outside our community and supplied 210 VIMS/SMS publications on request.

Additions to the Library include more shelving attached to the tops of existing stacks and fitted into window spaces. The lack of space in the Library was demonstrated to Governor John Dalton when he and his budget committee toured the state, visiting sites of proposed capital expenditure.

We have also acquired a computer terminal which can be used in direct interaction with VIMS' new Prime computer, or through an acoustic coupler with other computers. Library uses for the terminal will include cataloging and interlibrary loan through OCLC, online literature searching and data entry for both the Sea Grant union list and the Chesapeake Bay Bibliography.

## DIVISION OF THE EASTERN SHORE

### Research

The primary research effort of the Eastern Shore Division at Wachapreague is to develop and optimize aquacultural methods for growing commercially valuable marine species. Although the main effort continues on the hard clam (Mercenaria mercenaria), other commercial species are grown for specific studies, or to furnish experimental animals to other scientists within VIMS or outside institutions. These include the oyster (Crassostrea virginica), the soft clam (Mya arenaria), the surf clam (Spisula solidissima) and the bay scallop (Argopecten irradians). In addition, non-commercial species have been grown for other research. A joint project was carried out with researchers from Rutgers University and Woods Hole Oceanographic Institution in which the ocean quahog (Arctica islandica) and the marsh mussel (Geukensia demissa) were grown and the morphology of their hinge structures described. Altogether, over 50 molluscan species have now been grown at this facility.

The hatchery was modified again this year and several feeding and handling protocols were tested to improve larval clam production.

Work continued on improving the methods of growing seed clams as well. A pulse feeding experiment was carried out and coarse bag filters were tested. Some small post-set clams were grown in test trays suspended just above the bottom in natural areas. Another tray grow-out was monitored in the Machipongo River. A pilot-size clam

farm was operated to investigate various grow-out systems for clams. Methods have been improved to increase production per unit effort and to further reduce costs,

A cooperative study on clam genetics was carried out with scientists from George Mason University in which selected genetic crosses were made from specific populations of clams. Electrophoretic methods were used to identify isozyme alleles that distinguished various groups of siblings and fast growing populations.

Seed clams were also grown for a University of Georgia scientist who carried out growth and genetic studies on different populations of clams. The experiments were carried out near Skidaway Island, Georgia.

Field studies are continuing on a population of knobbed welks (Busycon carica) near Wachapreague Inlet. A laboratory population of this species has been maintained for 4 years.

Oyster disease monitoring, which has been carried out since 1958, continued at a reduced rate.

A study of parasites of black drum (Pogonias cromis) was also conducted by a graduate student.

Dr. Analia Amor from Facultad de Medicina, La Plata, Argentina, spent 3 months working at the laboratory to learn out techniques for growing molluscan species and to study invertebrate development.

## Education and Advisory Services

A total of 32 people enrolled in the two courses devoted to growing hard clams (Mercenaria mercenaria). These courses are conducted annually at the Eastern Shore Laboratory. This was the seventh successive year that such courses have been given. In addition to offering the courses, follow-up assistance was provided to the participants to help them start their clam growing enterprises.

Field trips for survey courses in Marine Biology were again offered throughout the year. The staff conducted 12 of the 19 trips that took place, with the others being led by scientists that accompanied their respective groups. Most of these groups were from schools or colleges.

Marine specimens were collected for the University of Delaware, the University of Maryland, several community colleges, and primary and secondary school classes.

Facilities and services to other scientific divisions of the Institute were also provided. The Eastern Shore Division furnished back-up personnel and boats as required in addition to laboratory and dormitory facilities.

Mr. Michael Castagna, the division director, served as president of the Estuarine Research Federation (ERF), an international organization of some 1700 scientists. He also served as a U.S. representative to the International Council for Exploration of the Seas (ICES). His assistant, Dr. John Kraeuter, served as president of

the Atlantic Estuarine Research Society (AERS), a scientific organization with about 850 members.

A great deal of time and effort on the part of the staff was spent in responding to questions of area residents, identifying marine specimens and advising on a number of fisheries, aquaculture, marine and coastal problems.



## PUBLICATIONS

### Journal and Book Contributions

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- Canino, Michael F. 1981. Aspects of the nutritional ecology of Sagitta tenuis (Chaetognatha) in the lower Chesapeake Bay. 81 p.

- Fisher, Daniel J. 1980. Effects of ingestion of kepone contaminated food by juvenile blue crabs (Callinectes sapidus Rathbun). 80 p.
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- Maccubbin, Alexander. 1980. Petroleum degradation by naturally occurring populations of marine bacteria from middle Atlantic outer continental shelf waters. 158 p.

Sedberry, George R. 1980. Food habits, prey selectivity and food resource partitioning of a community of fishes on the outer continental shelf. 166 p.

## SCIENTIFIC AND FACULTY PERSONNEL

- William J. Hargis, Jr.; Ph.D., Florida State University, Director/Dean and Professor of Marine Science; Marine Science administration, marine affairs, pathobiology, biological oceanography.
- Michael E. Bender; Ph.D., Rutgers University; Assistant Director and Professor of Marine Science; Ecology, pollution, toxicology.
- Maurice P. Lynch; Ph.D., College of William and Mary; Assistant Director and Professor of Marine Science; Marine ecology, physiology, information systems.
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- Jay D. Andrews; Ph.D., University of Wisconsin; Professor of Marine Science; Systematics, ecology, epidemiology of shellfish diseases, selective breeding of bivalve molluscs to produce genetic superiority.
- Robert E. Lee Black; Ph.D., University of Washington; Professor of Marine Science; cell biology, physiology.
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- Carl H. Hobbs, III; M.S., University of Massachusetts; Assistant Professor of Marine Science; Geological oceanography.
- Paul V. Hyer; Ph.D., University of Maryland; Assistant Professor of Marine Science; Physical oceanography.

- Robert A. Jordan; Ph.D., University of Michigan; Assistant Professor of Marine Science; Pollution biology, phytoplankton, benthic ecology.
- Howard I. Kator; Ph.D., Florida State University; Assistant Professor of Marine Science; Microbiology, ecology of estuarine and marine bacteria, biodegradation processes, water pollution microbiology.
- John N. Kraeuter; Ph.D., University of Delaware; Assistant Professor of Marine Science; Aquaculture of molluscs.
- Robert J. Orth; Ph.D., University of Maryland; Assistant Professor of Marine Science; Biology and ecology of submerged aquatic vegetation, ecology of benthic communities.
- Polly A. Penhale; Ph.D., North Carolina State University; Assistant Professor of Marine Science; Marine botany and ecology, productivity and nutrient cycling in seagrass communities, submerged angiosperm physiology.
- William F. Roller; Ph.D., Virginia Polytechnic and State University; Assistant Professor of Marine Science; Statistics.
- Craig L. Ruddell; Ph.D., University of Washington; Assistant Professor of Marine Science; Pathobiology, histochemistry, electron microscopy, and marine biology.
- Evon P. Ruzecki; Ph.D., University of Virginia; Assistant Professor of Marine Science; Physical oceanography.
- Phillip M. Shou; Ph.D., Scripps Institution of Oceanography; Assistant Professor of Marine Science; Chemical oceanography.
- Chih-Wu Su; Ph.D., University of California; Assistant Professor of Marine Science; Organic chemistry.
- William J. Wardle; Ph.D., Texas A&M University; Assistant Professor of Marine Science; Invertebrate zoology, parasitology.
- J. Ernest Warinner, III; M.A., College of William and Mary; Assistant Professor of Marine Science; Radiobiology, pollution biology, environmental physiology.
- Richard L. Wetzel; Ph.D., University of Georgia; Assistant Professor of Marine Science; Estuarine and coastal ecology, energetics; systems ecology.
- Frank J. Wojcik; M.S., University of Alaska; Assistant Professor of Marine Science; Systematics and ecology of marine fishes.
- Thomas A. Barnard, Jr.; M.A., College of William and Mary; Instructor in Marine Science; Marine resource management.

- Cynthia L. Bosco, M.A., College of William and Mary; Instructor in Marine Science; Estuarine water quality assessment, especially impacts of non-point pollution, phytoplankton successions and dynamics; benthic release of nutrients from sediments.
- Marcia A. Bowen; M.A., University of Rhode Island; Instructor in Marine Science; Taxonomy and ecology of marine invertebrates; Specializing in ostracods, amphipods.
- Carl F. Cerco; M.S., Massachusetts Institute of Technology; Instructor in Marine Science; Application of systems analysis and mathematical modelling techniques to areas of environmental concern; environmental education.
- Elizabeth A. Cornell; M.S., University of Rhode Island; Instructor in Marine Science; Marine education.
- Hayden H. Gordon; M.A.; College of William and Mary; Instructor in Marine Science; Remote Sensing.
- Carl Hershner; Ph.D., University of Virginia; Instructor in Marine Science; Wetlands ecology.
- J. Claiborne Jones; M.A., College of William and Mary; Instructor in Marine Science; Information transfer.
- Linda R. Kilch; M.S., Tennessee Technological University; Instructor in Marine Science; Water quality analyses; urban runoff; nutrient enrichment.
- Jon A. Lucy; M.A., College of William and Mary; Instructor in Marine Science; Sportfisheries, marine recreation; advisory services.
- Robert J. Lukens; B.S., Massachusetts Institute of Technology; Instructor in Marine Science; Instrumentation; computer science.
- John E. Olney; M.A., College of William and Mary; Instructor in Marine Science; Systematics; fish larvae.
- John B. Pleasants; M.M.A., University of Rhode Island; Instructor in Marine Science; Marine affairs.
- Ginny H. Shaw; M.S., College of William and Mary; Instructor in Marine Science; Computer science.
- Kenneth J. Sulak; M.S., University of Miami; Instructor in Marine Science; Ichthyology; Zoogeography; systematics.
- David E. Zwerner; M.A., College of William and Mary; Instructor in Marine Science; Parasitology; fish diseases.

## Appendix A

### SPONSORED RESEARCH

#### Key

BARDP - U.S./Israel Bilateral Agriculture Research and Development Program  
 C of E - U.S. Army Corps of Engineers  
 CPCB - Citizen's Program for the Chesapeake Bay  
 CRC - Chesapeake Research Corporation, Inc.  
 EPA - Environmental Protection Agency  
 F&WS - Fish and Wildlife Service  
 HRSD - Hampton Roads Sanitation District  
 HRWQA - Hampton Roads Water Quality Agency  
 MAFDC - Mid-Atlantic Fisheries Development Foundation  
 NASA - National Aeronautic and Space Administration  
 NMFS - National Marine Fisheries Service  
 NNSDDC - Newport News Shipbuilding and Dry Dock Company  
 NOAA - National Oceanic and Atmospheric Agency  
 NSF - National Science Foundation  
 OWRT - Office of Water Research Technology  
 SWCB - Virginia State Water Control Board  
 USDA - United States Department of Agriculture  
 USGS - United States Geological Survey  
 VDCEd - Virginia Department of Conservation and Economic Development  
 VDHT - Virginia Department of Highways and Transportation  
 VDT - Virginia Department of Taxation  
 VSWCS - Virginia Soil and Water Conservation Service  
 VWF - Virginia Wildlife Federation  
 W&M - William and Mary

<u>Title</u>	<u>Funding Agency</u>	<u>Amount</u>
Re-Evaluation Study of Virginia's Potomac Embayments	SWCB	\$ 150,000.00
Hard Clam Survey in Hampton Roads	VDHT	9,539.00
Relative Recruitment Estimates for Striped Bass	NMFS	18,000.00
The Distribution and Abundance of Bottle-Nosed Dolphins in the Near Shore Waters of Virginia	NMFS	9,890.00
1980 Summer Virginia Wildlife Federation Camp	VWF	2,000.00



<u>Title</u>	<u>Funding Agency</u>	<u>Amount</u>
Index of Juvenile Striped Bass, White Perch and Alosine Fishes in the Rappahannock River	Mason & Hauger-Silas Mason Co., Inc.	8,000.00
Production of Halogenated Organics during Wastewater Disinfection	HRSD	2,171.00
Chesapeake Bay Circulation and Water Quality Models	EPA	77,888.00
Landsat Analysis of the Dynamics of the Chesapeake Bay Plume on the Continental Shelf	NMFS	4,883.00
Obtain Continuous Cores in the Potomac Estuary, Washington D.C. to Chesapeake Bay	USGS	17,111.00
Study Areas of Leased Oyster Ground	VDHT	5,477.00
Study to Investigate Source & Transport Route of Marine Organisms in Hampton Roads and Current Velocity Profiles of Pier 12	U.S. Navy	98,203.00
In Situ Survival of Enteric Bacteria	OWRT	12,500.00
Validation of 2nd Sediment Interim Reference Material	NMFS	2,700.00
Investigation of Subsurface Conditions at Goose Hill Channel and Saucinx Point - Swann Point - Shoal Channel James River	C of E	19,791.00
Economic Evaluation on Crab Meal processing	MAFDC	8,080.00
Interaction of Fuels with Sediments.	U.S. Air Force	142,122.00
Grant in Aid	Sigma Xi	100.00
Analysis of Samples for Kepone	C of E	3,500.00

<u>Title</u>	<u>Funding Agency</u>	<u>Amount</u>
Grant in Aid	W&M	165.00
Vegetative Erosion Control	VSWCS	31,250.00
1981 Sea Grant Program	NOAA	669,554.00
Grant in Aid	W&M	75.00
Grant in Aid	W&M	238.00
Grant in Aid	W&M	247.00
Grant in Aid	W&M	167.00
Grant in Aid	W&M	137.00
Effects of Winter Temperatures on Juvenile Croaker	NMFS	475.00
Grant in Aid	W&M	300.00
Anadromous Fisheries Program	NMFS	120,408.00
Minor Research Grant for Automated Chemistry Adapter	W&M	300.00
Virginia Landsat Applications for Commonwealth Data Base	VDT	41,776.00
Water Pollution Control	EPA	194,635.00
Submerged Aquatic Vegetation	EPA	147,133.00
Assistance for Supplies	Anheuser-Busch	1,000.00
Oyster Production in the Outflow of Salt Water Fish Pond	BARDP	2,500.00
Assessment of Larval Striped Bass	NMFS	51,000.00
Study to Determine the Presence, Species, Composition and Relative Abundance of Anadromous Fish in Pohick Creek, Fairfax, Va. in Relation to Impoundment	USDA	2,400.00
Beam Trawl Demonstration.	Fass Brothers	2,851.00

<u>Title</u>	<u>Funding Agency</u>	<u>Amount</u>
Work Study	CRC	5,036.00
Development and Testing of an Automated Discriminative Unicellular Plankton Enumeration Technique	NSF	34,891.00
Striped Bass/3 rivers	NMFS	40,009.00
A Re-evaluation of the Gross Morphology of Placoid Scales from a Hydrodynamic Standpoint	NASA	5,999.00
Consulting Services	VDCEd	25,000.00
Sampling on N. Landing River	C of E	8,253.00
Mapping of the Sensitivity of Selected Coastal Environment in Maryland, Virginia and North Carolina to Spilled Oil	NOAA	32,700.00
Photographic Services	F&WS	3,661.00
Assessment of Starvation in Larval Striped Bass	F&WS	38,000.00
Sort and Identify Benthic Samples	F&WS	609.00
Marine Life Sampling	NNSDDC	1,132.00
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	TOTAL	\$2,056,856.00