

WILLIAM & MARY

SCHOOL OF
MARINE
SCIENCE

1992 - 1993



300

William & Mary

August 1992

NOTE: This catalog provides announcements for the 1992-93 academic year. It is current until August 1993. The College reserves the right to make changes in the regulations, charges, and curricula listed herein at any time.

Catalogs are issued for College programs as follows:

- Undergraduate
- School of Business Administration
- School of Education
- Graduate Studies in Arts and Sciences
- School of Marine Science
- Marshall-Wythe School of Law
- Summer Sessions
- Special Programs



WILLIAM
& MARY

School of Marine Science
Virginia Institute of Marine Science

1992-1993

VIMS
VIMS



Contents

Calendar	4	International Students	47
Board of Visitors	6	Admission Information	47
Officers of Administration	6	Classified Students	47
Administrative Staff	6	Unclassified Students	49
The College of William and Mary	7	Degree Requirements	50
School of Marine Science	8	General	50
History	8	Required Courses	53
Facilities	8	Degree of Master of Arts	53
Statement of Purpose	9	Degree of Doctor of Philosophy	55
School of Marine Science Faculty	10	General Statement of Policy	57
Associate Faculty	14	Honor System	57
Academic Program	17	Financial Information	58
General Program Description	17	Tuition and Fees	58
General Research Facilities	18	Graduate Assistantships	58
General Preparatory		Graduate Fellowships	59
Requirements	18	Research Graduate Student	
Graduate Study in		Status	59
Biological Oceanography	18	Eligibility for In-state	
Graduate Study in		Tuition Rate	59
Environmental Chemistry		Payment of Accounts	60
and Toxicology	21	Refunds to Students Who	
Graduate Study in		Withdraw from College	60
Fisheries Science	23	Withholding of Transcripts	
Graduate Study in		and Diplomas in Cases	
Geological Oceanography	25	of Unpaid Accounts	61
Graduate Study in Marine		Student Facilities and Services	62
Resource Management and		Campus Parking	62
Policy	26	Housing	62
Graduate Study in		Cultural Life at	
Physical Oceanography and		William and Mary	62
Environmental Engineering	28	Outdoor Life and Athletics	63
Description of Courses	31	Student Health Service	64
Undergraduate Courses	44	The Graduate Student	
Graduate Regulations	46	Association	64
Application for Admission	46		

Calendar

1992

Fall Semester

August 17-21	Registration Validation, Returning Students (Mon.-Fri.)
August 24-25	New Student Orientation/Registration (Mon.-Tues.)
August 26	BEGINNING OF CLASSES: 8:00 a.m. (Wed.)
September 2	Last Day to Drop Courses (Wed.)
September 4	Last Day to Add Courses (Fri.)
September 4	Last Day to File for December 1992 Graduation (Fri.)
October 9	Mid-Semester (for grading purposes only) (Fri.)
October 10-13	Fall Break (Sat.-Tues.)
October 19-23	Advanced Registration for Spring 1993 (Mon.-Fri.)
October 30	Last Day to File for May 1993 Graduation (Fri.)
November 25	Beginning of THANKSGIVING HOLIDAY: 8 a.m. (Wed.)
November 30	End of THANKSGIVING HOLIDAY: 8 a.m. (Mon.)
December 4	End of Classes: 5 p.m. (Fri.)
December 5-6	Reading Period (Sat.-Sun.)
December 7-8	Examinations (Mon.-Tues.)
December 9	Reading Period (Wed.)
December 10-11	Examinations (Thurs.-Fri.)
December 11	Last Day to Submit Theses and Dissertations for December Conferral of Degrees (Fri.)
December 12-13	Reading Period (Sat.-Sun.)
December 14-15	Examinations (Mon.-Tues.)
December 16	Reading Period (Wed.)
December 17-18	Examinations (Thurs.-Fri.)
December 21	OFFICIAL GRADUATION DATE (Mon.)

1993

Spring Semester

January 4-6	Registration Validation, Returning Students (Mon.-Wed.)
January 20	BEGINNING OF CLASSES: 8 a.m. (Wed.)
January 27	Last Day to Drop Courses (Wed.)
January 29	Last Day to Add Courses (Fri.)
February 13	Charter Day (Sat.)
March 5	Mid-Semester (for grading purposes only) (Fri.)
March 6	Beginning of SPRING VACATION (Sat.)
March 14	End of SPRING VACATION (Sun.)
March 15-19	Advanced Registration for Fall 1993 Semester (Mon.-Fri.)
April 30	End of Classes: 5 p.m. (Fri.)
May 1-2	Reading Period (Sat.-Sun.)
May 3-7	Examinations (Mon.-Fri.)
May 7	Last Day to Submit Theses and Dissertations for May Conferral of Degrees (Fri.)
May 8-9	Reading Period (Sat.-Sun.)
May 10-12	Examinations (Mon.-Wed.)
May 10-14	Advanced Registration for Summer (Mon.-Fri.)
May 16	COMMENCEMENT (Sun.)

1993

Summer Sessions

April 14	Summer School Bulletins Available (Watermen's 233) (Wed.)
May 31	Beginning of First Term and Long Term (Mon.)
June 7	Last Day to File for August 1993 Graduation (Mon.)
July 2	End of First Term (Fri.)
July 5	Beginning of Second Term (Mon.)
August 4	Last Day to Submit Theses and Dissertations for August Conferral of Degrees (Wed.)
August 6	End of Second Term and Long Term (Fri.)
August 9	OFFICIAL GRADUATION DATE (Mon.)

Board of Visitors

Hays T. Watkins, LL.D. '82 Rector
 James W. Brinkley '59 Vice Rector
 James E. Ukrop '60 Secretary

A. Marshall Acuff, Jr '62	Norma B. Harvey
Frank Batten	Janet Hill
Edward J. Campbell	Joseph R. Koons '68
J. Edward Grimsley '51	James W. McGlothlin '62
Gilbert M. Grosvenor, L.H.D. '87	James B. Murray, Jr. '74
Najceeb E. Halaby	Wallace H. Terry
Audrey M. Harris '60	John H. Tucker, Jr. '54

Officers of Administration

Timothy J. Sullivan President
 Melvyn D. Schiavelli Provost
 Edward T. Allenby Vice President for University Advancement
 William F. Merck II Vice President for Administration and Finance
 Dennis L. Taylor Dean, School of Marine Science
 Henry Aceto, Jr. Acting Dean of Graduate Studies, School of Marine Science
 Robert J. Byrne Director for Research and Advisory Services, School of Marine Science
 Paul V. Koehly Associate Director for Planning and Budget,
 School of Marine Science

Administrative Staff

Charles McFadden Library Director
 David A. Evans Director, Computer Center
 Sue N. Presson Student Records Coordinator
 Sarah R. Hamrick International Student Coordinator
 Robert H. George Consulting Veterinarian

The College of William and Mary

Founded in 1693 as the second institution of higher education in the country, The College of William and Mary in Virginia is today a small, residential, full-time, coeducational university. A state university, the college draws seventy percent of its 5,376 undergraduate students from the Commonwealth of Virginia. It is also national and international in character and contribution, enrolling students with varied backgrounds from throughout the nation and from many foreign countries.

William and Mary at the undergraduate level is dedicated to providing a liberal education that is rounded and thorough. All students gain a broad base of understanding and knowledge in arts and sciences in their freshman and sophomore years. In their junior and senior years, they may pursue work toward the Bachelor of Arts or Bachelor of Science degrees in a full range of concentrations in arts and sciences or education, or they may enter a program of study in the School of Business Administration leading to the Bachelor of Business Administration degree.

The College also provides the opportunity for 2,334 students to pursue graduate work compatible with the liberal undergraduate program. Several departments in the School of Arts and Sciences offer advanced studies leading to the Master of Arts or Master of Science degrees. The History, Physics, and Psychology departments have programs leading to the Ph.D. and Psy.D. degrees. In the professional schools, the Marshall-Wythe School of Law offers the Juris Doctor degree; the School of Business Administration offers the M.B.A.; and the School of Education offers the Master of Arts in Education, the Certificate of Advanced Study, and the Doctor of Education. The School of Marine Science (SMS) offers programs leading to M.A. and Ph.D. degrees.

The College's commitment in all programs to liberal education is the source of institutional coherence. William and Mary emphasizes, in its undergraduate, graduate and professional programs, the development of the student as a whole individual. The criterion of excellence in teaching and learning, in class and out of class, is at the heart of the educational process. With such objectives, and with a selective and limited enrollment, the College strives to provide its students with a high quality education, and to make a significant contribution to the Commonwealth of Virginia and to the nation through the development of independent, responsive individuals. Faculty, students, and administrators work closely together to create this educational environment, under the leadership of the Board of Visitors and with the support of the Board of the Society of the Alumni.

Continuing exploration of and participation in innovative and experimental approaches to teaching and learning are a significant aspect of the College's forward movement, and emphasis on research and high quality graduate programs contribute strongly to the development of excellence at William and Mary.

The College is accredited by the Southern Association of Colleges and Schools, offering a wide range of courses, seminars, and programs both for credit and non-credit, in the evening and during the day, at its Williamsburg campus and at the Gloucester Point and

Wachapreague campuses of the School of Marine Science. This contribution to the educational enrichment of the citizens of Virginia throughout their careers is provided by the professional schools of education, business, law, and marine science and by the faculty of arts and sciences. It is in keeping with the College's commitment as a state institution to community service and enhanced educational opportunities for the adult citizens of the Commonwealth, and for its more than 67,000 alumni.

School of Marine Science

Virginia Institute of Marine Science

History

The School of Marine Science had its inception in the establishment of the Virginia Fisheries Laboratory by the Commonwealth in 1940. From 1940 until 1959 the academic program of the Laboratory was conducted by the Department of Biology of the College of William and Mary.

In 1959 the program became the Department of Marine Science, and in 1961 the Board of Visitors established the marine training program as the School of Marine Science. The General Assembly in 1962 reestablished the Virginia Fisheries Laboratory as the Virginia Institute of Marine Science, an independent research and service institution providing educational offerings in the marine sciences through the School of Marine Science. In 1979 the General Assembly merged the Institute with the College of William and Mary.

Laboratories of the Institute originally were on the main campus at Williamsburg and at Yorktown. In 1950 the first permanent building was erected on the present campus at Gloucester Point, across the York River from Yorktown. The Virginia Institute of Marine Science, School of Marine Science (VIMS/SMS) campus at Gloucester Point occupies what once was the site of Gloucester Town, an early colonial settlement established in 1680 by an act of the Virginia Assembly. The remains of military fortifications on and near the campus reflect Gloucester Point's historic strategic importance: British conscripts occupied the area during the pivotal Siege of Yorktown in 1781, and during the Civil War Confederate soldiers and later Union troops held sway from the point's key location at the mouth of the York River. The School awarded its first master's degree in 1943, and in 1964 inaugurated a doctoral program in Marine Science.

Facilities

Students of marine science (including marine fisheries science, biological, chemical, geological, and physical oceanography, and certain other areas of concentration including marine resource management), through offerings of the School of Marine Science and various departments at the main campus in Williamsburg, have the unusual oppor-

tunity to participate in advanced undergraduate and graduate education at an active, year-round center of marine research.

The main campus is located at Gloucester Point on the York River, an important estuary with easy access to the Chesapeake Bay and the nearby Atlantic Ocean. The Institute and the School are admirably situated for performing research and teaching marine, estuarine, and freshwater biology, chemistry, geology, physical oceanography, and marine engineering. The campus of the Eastern Shore Branch Laboratory at Wachapreague, Virginia, offers access to the embayments, salt marshes, barrier beaches, and coastal waters of Virginia's Eastern Shore. The Wachapreague facility has laboratories for mariculture and research as well as dormitory and classroom space.

The first permanent building, Maury Hall, constructed in 1950, is devoted primarily to laboratories. Brooke Hall (1958) contains offices and other laboratory facilities, and Davis Hall (1961) houses the scanning and transmission electron microscopes. The second floor of Davis Hall (added in 1974) houses laboratories associated with the microbiology program. Byrd Hall (1969) houses ecology-pollution, chemistry, and laboratories. Jefferson Hall (which was purchased in 1966 and enlarged in 1972) houses most of the faculty and staff of marine fisheries science and their laboratories. Nunnally Hall was completed in 1992 to house the vertebrate and invertebrate collections of the Institute. Six buildings have flow-through saltwater systems providing additional experimental facilities. Modern, well-equipped chemical laboratories allow scientists and students to pursue marine chemistry with state-of-the-art facilities. Physical oceanography and environmental engineering faculty, staff and facilities are located in both Franklin and Newport Halls. Geological oceanography is centered in the Hoxton Building and also has facilities in several adjacent buildings. Watermen's Hall, completed in 1984, contains three fully-equipped teaching laboratories, three classrooms, a marine science library containing approximately 34,000 volumes and 1,500 serial titles, a time-sharing PRIME 9955 Model II computer, as well as central administration, advisory services, and a 273-seat auditorium.

The Institute has an extensive complement of modern scientific equipment including a mass spectrometer, two electron microscopes (scanning and transmission) and a sidescan sonar system. A hydraulic flume is housed in Franklin Hall.

Statement of Purpose for the School of Marine Science

The purpose of the School of Marine Science of the College of William and Mary is to provide excellence in graduate education to students pursuing careers in marine science.

The objective of the educational program is to provide a fertile and stimulating learning environment that produces high quality marine scientists to meet the needs of the Commonwealth and the nation. This is accomplished by providing students with a comprehensive educational program on the basic principles of marine science and marine resource management and the opportunity for close interaction with faculty actively involved in research and management issues.

School of Marine Science Faculty

Dennis L. Taylor, Dean and Professor of Marine Science. B.A., University of Pennsylvania; Ph.D., DSc., University of Wales. Biological Oceanography.

Henry Aceto, Jr., Acting Dean of Graduate Studies and Professor of Biology. B.S., State University of New York, Albany; M.S., University of California, Berkeley; Ph.D., University of Texas.

Robert J. Byrne, Director for Research and Advisory Services and Professor of Marine Science. M.S., Ph.D., University of Chicago. Geological Oceanography.

Jay D. Andrews, Professor Emeritus of Marine Science. B.S., Kansas State College; M.A., Ph.D., University of Wisconsin. Marine Fisheries Science.

Rudolf H. Bieri, Professor Emeritus of Marine Science. Dr.rer.nat. Johann Gutenberg University. Chemistry and Toxicology.

Michael Castagna, Professor Emeritus of Marine Science. B.S., M.S., Florida State University. Biological Oceanography.

William J. Hargis, Jr., Professor Emeritus of Marine Science. A.B., M.A., University of Richmond; Ph.D., Florida State University. Biological Oceanography.

Dexter S. Haven, Professor Emeritus of Marine Science. B.S., M.S., Rhode Island State College. Marine Fisheries Science.

Maynard M. Nichols, Professor Emeritus of Marine Science. B.S., Columbia University; M.S., Scripps Institution of Oceanography; Ph.D., University of California at Los Angeles. Geological Oceanography.

Willard A. Van Engel, Professor Emeritus of Marine Science. Ph.B., Ph.M., University of Wisconsin. Marine Fisheries Science.

J. Ernest Warinner, III, Assistant Professor Emeritus of Marine Science. B.S., M.A., College of William and Mary. Chemistry and Toxicology.

Frank J. Wojcik, Assistant Professor Emeritus of Marine Science. B.S., University of Massachusetts; M.S., University of Alaska. Marine Fisheries Science.

Herbert M. Austin, Professor of Marine Science. B.S., Grove City College; M.S., University of Puerto Rico; Ph.D., Florida State University. Marine Fisheries Science.

Michael E. Bender, Professor of Marine Science. B.A., Southern Illinois University; M.S., Michigan State University; Ph.D., Rutgers University. Biological Oceanography.

John D. Boon, III, Professor of Marine Science. B.A., Rice University; M.A., Ph.D., College of William and Mary. Geological Oceanography.

Mark E. Chittenden, Jr., Professor of Marine Science. B.A., Hobart College; M.S., Ph.D., Rutgers University. Marine Fisheries Science.

- William D. DuPaul**, Professor of Marine Science. B.S., Bridgewater State College; M.A., Ph.D., College of William and Mary. Marine Fisheries Science.
- George C. Grant**, Professor of Marine Science. B.S., University of Massachusetts; M.A., College of William and Mary; Ph.D., University of Rhode Island. Biological Oceanography.
- Robert J. Huggett**, Professor of Marine Science. M.S., Scripps Institution of Oceanography; Ph.D., College of William and Mary. Chemistry and Toxicology.
- Albert Y. Kuo**, Professor of Marine Science. B.S., National Taiwan University; M.S., University of Iowa; Ph.D., The Johns Hopkins University. Physical Oceanography and Environmental Engineering.
- Joseph G. Loesch**, Professor of Marine Science. B.S., University of Rhode Island; M.S., Ph.D., University of Connecticut. Marine Fisheries Science.
- Maurice P. Lynch**, Professor of Marine Science. A.B., Harvard University; M.A., Ph.D., College of William and Mary. Marine Resource Management.
- William G. MacIntyre**, Professor of Marine Science. B.S., M.S., Ph.D., Dalhousie University. Chemistry and Toxicology.
- Roger L. Mann**, Professor of Marine Science. B.S., University of East Anglia; Ph.D., University of Wales. Marine Fisheries Science.
- John A. Musick**, Professor of Marine Science. A.B., Rutgers University; M.A., Ph.D., Harvard University. Marine Fisheries Science.
- Bruce J. Neilson**, Professor of Marine Science. B.A., M.S.E., M.A., Princeton University; Ph.D., The Johns Hopkins University. Physical Oceanography and Environmental Engineering.
- Frank O. Perkins**, Professor of Marine Science. B.A., University of Virginia; M.S., Ph.D., Florida State University. Biological Oceanography.
- Morris H. Roberts, Jr.**, Professor of Marine Science. B.A., Kenyon College; M.A., Ph.D., College of William and Mary. Biological Oceanography.
- Gene M. Silberhorn**, Professor of Marine Science. B.S., Eastern Michigan University; M.S., West Virginia University; Ph.D., Kent State University. Biological Oceanography.
- N. Bartlett Theberge, Jr.**, Professor of Marine Science. B.S., J.D., College of William and Mary; LL.M., University of Miami. Marine Resource Management.
- Kenneth L. Webb**, Chancellor Professor of Marine Science. A.B., Antioch College; M.S., Ph.D., Ohio State University. Biological Oceanography.
- Richard L. Wetzel**, Professor of Marine Science. B.S., M.S., University of West Florida; Ph.D., University of Georgia. Biological Oceanography.
- L. Donelson Wright**, Professor of Marine Science. B.A., University of Miami; M.A., University of Sydney; Ph.D., Louisiana State University. Geological Oceanography.

- John M. Brubaker**, Associate Professor of Marine Science. A.B., Miami University; Ph.D., Oregon State University. Physical Oceanography and Environmental Engineering.
- Eugene M. Bureson**, Associate Professor of Marine Science. B.S., Eastern Oregon College; M.S., Ph.D., Oregon State University. Biological Oceanography.
- Fu-Lin Chu**, Associate Professor of Marine Science. B.S., Chung Chi College; M.S., University of Rochester; Ph.D., College of William and Mary. Biological Oceanography.
- Robert J. Diaz**, Associate Professor of Marine Science. B.A., LaSalle College; M.S., Ph.D., University of Virginia. Biological Oceanography.
- David A. Evans**, Associate Professor of Marine Science. B.A., M.A., Cambridge University; Ph.D., Oxford University. Physical Oceanography and Environmental Engineering.
- Mohamed Faisal Abdel-Kariem**, Associate Professor of Marine Science. B.V. Sci., M.V. Sci., Cairo University; D.V.M., University of Ludwig-Maximilian. Chemistry and Toxicology.
- Leonard W. Haas**, Associate Professor of Marine Science. A.B., Dartmouth College; M.S., University of Rhode Island; Ph.D., College of William and Mary. Biological Oceanography.
- John M. Hamrick**, Associate Professor of Marine Science. B.C.E., Georgia Institute of Technology; M.S., Massachusetts Institute of Technology; Ph.D., University of California, Berkeley. Physical Oceanography and Environmental Engineering.
- Carl H. Hershner**, Associate Professor of Marine Science. B.S., Bucknell University; Ph.D., University of Virginia. Marine Resource Management.
- Howard I. Kator**, Associate Professor of Marine Science. B.S., Harpur College; Ph.D., Florida State University. Biological Oceanography.
- James E. Kirkley**, Associate Professor of Marine Science. B.S., M.S., Ph.D., University of Maryland. Marine Resource Management.
- Romuald N. Lipcius**, Associate Professor of Marine Science. B.S., University of Rhode Island; Ph.D., Florida State University. Marine Fisheries Science.
- Robert J. Orth**, Associate Professor of Marine Science. B.A., Rutgers University; M.A., University of Virginia; Ph.D., University of Maryland. Biological Oceanography.
- Mark R. Patterson**, Associate Professor of Marine Science. A.B., Harvard College; A.M., Ph.D., Harvard University. Biological Oceanography.
- Evon P. Ruzicki**, Associate Professor of Marine Science. A.B., Knox College; M.S., University of Wisconsin; Ph.D., University of Virginia. Physical Oceanography and Environmental Engineering.
- Beverly A. Weeks-Perkins**, Associate Professor of Marine Science. B.A., Winthrop College; M.S. Tulane University; Ph.D., North Carolina State University. Chemistry and Toxicology.

- Bruce J. Barber**, Assistant Professor of Marine Science. B.S., Ohio State University; Ph.D., University of South Florida. Marine Fisheries Science.
- Thomas A. Barnard, Jr.**, Assistant Professor of Marine Science. B.A., Milligan College; M.A., College of William and Mary. Marine Resource Management.
- James A. Colvocoresses**, Assistant Professor of Marine Science. B.S., Tulane University; M.A., Ph.D., College of William and Mary. Marine Fisheries Science.
- Rebecca M. Dickhut**, Assistant Professor of Marine Science. B.S., St. Norbert College; M.S., Ph.D., University of Wisconsin, Madison. Chemistry and Toxicology.
- John E. Graves**, Assistant Professor of Marine Science. B.S., Revelle College, University of California, San Diego; Ph.D., Scripps Institution of Oceanography, University of California, San Diego. Marine Fisheries Science.
- Robert C. Hale**, Assistant Professor of Marine Science. B.S., B.A., Wayne State University; Ph.D., College of William and Mary. Chemistry and Toxicology.
- Carl H. Hobbs, III**, Assistant Professor of Marine Science. B.S., Union College; M.S., University of Massachusetts. Geological Oceanography.
- Jerome P.-Y. Maa**, Assistant Professor of Marine Science. B.S., University of Taiwan; M.S., Cheng-Kong University; Ph.D., University of Florida. Geological Oceanography.
- John E. Olney**, Assistant Professor of Marine Science. B.S., M.A., College of William and Mary. Biological Oceanography.
- Linda C. Schaffner**, Assistant Professor of Marine Science. B.A., Drew University; M.A., Ph.D., College of William and Mary. Biological Oceanography.
- Peter Van Veld**, Assistant Professor of Marine Science. B.S., University of North Carolina, Chapel Hill; M.A., College of William and Mary; Ph.D., University of Georgia. Chemistry and Toxicology.
-
- Kevin P. Kiley**, Instructor in Marine Science. B.S., Tufts University; M.A., College of William and Mary. Physical Oceanography and Environmental Engineering.
- Jon A. Lucy**, Instructor in Marine Science. B.S., University of Richmond; M.A., College of William and Mary. Marine Fisheries Science.
- Robert J. Lukens**, Instructor in Marine Science. B.S., Massachusetts Institute of Technology. Physical Oceanography and Environmental Engineering.
- Kenneth A. Moore**, Instructor in Marine Science. B.S., Pennsylvania State University; M.S., University of Virginia. Biological Oceanography.
- Walter I. Priest, III**, Instructor in Marine Science. B.S., Virginia Military Institute; M.S., Old Dominion University. Marine Resource Management.
- Martha W. Rhodes**, Instructor in Marine Science. B.S., Virginia Polytechnic Institute and State University; M.A., Medical College of Virginia, Virginia Commonwealth University. Biological Oceanography.

Jacques van Montfrans, Instructor in Marine Science. B.S., Florida State University; M.S., Florida Atlantic University. Biological Oceanography.

Associate Faculty

Associate Faculty are appointed to three-year renewable terms to engage in the graduate instruction and research program of the School of Marine Science.

Gary F. Anderson, B.S., Southampton College of Long Island University; M.A., College of William and Mary. Virginia Institute of Marine Science. Physical Oceanography and Environmental Engineering.

Carl Richard Berquist, Jr., B.E., M.S., Vanderbilt University; Ph.D., College of William and Mary. Virginia Institute of Marine Science. Geological Oceanography.

Steven Branstetter, B.S., Missouri Southern State College; M.S., University of South Alabama; Ph.D., Texas A&M University. Virginia Institute of Marine Science. Marine Fisheries Science.

Mitchell A. Byrd, B.S., M.S., Ph.D., Virginia Polytechnic Institute and State University. College of William and Mary. Biological Oceanography.

C. Scott Hardaway, B.A., M.S., East Carolina University. Virginia Institute of Marine Science. Geological Oceanography and Marine Resource Management.

Gerald H. Johnson, B.S., M.A., Ph.D., Indiana University. College of William and Mary. Geological Oceanography.

Victor A. Liguori, A.B., Haverford College; M.A., Ph.D., Princeton University. College of William and Mary. Marine Resource Management.

Mark W. Luckenbach, B.S., University of North Carolina; Ph.D., University of South Carolina. Virginia Institute of Marine Science. Biological Oceanography.

Charlotte P. Mangum, A.B., Vassar College; M.S., Ph.D., Yale University. College of William and Mary. Biological Oceanography.

James E. Perry, III, B.S., Murray State University; Ph.D., College of William and Mary. Virginia Institute of Marine Science. Marine Resource Management.

John N. Posenau, B.A., Christopher Newport College. Virginia Institute of Marine Science. Physical Oceanography and Environmental Engineering.

Gary W. Rice, B.S., James Madison University; Ph.D., Iowa State University. College of William and Mary. Chemistry and Toxicology.

Craig L. Smith, A.B., The Johns Hopkins University; Ph.D., University of Florida. Virginia Institute of Marine Science. Chemistry and Toxicology.

Michael A. Unger, B.S., Michigan State University; M.S., Ph.D., College of William and Mary. Virginia Institute of Marine Science. Chemistry and Toxicology.

- Wolfgang Vogelbein**, B.S., Southampton College; M.S., California State University; Ph.D., Louisiana State University. Virginia Institute of Marine Science. Chemistry and Toxicology.
-
- Donald F. Boesch**, B.S., Tulane University; Ph.D., College of William and Mary. Center for Environmental and Estuarine Studies, University of Maryland System. Biological Oceanography.
- David R. Burris**, B.A., College of Wooster; Ph.D., College of William and Mary. U.S. Air Force Engineering and Services Center. Chemistry and Toxicology.
- H. Jacque Carter**, B.S., M.S., Northern Illinois University; Ph.D., College of William and Mary. Wildlife Conservation International. Marine Fisheries Science.
- Carl F. Cerco**, B.S., Newark College of Engineering; M.S., University of North Carolina; M.S., Massachusetts Institute of Technology; Ph.D., College of William and Mary. Department of the Army, Waterways Experiment Station. Physical Oceanography and Environmental Engineering.
- Bruce B. Collette**, B.S., Ph.D., Cornell University. National Marine Fisheries Service. Marine Fisheries Science.
- Carroll N. Curtis**, B.A. Sweet Briar College; M.S., Old Dominion University. Environmental Consultant. Marine Resource Management.
- John W. Daniel, II**, J.D., T.C. Williams School of Law; B.A., St. Andrews Presbyterian College. McGuire, Woods, Battle & Booth. Marine Resource Management.
- Michael L. Fine**, B.S., University of Maryland; M.A., College of William and Mary; Ph.D., University of Rhode Island. Virginia Commonwealth University. Marine Fisheries Science.
- Robert H. George**, B.S., University of Maryland; D.V.M., University of Georgia. Gloucester Veterinary Hospital, Ltd. Marine Fisheries Science.
- John J. Govoni**, A.B., St. Anselm's College; M.S., Southeastern Massachusetts University; Ph.D., College of William and Mary. National Marine Fisheries Service. Marine Fisheries Science.
- Robert C. Harriss**, B.S., Florida State University; M.A., Ph.D., Rice University. Chemistry and Toxicology.
- G. David Johnson**, B.S., University of Texas at Austin; Ph.D., University of California at San Diego. Smithsonian Institution. Biological Oceanography.
- Cynthia Jones**, B.A., Boston University; M.S., Ph.D., University of Rhode Island. Applied Marine Research Laboratory, Old Dominion University. Marine Fisheries Science.
- Suzette M. Kimball**, B.A., B.S., College of William and Mary; M.S., Ball State University; Ph.D., University of Virginia. University of Virginia. Geological Oceanography and Marine Resource Management.

- Martin L. Lenhardt**, B.S., M.A., Seton Hall University; Ph.D., Florida State University. Virginia Commonwealth University. Marine Fisheries Science.
- Ole Secher Madsen**, B.S., M.S., Technical University of Denmark; ScD., Massachusetts Institute of Technology. R.M. Parsons Laboratory. Geological Oceanography.
- John V. Merriner**, B.A., Rutgers University; M.S., Ph.D., North Carolina State University. National Marine Fisheries Service. Marine Fisheries Science.
- Thomas A. Monroe**, B.S., Southeastern Massachusetts University; M.S., Ph.D., College of William and Mary. National Museum of Natural History. Marine Fisheries Science.
- Brenda L. Norcross**, A.B., MacMurray College; M.S., St. Louis University; Ph.D., College of William and Mary. University of Alaska, Fairbanks. Marine Fisheries Science.
- Polly A. Penhale**, B.A., Earlham College; M.S., Ph.D., North Carolina State University. National Science Foundation. Biological Oceanography.
- William G. Raschi**, B.A., State University of New York at Geneseo; M.S., Southern Massachusetts University; Ph.D., College of William and Mary. Bucknell University. Marine Fisheries Science.
- Theodore R. Reiff**, B.S., Michigan State College; M.D., NYU Bellevue College of Medicine. Chemistry and Toxicology.
- Charles D. Rice**, B.S., M.S., Virginia Commonwealth University; Ph.D., College of William and Mary. Medical College of Virginia. Marine Fisheries Science.
- George W. Sherk**, B.A., M.A., Colorado State University; J.D., University of Denver School of Law. Land and Water Resources Division, U.S. Department of Justice. Marine Resource Management.
- John E. Sherwood**, B.S., Ph.D., University of New South Wales. Warrnambool Institute, Australia. Chemistry and Toxicology.
- Carl N. Shuster, Jr.**, B.S., M.S., Rutgers University; Ph.D., New York University. Biological Oceanography.
- Michael E. Sieracki**, B.A., University of Delaware; M.S., Ph.D., University of Rhode Island. Bigelow Laboratory for Ocean Sciences. Biological Oceanography.
- Kenneth J. Sulak**, B.A., Harvard University; M.S., University of Miami. Huntsville Marine Laboratory, Canada. Marine Fisheries Science.
- Ruth D. Turner**, B.S., Bridgewater State College; M.A., Cornell University; Ph.D., Radcliffe, Harvard University. Harvard University. Marine Fisheries Science.
- Michael Vecchione**, B.S., University of Miami; Ph.D., College of William and Mary. National Museum of Natural History. Biological Oceanography.
- James E. Weaver**, B.S., M.S., Louisiana State University; Ph.D., University of Virginia. U.S. Fish and Wildlife Service. Marine Fisheries Science.
- Scott C. Whitney**, A.B., University of Nevada; LL.B., J.D., Harvard Law School. George Mason University. Marine Resource Management.

Academic Program



Graduate student measures a queen conch shell.

General Program Description

The academic program of the School of Marine Science is intended primarily for the student who wishes to specialize in marine science at the graduate level. Degrees offered are the Master of Arts and Doctor of Philosophy in Marine Science. The school offers research opportunities and instruction at the graduate level in five general areas: Physical Sciences, Biological Sciences, Environmental Chemistry and Toxicology, Resource Management and Policy, and Aquaculture and Fisheries Science.

Though the courses offered by the School are primarily for graduate students, advanced undergraduates (juniors and seniors) may participate. For instance, biology, chemistry, and physics majors may enroll in suitable 400 level marine science courses for credit toward the bachelor's degree provided certain conditions (see College of William and

Mary Undergraduate Program Catalog) are met. Undergraduates may also enroll for research credit to work on problems in marine science. The student is responsible for making the necessary arrangements with an individual School of Marine Science faculty member, and the consent of the chairperson of the student's major department is also required.

General Research Facilities

The graduate program of the School of Marine Science is well supported by extensive computing facilities, research vessels and field instrumentation.

A central Computer Center offers access to a PRIME 9955 Model II, and a microcomputer laboratory is available for student use. Other computers in use throughout the Institute's offices and laboratories also serve as terminals for the PRIME mainframe.

The Institute has a number of vessels for estuarine and coastal operations ranging from the 65-foot R/V *Bay Eagle* to 18-foot outboards. The Institute also operates a DeHavilland Beaver aircraft for remote-sensing and photographic applications.

General Preparatory Requirements

Students who are seriously interested in pursuing marine science as a profession should consult with their academic advisor or the Dean of Graduate Studies, School of Marine Science, early in their college careers concerning an academic program that will prepare them for graduate study in marine science.

Students interested in biological oceanography or marine fisheries science should have a strong background in basic sciences, including a suite of contemporary biology courses, physics and chemistry (through organic), and mathematics through calculus and differential equations. The prospective chemical, geological, or physical oceanography student should have an undergraduate degree with appropriate course work in chemistry, geology or related geophysical science, physics, meteorology, mathematics or engineering and a solid quantitative background. Course work in statistics and competence with computers is particularly important for prospective marine resource management students; it is also considered beneficial to students in all other fields of concentration as well.

Graduate Study in Biological Oceanography

Research Facilities

The School is well equipped with modern laboratory and field instrumentation in support of Biological Oceanography. Various laboratories are equipped with running salt water.

Examples of major equipment include transmission and scanning electron microscopes, two gas chromatograph/mass spectrometers, a computer-interfaced gas chromatograph, a ^{15}N -emission spectrometer, computer-assisted image analysis hardware, a remote sensing imaging processor, a preparative superspeed centrifuge, an electrophoresis instrument, and an atomic absorption spectrometer. Greenhouses are available for research on macrophytes. The Institute's 65-foot R/V *Bay Eagle* is equipped with wet/dry laboratories and is capable of handling large benthic sampling gear. The Institute has a commercial-size shellfish hatchery for large scale production of superior oysters from selected parental stocks.

Research Programs

The primary orientation of the School of Marine Science faculty is toward estuarine and continental shelf environments. Many of the faculty are actively engaged in applied research of direct concern to industry and regulatory/management agencies. Students often find their assistantship duties and/or research topics bring them into close contact with industry and state, regional, and federal management agencies.

Biologically oriented faculty are involved in a large number of varied research programs and instructional activities. Many research programs are interdisciplinary, involving cooperation with scientists in the disciplines of physical oceanography, marine chemistry and geology.

Major research programs include:

Benthic Ecology: Studies investigate benthic invertebrate ecology, population dynamics and community interactions. Present research focuses on animal-sediment interactions and the processes governing recruitment and secondary production within estuarine ecosystems.

Microbial Ecology: Basic process-oriented research to define elements of the microbial food web, rates of energy flow among these components, and ecological controls over the composition and function of these food webs are investigated. Color Image Analyzed Fluorescence Microscopy is utilized in these investigations. Additional studies concern the ecology and fate of allochthonous microorganisms in estuarine environments.

Pathobiology/Toxicology: In cooperation with Chemistry and Toxicology and Marine Fisheries scientists, acute and chronic effects of toxic chemicals on estuarine organisms are being determined by experimental analysis and by field studies. Emphasis is on fish histopathology and the effects of toxics on fish cellular immune responses and on survival of invertebrate larvae. Effects of toxics on all stages of the food web may be considered.

Plankton Processes: Studies stress interdisciplinary approaches to research. Long-term trends in species composition and/or abundance are studied in relation to eutrophication and nutrient enrichment. Short-term changes in phytoplankton processes, including trophic relationships, are investigated. In cooperation with Fisheries scientists, other research focuses on processes related to larval fishes.

Shellfish Biology: Studies concentrate on oyster biology and include larval ecology, nutrition, cell culture, predation, internal defense mechanisms, aquaculture, and a major program on the biology of the protozoan oyster diseases and their effects on the industry. Other studies concern microbe-shellfish interactions which affect harvesting of commercially-important species.

Wetlands Ecology: Studies of estuarine plant communities include studies of both submerged aquatic vegetation (SAV) and emergent species of salt- and freshwater marshes. SAV studies vary from distribution and abundance investigations using remote sensing, to plant physiological studies at the tissue level. Likewise, marsh plant research ranges from descriptive studies, to establishing artificial marshes to studies of nutrient cycling within these systems.

Nutrient Dynamics: Studies include determining the spatial and temporal control of phytoplankton production by either phosphorus or nitrogen, addressing nitrogen cycling processes with the use of stable isotopes and investigating the impact of these processes upon the food web. Sediment-related processes and exchange with overlying water also form a core research area within the program.

Preparatory Studies

Generally, a solid background in modern biology and basic science courses is required. This background should include mathematics through calculus, a year of statistics, physics and chemistry including organic and biochemistry, as well as contemporary biology courses. A foreign language such as German, French, Russian or Spanish is recommended.

Typical Course of Study

Students in this area must include in their programs the required courses (introduction to physical, chemical, geological and biological oceanography and statistics) as well as the advanced biological course. Additionally, courses related to the student's area of specialization should be included as appropriate, e.g. plankton and microbiology for specialization related to small planktonic organisms; marine benthos and secondary production of invertebrates for those interested in benthic specializations. Theoretical ecology, ecological modeling and computer applications should be included in any biological program which will rely on modeling or theoretical mathematical formulations.

Graduate Study in Environmental Chemistry and Toxicology

Research Facilities

Environmental Chemistry and Toxicology (C&T) studies utilize a variety of specialized equipment to accomplish its research programs. A wet lab permits both flow through and static studies, while specialized sampling gear is available for field studies. Additional laboratory equipment includes four liquid and ten high resolution gas chromatographs, with a variety of general and specific detectors; two mass spectrometers are also available for the identification of unknown compounds. All equipment is linked to a computerized data system for storing and manipulating resulting output. Liquid scintillation and gamma counters permit tracer and dating experiments. An ultracentrifuge and electrophoresis and immuno-detection equipment are available for performing biochemical assays.



Student feeds neo-natal mysids during an EPA exposure experiment.

Research Programs

The primary focus of this research area is on the fate and effects of pollutants in the estuarine and marine environments. Although understanding underlying mechanisms is emphasized, the majority of the research performed has direct practical applications. Applicable projects in the fields of fundamental chemical oceanography and biochemistry will also be considered. By their nature, many pollution-related problems require an interdisciplinary approach. As a consequence, students from a variety of fields work in this area.

Major research programs include:

Environmental Chemistry: Studies of the sources, distribution and bioavailability of pollutants in marine and estuarine environments, including water, sediment and interfacial areas. Interactions of toxic chemicals with marine life are also explored; processes such as bioaccumulation, toxicokinetics, and metabolism are studied.

Analytical Chemistry: New techniques to determine identities and concentrations of anthropogenic compounds and their breakdown products are investigated. Computer programs aimed at improved data collection, manipulation and retrieval are developed.

Fate and Transport Processes: Research is conducted on the basic equilibrium and kinetic processes governing the fate and transport of pollutants in aquatic, atmospheric and groundwater systems. Field projects include studies of pollutant cycling, atmospheric deposition, and groundwater transport. Laboratory studies of fundamental mechanisms controlling environmental fate are an important component of this program.

Biochemistry: Laboratory and field investigations focus on biochemical responses of marine organisms to pollutants and their environment. Specific examples include characterization of enzyme systems, protein composition and physiological condition.

Toxicology: Studies examining the influence of toxic chemicals on critical biological pathways and the health of organisms are performed. Examples of effects studied include disruption of immunocompetence and alterations in cell growth, reproduction and survival.

Pathobiology and Histology: Studies of abnormalities in structure and function at the cellular and organismal level are conducted. Techniques include gross examination, as well as detailed electron and light microscopic studies aimed at elucidating critical impacts and their causes.

Preparatory Studies

Strong written communication skills, one year of organic chemistry, basic training in statistics and familiarity with computer usage recommended.

Typical Course of Study

All C&T programs include the required SMS core courses. In addition, students are encouraged to take specialized courses. Paths may emphasize biological principles, e.g. immunology or physiology; or chemical, e.g. analytical chemistry or biochemistry. However, the interdisciplinary nature of the field requires a broad background to meet the challenges required of environmental professionals.

Graduate Study in Fisheries Science

Research Facilities

In addition to the general equipment and facilities listed for the SMS, Fisheries scientists and students often make use of larger ocean-going vessels through vessel charters, participation in the University Oceanographic Laboratory System, or by participating in cruises on National Oceanic and Atmospheric Administration (NOAA) and National Marine Fisheries Service (NMFS) vessels.

Personal computers are in use throughout Fisheries offices and laboratories and many of these also serve as terminals for the SMS PRIME mainframe. The fish population laboratory has available automated fish measuring boards which electronically record and store length and bionomic data as they are being collected. The age and growth laboratory has computerized scale projectors and a Biosonics digitizing system used in ageing and morphometric studies. The larval fish laboratories house a reference collection containing over 120 families of marine, estuarine and freshwater fishes. Faculty and students in the Larval Fish Program utilize an *in situ* silhouette plankton camera as well as more traditional plankton gear in their field studies.

The Crustacean Ecology and Bivalve Ecology programs also have dedicated laboratories.

Other major facilities include a modern molecular genetics laboratory with full capability for isozyme and mtDNA analysis, and a catalogued fish collection containing approximately 14,000 lots. This research and teaching collection incorporates extensive holdings from Chesapeake Bay, the Middle Atlantic Bight, and from Appalachian freshwater habitats as well as an internationally-recognized deep-sea fish collection. Under construction is a new Systematics and Ecology building, which will house the fish collection and provide additional laboratory space for dissection of marine mammals, sea turtles, sharks and other large fishes.

Two wet lab facilities are available to Marine Fisheries faculty and students. The general wet lab contains a flow-through system with several wet tables and tanks. In addition, a special greenhouse/wet lab houses the large sea turtle holding tanks, which are supplied with recirculated filtered sea water. Adjacent to the sea turtle greenhouse is a 7,560 gallon tank used for research and rehabilitation of small marine mammals.

Research Programs

Major research programs include:

Crustacean Ecology: Behavioral ecology, population dynamics and recruitment mechanisms of blue crabs in Chesapeake Bay, and of spiny lobsters in the Caribbean. Emphases have included predator/prey interactions with additional concentration on population and fisheries modeling, the ecology of natural and artificial reef systems, and the ecology of tropical fish and queen conch.

Bivalve Ecology: Studies on recruitment of bivalves, particularly oysters, and effects of the environment on physiology and behavior of larval oysters and other bivalves; oyster population assessments and development of disease-resistant hybrids.

Fisheries Oceanography: Studies of the effects of environmental variables (weather and climate) on survival, recruitment, and distribution of fishes and other marine organisms.

Finfish Ecology: Research on the population dynamics, recruitment, stock structure, and life history of marine, estuarine and anadromous fishes; based on sampling fisheries landings, extensive research surveys and tagging studies. Much information collected in this program area is directly applied to fisheries management by state and regional agencies.

Chondrichthyan Biology: Studies of comparative morphology (drag reducing mechanisms, electroreception, etc.) of sharks and their relatives; population dynamics, reproduction, feeding strategies and energetics of coastal and deep-sea sharks; shark fishery management problems.

Sea Turtle Ecology: Research on distribution, abundance, ecology and energetics of sea turtles; behavior and migration studies using sonic, radio and satellite tracking; studies on nesting and sex ratios; population studies using aerial surveys. The SMS is the Sea Turtle Stranding Center for Virginia.

Marine Mammal Ecology: Studies on distribution, abundance and ecology of marine mammals; aerial surveys of marine mammals. The SMS serves as the Marine Mammal Stranding Center for Virginia.

Systematics: Research on the morphology, evolution, taxonomy and zoogeography of various finfish groups. Studies involve both larval and adult characters. Available software includes various statistics and advanced morphometrics packages.

Larval Fish Ecology: Studies on the distribution and abundance of ichthyoplankton in temperate and tropical seas. Investigations of factors affecting survival and recruitment. Population dynamics and stock assessment based on ichthyoplankton surveys.

Population Genetics: Research using molecular genetics to define inter- and intraspecific relationships of fishes and other marine organisms for stock discrimination and phylogenetic studies. Current work focuses on sharks, marlin and other finfishes.

Preparatory Studies

Students interested in graduate study in Vertebrate Biology and Marine Fisheries should have a solid undergraduate background in biology including: physiology, biochemistry, comparative morphology or developmental biology, histology or cytology, genetics, ecology and related topics, and evolutionary biology. College physics, chemistry (through organic) and college math through calculus are required. Courses in statistics, marine biology and fishery biology may be helpful but are not prerequisites.

Typical Course of Study

In addition to the core courses required of all SMS graduate students, Fisheries students are required to take Design and Analysis of Experiments (MS 619); a third upper level quantitative course is also recommended. Among the courses offered by the Fisheries faculty are Fisheries Oceanography (MS 606), Ichthyology (MS 608), Experimental and Quantitative Ecology (MS 613), Marine Fisheries Science (MS 618), Early Life History of Marine Fishes (MS 630), Theoretical Ecology (MS 643), Dynamics of Fish Populations (MS 640), and Marine Population Genetics (MS 662).

Graduate Study in Geological Oceanography

Research Facilities

Geological Oceanography has numerous facilities and equipment items to support its research programs in the coastal ocean and estuarine environments. Shipboard systems include an EG&G 960 sidescan sonar system, a Datasonics sub-bottom acoustic profiler, an Endeco Type 174 bidirectional, tethered current meter/CTD profiling system with IBM-PC microcomputer interface, and sediment sampling and coring devices. Our research vessel, the R/V *Bay Eagle*, serves as a deployment platform for this equipment as well as three bottom-mounted tripod-tetrapod systems containing wave, current and sediment monitoring devices designed to collect data automatically under all weather conditions. The tripod/tetrapod frames accept a number of self-contained systems including three Seadata Model 635-9 directional wave gage and current meter systems with Marsh-McBirney electromagnetic flow sensors, a Seadata Model 626 current profiling array with three Marsh-McBirney sensors, a Downing Model OBS-2 sediment monitoring array with five optical sensors, and three Datasonics PSA-900 digital sonar altimeters. A complete sedimentation lab is available with a PC-controlled rapid sand analyzer, a Coulter Model TA fine particle analyzer, microscopes and heavy mineral separation equipment. A local area network (LAN) connects departmental IBM-PC microcomputers and peripheral devices for word processing and computational work.

Research Programs

Geological Oceanography faculty are engaged in basic and applied research in estuarine and inner shelf sedimentology and sediment transport, fluid mud behavior, dredging and pollution control, benthic boundary layer processes, shoreface dynamics and shoreline processes including beach preservation and restoration. Special attention has been given to benthic boundary layer studies investigating near bottom sediment entrainment and transport in the presence of waves and currents. A supporting wave climatology project is now being conducted that features continuous directional wave measurements at sites in lower Chesapeake Bay. Support has been obtained from both federal and state sources including the Virginia Division of Mineral Resources, NOAA Sea Grant and Coastal Zone Management, U.S. Army Corps of Engineers, Office of Naval Research and the National Science Foundation.

Preparatory Studies

An undergraduate degree in a geological or related geophysical science and engineering field is a prerequisite for admission to the program. Mathematics through calculus is required along with course work in physics and the earth sciences. A course or courses in statistics and use of computer systems are highly recommended.

Typical Course of Study

The four introductory marine science core courses as well as statistics are required of all students unless an exemption is granted, usually on the basis of previous course work taken and approval by the core course instructor. Following the first year and successful completion of the comprehensive exam, each student may pursue his or her area of special interest after selecting a thesis advisor and committee. Students electing to pursue research topics in areas involving fluid-sediment dynamics will normally enroll in additional courses as recommended by their thesis advisor. These courses may include linear wave theory, sediment transport and benthic boundary layer processes, estuarine hydrodynamics and time series analysis. Others may follow a program emphasizing the geology of modern marine environments, taking available courses in coastal stratigraphy, sedimentology, littoral processes and multivariate analysis.

Graduate Study in Marine Resource Management and Policy

Research Facilities

All graduate research programs are supported by a central computing facility offering access to the PRIME mainframe, research vessels and field instrumentation. The marine resource management program utilizes PCs equipped with software packages incorporat-

ing word processing, inventorying, graphics and mapping functions. In addition, an up-to-date resource management/legal library is available to all students.

Research Programs

Since 1940, faculty and staff of the Institute and School of Marine Science have worked closely with representatives of the public, marine industries and state and federal agencies to integrate sound scientific principles into the management of marine resources. This tradition is continued today under a specific legislative mandate and is evidenced by state of Virginia support which provides approximately seventy percent of the Institute's total budget. Marine resource management related activities of the Institute's faculty and staff permeate every disciplinary and organizational entity.

Although most disciplines and divisions of the Institute are engaged in resource management related research, the Marine Resource Management program offers marine science students an exposure to the legal, political, theoretical and institutional systems in which they will be working as well as exposing them to the perspectives of other disciplines, such as economics and sociology, important to the management of marine resources.

Major research programs include:

Fisheries: Studies related to the management of commercial and recreational fisheries.

Aquaculture: Studies leading to the identification of legal, policy and institutional considerations affecting the development of aquaculture.

Wetlands: Studies leading to the development of effective management regimes for tidal and non-tidal wetlands.

Geology: Studies related to subaqueous minerals management, dredging and erosion.

Coastal Zone Management: Studies addressing resource use conflicts and public versus private ownership of resources.

Preparatory Studies

Students interested in pursuing a career in marine resource management will benefit by having a solid background in mathematics as well as competence with computers. Strong writing and verbal communication skills are also recommended.

Typical Course of Study

Students pursuing research programs in marine resource management are required to take the School of Marine Science core courses in physical, chemical, geological, biological oceanography and statistics as well as two resource management courses, Principles

and Theory of Resource Management (MS 604) and Law and Resource Management (MS 650). Students may elect to take only the two required courses or additional advanced courses. The following courses are offered or can be specially arranged with an instructor: Resources, Regulation and Science: The Management of Marine Resources in Virginia (MS 624), Satellite and Aerial Marine Remote Sensing (MS 642), Introduction to Marine Resource Economics (MS 648), Practical Application of Marine Resource Management Techniques (MS 652), and History of Marine Science (MS 658).

Students may take courses in marine resource management and do a marine resource management related thesis or dissertation, or they may choose to take marine resource management courses and pursue a non-marine resource management related thesis or dissertation.

Graduate Study in Physical Oceanography and Environmental Engineering

Research Facilities

Graduate research programs in this area are supported by extensive computing facilities, research vessels, and field instrumentation generally available for the support of Institute activities. Central computing support is provided by the Computer Center, offering general access to a PRIME 9955 and peripherals. Physical Oceanography and Environmental Engineering programs utilize additional distributed computer facilities, including a network linking Sun Sparcstations, PCs, Macintoshes, and a Microvax II. Access to Internet is also available. Among the fleet of research vessels available, the 65-foot R/V *Bay Eagle*, the 44-foot R/V *Langley*, and several smaller workboats offer "dry lab" space suitable for computers and other electronics. The technical staff has considerable experience in shallow-water mooring deployments. A variety of instrumentation is available for shipboard and moored observations, including: a 1.2 MHz acoustic Doppler current profiler, eleven S4 electromagnetic current meters (eight with conductivity and temperature sensors), several conductivity-temperature-depth profilers, a dual-frequency acoustic backscatter sounder, Turner fluorometers, Del Norte positioning system, and self-contained data recorders with dissolved oxygen probes and other sensors. A 15 m recirculating flume with 0.9 by 0.9 m cross-section, a calibration lab, and a nutrient analysis lab are also available.

Research Programs

The faculty in physical oceanography and environmental engineering is engaged in a variety of observational and modeling programs, with emphasis on coastal waters. Active research is underway on physical processes in estuaries, where the combined effects of gravitational circulation, tidal currents, surface wind stress, and interaction with bottom topography lead to a variety of phenomena with interesting physical dynamics, usually with some associated interdisciplinary significance as well. Examples include dynamics of stratification cycles, especially on spring/neap (fortnightly) time scales; general circula-

tion of large, partially-mixed estuaries; the role of fronts that form, evolve, and dissipate on semidiurnal time scales; and physical processes associated with the depletion of near-bottom dissolved oxygen. Other research areas, some shared with other disciplines, include remote sensing and image analysis, aspects of bay-shelf exchange, and inner shelf processes.

Numerical circulation and transport models in one, two, and three spatial dimensions are in use and under development, incorporating various levels of turbulence closure schemes as appropriate. Other modeling efforts are directed toward research on water quality in estuaries. Observational studies are based on deployments of moored arrays, typically over periods of weeks to months, and on vessel-based measurements and sampling on research cruises. Relatively large data sets and model output results have highlighted the need for enhanced computer graphics and visualization techniques, an area of recent activity.

Preparatory Studies

Generally, students in this area have an undergraduate degree or concentration in physics, mathematics, engineering, or related areas. Undergraduate courses in biology, chemistry, geology, statistics, and a foreign language are highly recommended (note the foreign language and core course requirements of the School). Exposure to various areas within the broad field of earth sciences (for example, atmospheric science, geophysics) provides useful perspective. Prior study of fluid dynamics is helpful, but is not required.

Typical Course of Study

In addition to the introductory courses in physical, geological, chemical, biological oceanography and statistics, the two-semester sequence in ocean dynamics is required of students pursuing research programs in physical oceanography and environmental engineering. Further course work to be included in the program is worked out on an individual basis for each student by his or her advisory committee, in consideration of the student's particular background and proposed area of research. Courses in the following areas are offered: introduction to physical oceanography, ocean dynamics (I and II), numerical modeling in oceanography, estuarine hydrodynamics (I and II), estuarine water quality models, satellite and aerial marine remote sensing, oceanographic instrumentation, and analytical methods for water quality studies. Courses dealing with selected topics of current interest are available as well.



Student using dropping net for the collection of motile benthic organisms in submerged aquatic vegetation beds.

Description of Courses

The courses presented below may be offered in a different format than listed under the course description if the number of students registering for the course is such that the listed format is inappropriate. For example, if only one student registers for a course listed as being taught in a lecture format, the instructor may decide the content is better presented through directed readings and one-on-one discussion.

501. Introduction to Physical Oceanography. Fall (3) Mr. Ruzecki. Prerequisites: Undergraduate Physics, Differential and Integral Calculus.

Physical properties of seawater, descriptive oceanography, air-sea interactions, heat budget, methods and measurements, dynamics of circulation, waves and tides. Required of all students unless justification for exemption is approved by the Dean of Graduate Studies upon the recommendation of the appropriate faculty committee. Lectures and laboratory.

502. Introduction to Chemical Oceanography. Spring (3) Mr. Hale, Mr. Huggett. Prerequisite: Undergraduate Chemistry.

Major and minor components of seawater, the concept of residence time, solution chemistry of organic compounds, nutrient cycling, dissolved gases, radioactive dating, geochemical cycles, biosynthesis in marine environments, organic geochemistry, anthropogenic input. Laboratory demonstration of analytical methods for organic analysis. Required of all students unless justification for exemption is approved by the Dean of Graduate Studies upon the recommendation of the appropriate faculty committee.

503. Introduction to Biological Oceanography. Spring (3) Mr. Bureson, Staff.

Introduction to biological oceanographic processes emphasizing primary production and nutrient cycling; plankton, nekton and benthic processes, including feeding and reproduction strategies and animal/sediment relations; population regulation; estuaries as ecosystems. Required of all students unless justification for exemption is approved by the Dean of Graduate Studies upon the recommendation of the appropriate faculty committee. Lectures and laboratory.

504. Introduction to Geological Oceanography. Fall (3) Mr. Boon, Mr. Wright.

Concepts of marine geology; coastal processes, sea-floor spreading and plate tectonics, sediments and sedimentation, shelf and canyon development. Required of all students unless exemption is approved by the Dean of Graduate Studies upon the recommendation of the appropriate faculty committee. Lectures and field trips.

506. Introduction to Marine Science. Summer (3) Mr. Loesch.

A general introduction to marine science, including biological, chemical, geological, and physical oceanography. Normally taught on the Williamsburg campus. Not open to graduate students in the School of Marine Science; credit earned cannot be applied to the School's degree program.

508. Introduction to Computers for Marine Scientists. Fall (1) Mr. Anderson.

An introduction to the use of computers in scientific research. Topics covered include the creation, editing and organization of files into directories, and an introduction to software systems for data analysis (SPSS, SAS), spatial analysis (SURFACE II), word processing (WordMarc), and graphics (SPSS, SAS, and BAYPLOT). Class assignments will be carried out on the VIMS time-sharing minicomputer system; however, the role of microcomputers in marine research will also be discussed. One lecture hour and two laboratory hours weekly.

509. Program Design and Data Structures Using Pascal. Spring (2) Staff.

Structured programming techniques are presented using the Pascal programming language. Elementary data structures are presented with attention to forms which are useful in scientific programming. Practical applications are stressed with emphasis on graphics in the latter portion of the course. The linkage of system and user-written libraries to Pascal programs is covered. Class assignments are carried out on the VIMS PRIME 9955 Model II System.

510. Invertebrate Zoology. Summer (4) Mr. Roberts, Ms. Schaffner, Mr. Diaz. Prerequisite: Undergraduate Biology.

Discussion of major invertebrate metazoan phyla, including basic taxonomy, anatomy, physiology, and the role of invertebrates in ecosystems. Emphasizes marine and estuarine species present in Chesapeake Bay and vicinity.

512. Marine Botany. Summer (4) Mr. Silberhorn, Staff.

This course is primarily a survey of the micro- and macroalgae and vascular vegetation of the coastal region of Virginia, with emphasis on the latter. Course of study is aimed to improve knowledge of the floristics, community structure, phytogeography and descriptive plant ecology of the area.

513. Coastal Botany. Fall (3) Mr. Silberhorn.

A general survey of maritime vascular plant communities. Marshes, swamps, beaches, dunes, maritime forests and submerged aquatic communities of the coastal region. Field trips, laboratory and lectures.

515. Environmental Chemistry. Fall (3) Ms. Dickhut. Prerequisite: Undergraduate Chemistry (308) and Mathematics (112), Physical Chemistry (301) recommended.

Fundamentals of aquatic, atmospheric, and geo/soil chemistry. Introduction to aquatic microbial biochemistry and toxicological chemistry.

516. Mathematical Review for Marine Scientists I. As required (3) Mr. Evans.

A review of mathematical techniques and concepts with which a student in marine science is expected to be familiar. A pragmatic approach to the topics is adopted with examples of applications of mathematical notions whenever possible. Topics to be covered include: elementary algebraic manipulation, linear and quadratic equations, simultaneous equations, trigonometry, analytical geometry, binomial theorem, exponents and logarithms, and elementary differential calculus.

517. Mathematical Review for Marine Scientists II. As required (3) Mr. Evans.

A review of mathematical techniques and concepts with which a student in marine science is expected to be familiar. A pragmatic approach to the topics is adopted with examples of applications of mathematical notions wherever possible. Topics to be covered include: integral calculus, simple differential equations, vectors, matrices (linear algebra).

520. Scientific Writing and Information Sources. Spring (1-2) Mr. Lynch.

Instruction on content and use of selected bibliographic, abstracting, indexing, data and other information data bases useful to marine scientists (emphasis is on on-line bases). Structure and content of journal articles, theses, dissertations and technical reports. Emphasis is on writing; students prepare and are evaluated on several written assignments.

526. Principles of Biological Oceanography.* Fall, even years (evenings) (3) Staff.

Description of biological processes in marine waters with particular emphasis on primary production; nutrient cycling; feeding and reproduction; planktonic, nektonic and benthic life strategies; animal and plant habitat requirements and estuaries as an ecosystem. (This course is designed for individuals desiring a thorough understanding of the concepts of biological oceanography, but who do not plan on continuing for an advanced degree in marine science. Credit earned cannot be applied to the M.A. or Ph.D. in Marine Science offered by the School of Marine Science.)

527. Principles of Chemical Oceanography.* Fall, odd years (evenings) (3) Staff.

Description of chemical processes in marine and estuarine waters. Emphasis on structure, components and properties of water; origin, behavior and fate of inorganic and organic compounds in the aquatic environment. (This course is designed for individuals desiring a thorough understanding of the concepts of chemical oceanography, but who do not plan on continuing for an advanced degree in marine science. Credit earned cannot be applied to the M.A. or Ph.D. in Marine Science offered by the School of Marine Science.)

528. Principles of Geological Oceanography.* Spring, even years (evenings) (3) Staff.

Overview of geological concepts, earth history and geological research methods. Basic introduction to modern plate tectonic theory, sea floor spreading and the development of ocean basins including major topographic features such as mid-ocean ridges and continental margins. Discussion of earth dynamics including global and sea level change, ocean processes with emphasis on coastal environments and the evolution of coastal features including beaches, estuaries, marshes and lagoons. (This course is designed for individuals desiring a thorough understanding of the concepts of geological oceanography, but who do not plan on continuing for an advanced degree in marine science. Credit earned cannot be applied to the M.A. or Ph.D. in Marine Science offered by the School of Marine Science.)

* MS 526, 527, 528 and 529 may be substituted for MS 501, 502, 503 and 504 by students enrolled in the program leading to an M.A.Ed. in Secondary School Teaching with an emphasis in Marine Science. See the current catalog for the School of Education graduate programs.

529. Principles of Physical Oceanography.* Spring, odd years (evenings) (3) Staff.

Physical properties of seawater, descriptive oceanography, air-sea interaction, heat budget, methods and measurement, dynamics of circulation, waves and tides. (This course is designed for individuals desiring a thorough understanding of the concepts of physical oceanography, but who do not plan on continuing for an advanced degree in marine science. Credit earned cannot be applied to the M.A. or Ph.D. in Marine Science offered by the School of Marine Science.)

530. Probability and Statistics for Marine Scientists. Fall (3) Mr. Evans.

Introduction to probability, discrete and continuous distributions; sample statistics; parameter estimation and hypothesis testing; functions of a random variable; student's t-test; one way analysis of variance; and distribution fitting. Required for all students undertaking a marine science degree program, unless specifically exempted.

545. Marine Sedimentation. Fall, even years (2-3) Staff. Prerequisite: Permission of the instructor.

Characteristics of marine sediments including texture, mineralogy, and chemical and biological properties. Principles of clastic and carbonate sedimentation: hydrodynamic parameters; bedforms; primary and secondary bedding structures; regional distribution of sediments and modern depositional environments. Two lecture and two laboratory/field hours. Field project required for three credit hour option.

560. Thesis. Fall, Spring, and Summer (hours to be arranged).

Original research in biological, physical, chemical or geological oceanography, marine fisheries science and marine resource management. Project to be chosen in consultation with the student's major professor and the Dean of the School.

597. Problems in Marine Science. Fall, Spring, and Summer (1-4) Staff.

Supervised projects selected to suit the need of the graduate student. Projects are chosen in consultation with the student's supervising professor and the instructor. Credit hours depend upon the difficulty of the project and must be arranged with the instructor in advance of registration. (See MS 697).

598. Special Topics in Marine Science. Fall, Spring, and Summer (1-3) Staff.

This is the avenue through which subjects not covered in other formal courses are offered. These courses are offered on an occasional basis as demand warrants. Subjects will be announced prior to registration. Hours to be arranged.

601. Marine Science Seminar. Fall and Spring (1-3) Staff.

Multidisciplinary review of significant areas of marine science. The topic will vary each semester. Guest speakers will present a variety of views. Course participants will organize and present talks related to the seminar theme. Credit will be determined by the level of participation. One credit hour (pass/fail only) for attendance and participation at seminars; two credits (pass/fail or grade option) for additional participation by contribution to discussions and presentation of seminar; three credits

(pass/fail or grade option) for additional submission of written critical literature review/synthesis.

604. Principles and Theory of Resource Management. Fall (1-3) Staff.

An introduction to the history of the management of natural resources and a survey of principles and theories associated with resource management. Although the course addresses general concepts, marine oriented materials and examples will be emphasized. Required of all students in Marine Resource Management.

605. Radiobiology. As required (2-4) Staff.

The principles of tracer techniques and procedures for radio-assay determinations in marine studies. Lecture and laboratory.

606. Fisheries Climatology. Fall, odd years (3) Mr. Austin. Prerequisite: MS 501 or MS 618.

Concept of the effects of natural environmental variability on the recruitment, availability (yield), abundance and behavior of living marine resources. Application to real-time fishing operations and climate scale analysis of fishery fluctuations. Instruction in basic meteorology and climatology with application to the ocean. Two lecture hours and one laboratory hour.

607. Marine Microbiology. Spring, even years (4) Mr. Kator, Staff. Prerequisite: Biology 301 or equivalent.

Morphology, physiology, ecology, taxonomy, and methods of isolation, cultivation environmental variability and identification of micro-organisms encountered in the marine environment. Three lecture and four laboratory hours.

608. Ichthyology. As required (3 or 5) Mr. Musick.

Functional morphology, behavior, ecology, zoogeography and evolution of fishes. Seven lecture, laboratory and field hours. Three credits without laboratory; five credits with laboratory.

609. Oceanographic Instrumentation. Summer, even years (2 or 3) Mr. Ruzecki.

General description, physical characteristics, capabilities and limitations of oceanographic instruments are discussed and demonstrated. Emphasis is on instruments used to obtain physical data with inclusion of selected chemical and geological instruments. Operation, deployment and data retrieval are emphasized. This course will be taught in a long summer session. Two credits for lecture, with an optional one hour for laboratory and field work.

610. Pollution Biology. As required (3) Mr. Bender.

Study of the various types of pollutants, domestic and industrial wastes, soils, insecticides and radioactive materials and their effects on the marine environment.

611. Quality Assurance for Water Quality Studies. Spring, even years (1) Mr. Neilson.

Design of quality assurance plans, data quality objectives, sampling protocols, selection of analytical methods, precision, accuracy, method detection limits, quality control procedures, standard reference materials, and quality assurance of data files. The course will be offered as a three hour laboratory. Students will work with a data set provided to them or they may use their own data with the consent of the instructor.

612. Diseases of Marine Organisms. Fall, odd years (4) Mr. Burreson, Staff.

Identification, life cycles, pathology and control of disease agents, including viruses, bacteria, protozoa, helminths and arthropods in marine fishes and shellfishes. Three lecture and two laboratory hours.

613. Experimental and Quantitative Ecology. Fall, even years (1-4) Mr. Lipcius, Mr. Luckenbach. Prerequisite: MS 530 or equivalent.

The design, conduct, analysis and interpretation of field and laboratory experiments in ecology and behavior. Includes lectures, discussion and supervised field and laboratory projects designed to illustrate the diversity of experimental approaches in use by ecologists and ethologists. Topics include experimental design, advanced statistical techniques, modeling, predator-prey dynamics, recruitment phenomena, life history tactics, intraspecific competition, benthic processes and others emphasizing recent ecological and behavioral advances. Lecture and laboratory.

614. Coastal Processes. As required (3) Staff. Prerequisites: MS 501 and 504 or consent of instructor.

Sedimentary processes of erosion, transportation and deposition in response to energy by currents, waves, organisms and man. Character of sedimentary features in a range of environments: estuaries, lagoons, marshes, tidal flats and the continental shelf. Readings of classics, field trips and seminars with discussion of recent advances and controversial questions.

616. Analysis of Discrete Data. Fall (3) Mr. Diaz. Prerequisite: MS 530 or equivalent.

Design, analysis and interpretation of field and laboratory studies that rely on discrete or count data, including rates and proportions. Models based on Chi-squared and other nonparametric distributions for uni-, bi-, and multi-variate data will be covered. Topics include sample size experimental design, single and cross classification, covariate inference, and numerical classification techniques. Lecture and computer laboratory.

617. Wetland Ecology: Structure, Classification and Delineation. Fall (2 or 3) Mr. Perry. Prerequisite: Consent of instructor.

Introduction to physical and biological structures of tidal and nontidal wetlands, taxonomic schemes for classifying wetland types, and applied methods of wetland identification and delineation. Emphasis on field indicators, map and aerial photography interpretation, and use of federal delineation manuals. Laboratory.

618. Marine Fisheries Science. Fall, even years (4) Mr. Austin.

Principles and techniques, including the theory of fishing, age and growth, definition of stocks, catch statistics, description of world fisheries, goals and problems in managing a common property resource. Six lecture, laboratory and field hours.

619. Design and Analysis of Experiments. Spring (3) Mr. Loesch. Prerequisite: MS 530 or equivalent.

Concepts and methods of experimental statistics. Topics in regression, functional geometric regression, bivariate normal model and an introduction to multiple regression. Analysis of variance models (single factor and multifactor) include randomized designs, randomized complete block designs and nested designs. Analysis of covariance will be presented, and other models as time permits. Lecture and laboratory. Required of all students in Marine Fisheries Science.

620. Aquatic Toxicology. Fall (3) Mr. Van Veld. Prerequisite: College Chemistry/Biology.

A study of mechanisms involved in uptake, metabolism and clearance of foreign compounds by aquatic organisms and responses of these organisms to pollution exposure.

621. Advanced Chemical Oceanography. As required (3) Mr. MacIntyre. Prerequisites: Chemistry 202, Math 203, and Physics 102.

Physical chemistry of electrolytic solutions. Study of equilibrium and non-equilibrium models of chemical processes occurring at water-sediment, water-organism and water-atmosphere boundaries.

622. Mass Spectrometry of Organic Molecules I. Fall (2) Staff. Prerequisite: Consent of instructor.

Ionization of atoms and molecules, the deflection of charged particles by electric and magnetic fields. Discussion of different methods of mass to charge separation. Description of several types of mass spectrometers and special requirements for GC-MS and LC-MS systems. Other subjects including vacuum techniques and detection methods.

623. Mass Spectrometry of Organic Molecules II. Spring (1) Staff. Prerequisite: MS 622 or consent of instructor.

Interpretive aspects of mass spectra. General discussion of fragmentation. Systematic trends linked to molecular structure will be treated and explained through the use of key examples. Active participation of the student is expected.

624. Resources, Regulation and Science: The Management of Marine Resources in Virginia. As required (1-3) Staff.

Overview of evolution of Chesapeake Bay and its major living and non-living resources including the effects of man's recent impingement bringing into focus political, socio-economic and legal aspects of resource management. Description of laws passed to protect and manage marine resources with specific case studies using contemporary management problems. Class observations of the existing management structure with required policy analysis paper. Credit varies depending upon the extent of preparation of issue papers and participation in class project.

628. Biological Oceanographic Processes. Fall (3) Staff. Prerequisite: MS 503 or consent of instructor.

Lecture and discussion of contemporary concepts in oceanographic processes emphasizing microbial-plankton interactions, zooplankton, benthic processes, population dynamics, nutrient cycling and systems and simulation modeling. Required of all students in Biological Oceanography.

629. Introduction to Benthic Boundary Layers and Sediment Transport. As required (3) Mr. Boon, Mr. Byrne, Mr. Wright.

Physical and geological aspects of coastal and estuarine benthic boundary layers, their dynamic forcings and the associated suspension and transport of granular sediments. Principles of waves, tides and currents are introduced with emphasis on shallow-water processes. Boundary layer structure and shear stress on the seabed, wave boundary layers and turbulence are considered in relation to the coastal environment. Forces on sediment particles, initiation of sediment movement and principles of sediment transport are treated at an intermediate level.

630. The Early Life History of Marine Fishes. Fall, odd years (3) Mr. Olney. Prerequisite: MS 608 or consent of instructor.

Ontogeny, systematics, physiology, behavior and ecology of egg, larval and juvenile stages of fishes with special reference to adaptations for survival. Population dynamics and the importance of early life history in the recruitment process are emphasized. Ichthyoplankton sampling methods are outlined. In the laboratory, eggs and/or larvae of 100+ families of teleostean fishes are examined, and characters useful in identification are presented. Two lecture and two laboratory hours.

631. Estuarine Hydrodynamics I. As required (3) Mr. Kuo. Prerequisite: Consent of instructor.

Classification of estuaries, time scales of motions, tidal dynamics in estuaries, non-tidal circulation, mechanism of arrested salt wedge, gravitational circulation, diffusion induced circulation, turbulence in stably stratified flows.

632. Estuarine Hydrodynamics II. As required (3) Mr. Kuo, Mr. Hamrick. Prerequisite: MS 631.

Zero-, one- and two-dimensional descriptions of estuaries, salt intrusion, pollutant flushing, sediment transport through estuaries, field experience in estuaries, model laws for estuarine models.

635. Multivariate Analysis and Time Series. Spring (3) Mr. Boon, Mr. Evans.

Eigenvector methods, principal component analysis and factor analysis; regression methods; Fourier and stochastic models applied to geophysical and other time series data sets. Two lecture hours and one hour of computer laboratory with assigned problems.

636. Ecological Modeling and Simulation and Analysis. Fall, as required (3) Mr. Wetzel. Prerequisite: Consent of instructor.

Theoretical and practical aspects of conceptualizing, simulating and analyzing digital computer models of estuarine and marine ecosystems. Systems theory, control and optimization is presented in terms of ecological processes. Computer modeling project required.

637. Wetlands Ecology. Spring (2-4) Mr. Hershner. Prerequisite: Consent of instructor.

Classical and recent work on wetlands ecology, primarily in tidal marshes. Emphasis on the analysis of the marsh system at the community level. Introduction and practical experience in common research techniques, including vegetation mapping, sediment coring and faunal sampling methods. Individual research project and/or paper expected. Lectures and field trips.

639. Estuarine Water Quality Models. Fall, even years (3) Mr. Kuo, Mr. Neilson. Prerequisite: MS 631.

Principles of mass balance, physical transport processes, diffusion and dispersion in estuarine environments. Water quality processes, representation of biochemical transformations, dissolved oxygen modeling, survey of available models.

640. Fisheries Population Dynamics. Fall, even years (4) Mr. Chittenden.

Theory and practice of stock identification, growth, abundance, mortality, recruitment, and biomass production in fisheries stocks. Objectives of fishery management. Responses of stocks and fisheries to exploitation. Fluctuations in abundance, population growth forms, and population regulation. Theory, interpretation, and application of fisheries yield models including yield and eggs-per-recruit, production, and spawner-recruit models. Examples and seminars drawn from finfish and shellfish stocks.

641. Waves and Their Analysis. As required (3) Mr. Wright, Mr. Boon. Prerequisite: MS 501.

Introduction to linear wave theory and shoaling wave transformations, wave dispersion, radiation stress, refraction, reflection, and topographic trapping. Mechanisms of wave generation in the coastal boundary layer including oscillations at infragravity, tidal and transtidal frequencies. Time series analysis, interpretation of wave records using harmonic and spectral methods and computer labs on the VIMS PRIME 9955 Model II System.

642. Satellite and Aerial Marine Remote Sensing. Fall, odd years (2) Mr. Kiley. Prerequisite: MS 501.

Theory and techniques in satellite and aerial marine remote sensing and associated image processing operations. Emphasis on analysis of remotely-sensed sea-surface features (color, temperature, salinity, etc.), wetlands, shorelines and nearshore areas. Laboratory sessions will employ interactive image processing equipment for analysis, enhancement and display of remotely-sensed marine data. Lecture and laboratory.

643. Theoretical Ecology. Fall, odd years (1-3) Mr. Lipcius, Mr. Luckenbach.

Lecture and discussion of fundamental ecological theory. Emphasis is placed on defining testable aspects of modern ecological theory and evaluating recent empirical work within the framework of this theory. Topics include life history strategies, optimization theory, factors regulating populations and structuring communities, successional models, island biogeography, and ecosystem models.

646. Marine Plankton Ecology. Spring (3) Staff. Prerequisite: MS 501, 502, 503, 504 and 628.

Contemporary topics in cellular, population, community and ecosystem level ecology of marine plankton, including bacteria, protists, phytoplankton and zooplankton.

647. Marine Benthos. Spring (3) Ms. Schaffner, Mr. Diaz. Prerequisite: MS 503.

Ecology of marine and estuarine benthos. Emphasis is placed on determining how ecological processes effect function and structure of benthic communities. Consideration is given to interactions among autotrophs, microheterotrophs and larger metazoans and interactions between these organisms and their physical-chemical environments.

648. Introduction to Marine Resource Economics. Fall (3) Mr. Kirkley. Prerequisite: Differential and Integral Calculus.

An introduction to economic theories and principles which determine the exploitation, utilization, and management of marine resources. The course presents theories and principles in mathematical terms, but the interpretation and understanding of policies and solutions are emphasized. The objective of the course is to provide a balanced understanding of the underlying economics of conflicting marine resource based industries and user groups. Topics include the economics of commercial and recreational fisheries, aquaculture, coastal development, environmental degradation, and international trade in fisheries.

649. Marine Science in Public Affairs. As required (2) Staff.

Consideration of the methods by which public policy and programs regarding marine resources and the environment are established and executed and the role of marine science in those activities. The structure, functioning and management of modern marine research and advisory institutions. Interaction between science and technology, public environment, and resource management activities. Discussion of the problems and premises of marine science in public affairs. Lecture, discussion and observation.

650. Law and Resource Management. Spring (1-3) Mr. Theberge.

An interdisciplinary course designed to examine the interrelationships between scientific and legal concepts. Issues, legislation, and institutions associated with coastal zone management, outer continental shelf development, fisheries, and other questions related to marine resource management will be examined. Required of all students in Marine Resource Management.

652. Practical Application of Marine Resource Management Techniques. Fall and Spring (1-4) Staff. Prerequisite: MS 650.

This course is designed to offer students possessing management fundamentals an opportunity to participate in real world management activities under the guidance of involved faculty members and association and consultation with members of various levels of government. Such activities will possibly include but not be limited to issue identification and resolution, committee involvement at local, regional, state, interstate, and federal levels of government, development of management plans, drafting position papers, developing draft legislation and exposure to policy making mechanisms. Student requirements may vary significantly depending on the management issue(s) addressed. Students will be evaluated on participation, written work (memoranda, position papers, etc.) and knowledge gained as evidenced by interaction with staff and by other means. Students may repeat the course provided the instructor determines there is no duplication of material. Credit, which must be arranged in advance of registration, will depend upon difficulty of the assignment.

653. Secondary Production of Invertebrates. As required (3) Mr. Diaz.

Principles and theories of secondary production. Physical and biological factors influencing production, role of habitat complexity, implications for community structure, estimation of trophic resources and techniques of measuring secondary production.

654. Oligochaete Biology. As required (2) Mr. Diaz.

Taxonomy of aquatic and marine oligochaetes, life history strategies and ecology, and the role of oligochaetes in benthic communities.

655. Scanning Electron Microscopy in Marine Science. As required (1-4) Mr. Burreson.

Lectures on theory of the scanning electron microscope, techniques of specimen preparation and image interpretation. Instruction in use of scanning electron microscope and use of instrumentation necessary for specimen preparation. Research project required.

656. Seagrass Ecosystems. As required (1-2) Mr. Wetzel.

A lecture-seminar course covering topics related to seagrass ecosystems. Emphasis on the structure and function of seagrass communities, submerged angiosperm physiology, primary and secondary production, and integration of seagrass communities to the marine environment. Students will be assigned projects to complete. Credit, which must be arranged in advance of registration, will depend upon difficulty of the assignments.

658. History of Marine Science. As required (3) Staff.

Comprehensive review and evaluation of the major events, personages, and organizations involved in the development of marine science and marine resource management, the acquisition of knowledge of the World Ocean, its coastal waters and tributaries, and the ability to work on and in the sea and make use of its resources and amenities, with consideration of the impacts of the resources and amenities of the ocean on the affairs of men. Lecture, discussions and reading. All students will be required to prepare and submit a suitable course-related term paper.

659. Molluscan Biology. Fall (3) Ms. Chu.

Emphasis is placed on contemporary issues of molluscan biology. Topics include factors affecting reproduction, larval biology, feeding, nutrition and metabolism, mechanisms of internal defense and host-parasite interaction.

660. Dissertation. Fall, Spring and Summer (hours to be arranged).

Original research in biological, physical, chemical or geological oceanography, marine fisheries science, or marine resource management. Project to be chosen in consultation with the student's major professor with the approval of the Dean of Graduate Studies.

661. Applied Regression and Forecasting. Spring (3) Mr. Kirkley. Prerequisite: Calculus, MS 530 or equivalent.

Course introduces theory and practice of quantitative methods in marine science. Methods of regression and time-series analysis will be emphasized. Topics include linear and nonlinear regression, model validation and testing, univariate and multivariate models, transfer functions, intervention analysis, and forecasting.

662. Marine Population Genetics. Fall (3) Mr. Graves. Prerequisite: Undergraduate Genetics or permission of instructor.

A study of the evolutionary processes responsible for the intra- and interspecific genetic relationships of various marine organisms with an emphasis on current molecular methodologies.

663. Analytical Instrumentation and Methods. Spring, even years (2 or 3) Staff.

Discussion and demonstration of analytical instrumentation and methods including chromatography, mass spectrometry, electrophoresis, atomic absorption spectrophotometry, and related techniques. Discussion of sample preparation, quality control, quantification, etc. (Number of credits based upon laboratory participation.)

665. Immunology of Marine Organisms. Spring (3) Ms. Weeks-Perkins.

A course dealing with fundamental concepts in immune responses. The development of cellular and humoral immune responses and their regulation are considered in relation to infectious disease, allergy, tissue transplantation, neoplasia, autoimmune disease and immunodeficiency. Also considered are the properties of antigens and immunoglobulins, immunologic specificity and methods for monitoring immune responses. Acquired and innate immunity and the structure and function of the lymphoreticular system of fish will be considered in detail.

667. Coastal and Marine Stratigraphy and Facies. Spring, even years (2) Mr. Hobbs. Prerequisite: MS 545 or consent of instructor.

Analysis and interpretation of clastic facies, facies relationships, and stratigraphy emphasizing deposits produced in coastal and marine sedimentary environments. Study and comparison of coastal plain and modern sediments. Instruction in the interpretation and use of high resolution, marine, seismic reflection systems and sidescan sonar. Two lecture hours, laboratory and field exercises.

669. Ocean Dynamics I. Fall (3). Mr. Hamrick, Mr. Brubaker. Prerequisite: Consent of instructor.

A presentation of the fundamentals of fluid dynamics essential to the study of oceanic motions. The equations of motion for rotating fluids. Transport equations. Vorticity dynamics. Irrotational flows. Scale analysis. Hydrostatic and Boussinesq approximations. Turbulence, boundary layers and convection. Analytical solution techniques.

670. Ocean Dynamics II. Spring (3) Mr. Brubaker. Prerequisite: MS 669 or consent of instructor.

Dynamics of coastal waters and the open ocean, with systematic development of the role of density stratification and the earth's rotation. Gravitational adjustment and various classes of free-wave motion, including internal waves. Influence of coastal boundaries: Kelvin and shelf waves, upwelling. Wind-driven circulation, including western boundary currents.

671. Numerical Modeling in Oceanography. Spring (3) Mr. Hamrick. Prerequisite: MS 669.

A survey of numerical methods for partial differential equations emphasizing applications in oceanography. Finite difference, finite element and spectral methods. Stability, consistency, and convergence. Formulation and implementation of circulation and mass transport models for oceanic and estuarine applications.

697. Advanced Problems in Marine Science. Fall, Spring and Summer (1-4) Staff.

Supervised projects selected to suit the needs of the graduate student. Projects to be chosen in consultation with the student's major professor and the instructor. Acceptable research outlines and project reports are required. Amount of credit depends upon difficulty of course. Hours to be arranged with instructor prior to registration. The degree of difficulty and requirements of this course surpass those of MS 597.

698. Special Topics in Marine Science. Fall, Spring and Summer (1-3) Staff.

This is the avenue through which subjects not covered in other formal courses are offered. These courses are offered on an occasional basis as demand warrants. Subjects will be announced prior to registration. Hours to be arranged.

Undergraduate Courses

401. Introduction to Physical Oceanography. Fall, (3) Mr. Ruzecki. Prerequisites: Undergraduate Physics, Differential and Integral Calculus, consent of instructor.

Physical properties of seawater, descriptive oceanography, air-sea interactions, heat budget, methods and measurements, dynamics of circulation, waves and tides. Lectures and laboratory.

402. Introduction to Chemical Oceanography. Spring (3) Mr. Hale, Mr. Huggett. Prerequisite: Undergraduate Chemistry, consent of instructor.

Major and minor components of seawater, the concept of residence time, solution chemistry of inorganic compounds, nutrient cycling, dissolved gasses, radioactive dating, geochemical cycles, biosynthesis in marine environments, organic geochemistry, anthropogenic input. Laboratory demonstration of analytical methods for organic analysis. Three lecture hours.

403. Introduction to Biological Oceanography. Spring (3) Mr. Burreson. Prerequisite: Consent of instructor.

Introduction to biological oceanographic processes emphasizing primary production and nutrient cycling; plankton, nekton and benthic processes, including feeding and reproduction strategies and animal/sediment relations; population regulation; estuaries as ecosystems. Lectures and laboratory.

404. Introduction to Geological Oceanography. Fall (3) Mr. Boon, Mr. Hobbs, Mr. Wright. Prerequisite: Consent of instructor.

Concepts of marine geology; coastal processes, seafloor spreading and plate tectonics, sediments and sedimentation, shelf and canyon development. Lectures and field trips.

406. Introduction to Marine Science. Summer (3) Mr. Loesch.

A general introduction to marine science, including biological, chemical, geological, and physical oceanography. Three lecture hours. Offered at night at the Williamsburg campus. Not open to graduate students in the School of Marine Science.

410. Invertebrate Zoology. Summer (4) Mr. Roberts, Ms. Schaffner, Mr. Diaz. Prerequisite: Undergraduate Biology.

Discussion of major invertebrate metazoan phyla, including basic taxonomy, anatomy, physiology, and the role of invertebrates in ecosystems. Emphasizes marine and estuarine species present in Chesapeake Bay and vicinity.

412. Marine Botany. Summer (4) Mr. Silberhorn, Staff.

This course is primarily a survey of the micro- and macroalgae and vascular vegetation of the coastal region of Virginia, with emphasis on the latter. Course of study is aimed to improve knowledge of the floristics, community structure, phytogeography, and descriptive plant ecology of the area.

413. Coastal Botany. Fall (3) Mr. Silberhorn. Prerequisite: Consent of instructor.

A general survey of maritime vascular plant communities. Marshes, swamps, beaches, dunes, maritime forests and submerged aquatic communities of the coastal region. Field trips, laboratory and lectures.

445. Marine Sedimentation. Fall, even years (2-3) Ms. Kimball. Prerequisite: Permission of the instructor.

Characteristics of marine sediments including texture, mineralogy, and chemical and biological properties. Principles of clastic and carbonate sedimentation: hydrodynamic parameters; bedforms; primary and secondary bedding structures; regional distribution of sediments and modern depositional environments. Two lecture and two laboratory/field hours. Field project required for three credit hour option.

497. Problems in Marine Science. Fall, Spring and Summer (1-4) Staff.

Supervised projects selected to suit the need of the graduate student. Projects are chosen in consultation with the student's supervising professor and the instructor. Credit hours depend upon the difficulty of the project and must be arranged with the instructor in advance of registration.

498. Special Topics in Marine Science. Fall, Spring and Summer (1-3) Staff.

This is the avenue through which subjects not covered in other formal courses are offered. These courses are offered on an occasional basis as demand warrants. Subjects will be announced prior to registration. Hours to be arranged.

Graduate Regulations

Application for Admission

Requests for application forms and completed application materials should be sent to:

Dean of Graduate Studies
School of Marine Science
College of William and Mary
Gloucester Point, Virginia 23062

Students are encouraged to apply for admission during the winter of each calendar year with a closing date of February 15. Applicants will be notified after March 15 and no later than April 1. Admission will be valid for matriculation for the following summer, fall and winter semesters. Most students should anticipate a fall matriculation. The Dean of Graduate Studies should be contacted prior to submitting applications at any other time or regarding any special circumstances the student's application or matriculation might present.

The following are required of applicants to the School of Marine Science:

1. One (1) copy of the completed application form.
2. A *non-refundable* processing fee of \$20. This fee is not credited to the student's account. There is no fee for application for admission as an unclassified (post-baccalaureate) student.
3. Three (3) letters of recommendation.
4. Official transcripts of all college work. (Final degree transcripts are required of admitted students before they matriculate.)
5. Official Scores of the Verbal and Quantitative sections of the Graduate Record Examination (GRE).

Scores in an Advanced section of the Graduate Record Examination in the applicant's undergraduate major field or an area appropriate to the applicant's proposed concentration in marine science are informative but not essential. *GRE scores which are more than 5 years old are not acceptable and the examination must be retaken. Applicants are encouraged to take the Graduate Record Examination at scheduled dates which will allow for receipt of scores by the aforementioned closing date. Applications lacking GRE scores or other critical materials after the closing date may not be evaluated by the Faculty.*

International Students

International applicants whose primary language is not English must submit the results of the GRE English Language Proficiency Test, Test of English as a Foreign Language (TOEFL).

In general, the minimum acceptable TOEFL score is 550. The TOEFL requirement may be waived if the applicant has completed an undergraduate or graduate degree at an accredited U.S. institution or other appropriate institution in which the language of instruction is English. Students with marginal proficiency in English will be required to register for an appropriate English course offered at the Williamsburg campus. A reduced level of graduate courses is suggested for these students.

Transcripts, certificates of degrees, and similar documents submitted by international applicants must be accompanied by an English translation and must include titles of all courses taken and the grade received in each course.

International students admitted to the School must present proof that they have available funds sufficient to meet all costs they will incur while studying at the School of Marine Science. The form I-20 *will not be mailed* until this proof of financial support is received. For those students offered financial aid by the School of Marine Science, such aid may be included as a source of funds. For additional information, please contact the International Student Coordinator.

Admission Information

Applicants are encouraged to visit the campus to contact faculty members about specific research interests, funding opportunities, and program information.

Admission to the School of Marine Science is highly competitive and accordingly the Faculty carefully evaluates criteria of performance which include GRE scores, overall GPA and GPA in area of concentration, the difficulty of the applicant's educational program, the applicant's statement of purpose, letters of recommendation, and prior experience. Although it is neither possible nor desirable to provide absolute values of criteria that will ensure admission, the table on the following page shows GRE and GPA scores of applicants offered admission in Fall, 1992.

Classified Students

Students are admitted as regular or provisional graduate students. For matriculation as a regular graduate student, an applicant must have completed the requirements for a bachelor's degree at an accredited college, with a record of high performance, and must have the recommendations of the Faculty and officials of the School of Marine Science.

**GPA and GRE statistics of applicants offered admission
for the Fall semester, 1992**

GPA	GRE Scores							Totals
	<900	900-999	1000-1099	1100-1199	1200-1299	1300-1399	≥1400	
<2.0								
2.0-2.4	1						1	2
2.5-2.9		1		1		1	2	5
3.0-3.4			2	7	12	5	4	30
3.5-4.0			1	7	11	3	4	26
Totals	1	1	3	15	23	9	11	63

Applicants judged deficient in preparatory studies or other areas may be admitted as provisional students. A provisional student may petition for regular student status after successful completion of those requirements stipulated in his or her notification of admission. Petition for change in status shall be reviewed by the Committee on Academic Status and Degrees, using as criteria overall academic performance and performance standards previously specified on the student's notification of admission. Graduate credit earned by a provisional student will be applied toward the graduate degree upon conversion to regular student status.

Students may be admitted to either the Master of Arts or Doctor of Philosophy programs. Direct admission into the Doctor of Philosophy program is available to qualified applicants without a Master's degree. Applicants requesting this option should indicate this choice in the appropriate section of the application form. Direct admission must be granted and therefore requires an evaluation by the Admissions Committee. The following guidelines are employed by Admissions for this purpose: (1) direct admission is considered for applicants of exceptional promise and superior academic performance, and (2) the applicant must have the support of an appropriate faculty member who agrees to mentor the applicant over the course of study. Identification of a faculty mentor usually requires that the applicant visit campus to interview appropriate SMS faculty. Admissions' actions on requests for direct admission are transmitted to the Dean of Graduate Studies for final action. Following completion of the course requirements for the M.A. degree in Marine Science, a student initially admitted to the master's program may petition for permission to bypass the master's degree and proceed directly toward the doctorate, assuming the student has met all requirements. The petition, which must be submitted to the Committee on Academic Status and Degrees, should not be submitted until the student has successfully completed the comprehensive examination and must have support of the student's advisory committee. The advisory committee must support this petition with a written statement confirming that the student has begun work on a research project acceptable as the basis for a doctoral dissertation, and that it is the consensus of the committee that the student has demonstrated a level of excellence to proceed directly to the doctorate. Following review of the petition and supporting

documents and consideration of all faculty approved requirements for bypass, the Committee on Academic Status and Degrees will recommend to the Dean of Graduate Studies whether or not permission to bypass should be granted. Authority for the final decision rests with the Dean of Graduate Studies.

Students completing an M.A. degree in the School of Marine Science who desire to enter the Ph.D. program are required to submit a formal application for admission.

Unclassified Students

Students who have received a bachelor's degree from an accredited college or university and who wish to take courses in the College but who are not entering an advanced degree program, may apply for unclassified student status (post-baccalaureate). Graduate credit earned as an unclassified student may be applied toward the graduate degree upon matriculation as a regular graduate student.



Students measure growth of young oysters in trays suspended from VIMS pier.

Degree Requirements

General

Students generally are bound by the requirements stated in the catalog in effect when they enter the School. The following are usually the minimum requirements. The separate subfaculties and individual advisory committees may prescribe additional requirements for their students.

Residency: To fulfill the full-time academic residency requirement of the School of Marine Science, students must enroll for one of the following:

1. Twelve credit hours in the fall semester and twelve hours in the following spring semester;
2. Twelve hours in the spring semester and twelve hours in the following fall semester;
3. Twelve hours in the spring semester, followed by six hours in Summer Session I and six hours in Summer Session II; or
4. Six hours in Summer Session I, six hours in Summer Session II, and twelve hours in the following fall semester.

Satisfactory Progress: To continue in a degree program, a student must make satisfactory progress towards the degree. If the faculty of a program in which a student is enrolled determines that satisfactory progress is not being made, a student may be required to withdraw because of academic deficiency. A student may appeal a determination of lack of satisfactory progress to the Committee on Academic Status and Degrees.

Comprehensive Exam: Each student must satisfactorily complete a comprehensive examination within one regular semester, excluding summer sessions, following completion of the core courses. Comprehensive examinations may be written or oral.

Registration Requirements: All active students (i.e. those working toward completion of a degree program who have not been granted leave), whether in residence or not, must register for a minimum of three paid hours each semester, and one paid hour for each term of the summer session. Students must be registered in the semester during which they graduate.

System of Grading and Quality Points: The grades A (excellent), B (good), C (satisfactory), P (pass), in certain courses, D (unsatisfactory), and F (failure) are used to indicate the quality of work in a course. "W" indicates that a student withdrew from the College before mid-semester or dropped a course between mid-semester and the last day of class and was passing at the time that the course was dropped.

For each semester credit in a course in which a student is graded A, 4 quality points are awarded; B, 3; C, 2. P carries credit but is not included in a student's quality point average; D and F carry no credit but the hours attempted are included in the student's average.

In addition to the grades A, B, C, P, D, F, and W, the symbols "G" and "I" are used on grade reports and in the College records. "G" indicates that the instructor has deferred reporting the student's grade since there is not sufficient evidence on which to base a grade. "I" indicates that because of illness or other major extenuating circumstances, the student has postponed, with the explicit consent of the instructor, the completion of certain required work. "I" automatically becomes "F" at the end of the next semester if the postponed work has not been completed.

Transfer of Graduate Credit: On the recommendation of the Committee on Academic Status and Degrees and the approval of the Dean of Graduate Studies, a regular student may apply up to six hours of graduate credit earned at another accredited institution of higher learning toward an advanced degree at the College of William and Mary, School of Marine Science. The credits must have been earned in courses appropriate to the student's program in the School and must fall within the time specified by the general college requirements for degrees. Credit may be transferred only for courses in which the student received a grade of "B" or better and may not be counted in compiling his or her quality point average at William and Mary.

Retaking a Course: Degree credit is granted only for coursework in which a student earns a grade of "C" or above. A graduate student may repeat one course in which a grade of "C" or lower is received; however, the initial grade earned remains a part of the student's record and is included in computations of quality point requirements. Any student receiving more than one "D" or "F" in a program of study will not be permitted to continue in the School of Marine Science.

Changes in Registration: All changes in students' schedules after the close of registration require approval of the instructors involved and the Dean of Graduate Studies. Students may not add courses after the last day for changes in registration as indicated in the calendar. If the student drops a course or courses before mid-semester but remains registered for other academic work, the course or courses dropped will be removed from the student's record. If the student drops a course or courses after mid-semester through the last day of classes but remains registered for other academic work, the grade of "W" or "F" will be awarded by the instructor in the course depending upon whether or not the student was passing at the time the course was dropped.

A student wishing to withdraw from a course (or courses) because of medical reasons after mid-semester may apply to the Committee on Academic Status and Degrees for approval. If the Committee on Academic Status and Degrees verifies the legitimacy of the medical reason for withdrawal, a grade (or grades) of "W" will appear on the transcript.

Students may not drop a course after the last day of classes. If for medical reasons a student does not complete a course, "W" with appropriate notation will be entered on the record upon approval of the Dean of Graduate Studies and the appropriate authorities at the College.

Leave of Absence: A student may request a leave of absence from the program for a specific period of time. Leaves of absence will relieve the student of the obligation of paying tuition while still remaining as a student in good standing. A student must terminate the leave of absence and be a registered student in the semester in which his or her degree requirements are completed or in which he or she graduates.

Probation: A student will be placed on probation for: receipt of a grade below a C (<2.0) or a cumulative average less than a B (<3.0).

Probation will last until a student's cumulative average is raised to at least a B (3.0) and will in no circumstances last longer than one calendar year.

If, during probation, the student receives a grade less than C (<2.0), receives a semester average less than a B (<3.0), or fails to raise cumulative average to at least a B (3.0), the penalty is automatic dismissal from the School of Marine Science, with the possibility of appeal to the Committee on Academic Status and Degrees for reinstatement.

Withdrawal from the Program: Withdrawal from the program constitutes termination of the student's program of study in the School of Marine Science. Withdrawal may be voluntary on the part of the student or be imposed by the School of Marine Science for reasons of academic deficiency. A student who fails to register for a regular semester (fall or spring) once the student has begun his or her graduate study, who has not requested a leave of absence or permission to withdraw, will be placed on a leave of absence for one semester by the Dean of Graduate Studies. If the student has not applied for a leave of absence prior to the end of registration for the next regular semester, or if the Dean of Graduate Studies is not able to justify continuing the leave of absence, the student's record will be marked withdrawn unofficially.

If the student withdraws from the College before mid-semester, a grade of "W" will appear on the record for each course in progress at the time of withdrawal. After mid-semester through the last day of classes, students who withdraw from the College will be awarded a "W" or "F" by the faculty member teaching each course in progress at the time of withdrawal.

Reinstatement After Withdrawal: A student wishing reinstatement after withdrawal must reapply to the School of Marine Science under the procedures in effect at the time of reapplication.

Extension of Time Limit: Classified (regular) students who have exceeded the time limit for degree completion and who have not been granted a time extension will not be permitted to register in the School of Marine Science.

Required Courses

All students: By the end of a student's second year in the School, the student either must be granted an exemption from or have passed the following core courses, MS 501, MS 502, MS 503, MS 504, MS 530 (another approved statistics course may be substituted for MS 530).

Students in Biological Oceanography: MS 628.

Students in Marine Fisheries Science: MS 619 (A different course may be substituted with approval of the student's committee).

Students in Marine Resource Management: MS 604 and MS 650.

Language Requirement: Reading knowledge of one foreign language is required for either the M.A. or Ph.D. degree. Candidates for the doctorate who have passed a language examination for the master's degree in the School of Marine Science need not take another language examination. Individual committees may adopt additional language requirements at their discretion.

The student may fulfill the language requirement by completing one of the following:

1. At least six (6) semester hours in one pertinent foreign language (German, French or Russian are recommended) at the college sophomore level or above with grade of C or better; or
2. Obtain a score no lower than the forty-fifth percentile in the Educational Testing Service Foreign Language Examination; or
3. Pass an examination administered by a member of the Department of Modern Languages who is competent in the language.

Students whose native language is not English may, with the permission of the Dean of Graduate Studies, use English to fulfill the foreign language requirement. Proficiency in the use of the English language may be demonstrated by the completion of twelve credit hours of formal class work with grades of B or higher in the School of Marine Science. Upon recommendation of the Committee on Academic Status and Degrees of the faculty, the Dean of Graduate Studies may approve alternate methods.

Degree of Master of Arts

The steps to be accomplished and requirements for the degree are as follows:

1. As soon after initial registration as possible, the student must select a major professor, an advisory committee and a research project. The major professor, working with the committee, will prescribe the student's program which will include the required courses.

2. The major professor and Advisory Committee, chosen by the student and approved by the Dean of Graduate Studies, direct the student's program. The Advisory Committee consists of at least five members, the majority of which must be from the School of Marine Science. Committee members from outside of the School of Marine Science must possess the qualifications appropriate for status on the committee. For students with a concentration in biology or marine fisheries science, at least one of the members must be from the discipline of physical, chemical or geological oceanography. For students with a concentration in physical, chemical or geological oceanography, at least one member must be from the discipline of biological oceanography or marine fisheries science. For students with a concentration in marine resource management, one member must be from the discipline of physical, chemical or geological oceanography and at least one member from either the discipline of biological oceanography or marine fisheries science.
3. At least one year of each student's program must be spent as a full-time resident student as defined in the general degree requirements.
4. At least 30 semester credits of advanced work, of which at least 12 credits must have been earned in courses numbered 600 or above, with a grade average of 3.0 or better, are required for the M.A. degree. In addition, a student must have registered for thesis (MS 560) for at least one semester. No more than six thesis credits may be counted toward the minimum 30 credits required for the M.A. Thesis hours credited to a student in Research Graduate Status, above and beyond those for which they have paid, may not be counted for the minimum number of thesis credits required for the degree.
5. Upon a favorable recommendation of the student's Advisory Committee and the Committee on Academic Status and Degrees, followed by a majority vote of the faculty of the School of Marine Science and the approval of the Dean of Graduate Studies, a student may be admitted to candidacy after completion of the following requirements:
 - a. The student must have achieved a grade point average of B (3.0) or better, averaged over all courses taken for credit at the time of application for admission to candidacy.
 - b. All core courses required by the School of Marine Science, including MS 501, MS 502, MS 503, MS 504 and statistics, must be passed or officially exempted, and all other courses specifically required by the student's Advisory Committee must be completed.
 - c. The language requirement and the comprehensive examination must be satisfactorily completed.
6. The student must present a seminar to the marine science faculty, staff and students on a thesis topic approved by the major professor, the Advisory Committee and the Dean of Graduate Studies, and must defend this thesis before his or her major professor and committee. The defense of the thesis shall be separate from any other examination. The thesis must be submitted in final form to the College two weeks before the student expects to receive the degree. The degree will not be granted until 5 copies (approved and signed

by the major professor and the committee and prepared for binding), one of which is the original, have been presented by the student to the authorities as required by the College. Detailed information regarding procedures for submission of the thesis can be obtained from the Office of the Dean of Graduate Studies.

7. All requirements for the degree must be completed within six calendar years after commencing graduate study. In exceptional cases, if recommended by the appropriate faculty committee, time extensions may be approved by the Dean of Graduate Studies.

Degree of Doctor of Philosophy

The steps to be accomplished and the requirements for the degree are as follows:

1. The student must select a suitable major professor, who must be a faculty member of the College, as soon as possible following admission. The student and the major professor will choose an Advisory Committee, which must be approved by the Dean of Graduate Studies. The major professor and Advisory Committee direct the student's program.

2. Doctoral candidates must complete the course requirements (except thesis) for the Master of Arts degree in the School of Marine Science, or have fulfilled similar requirements at another equivalent institution. Course requirements beyond those required for a Master's degree will be established and approved by the student's major professor and Advisory Committee.

3. The Advisory Committee, chosen by the student and approved by the Dean of Graduate Studies, must consist of at least five members, at least one of whom must be from outside the School of Marine Science. A majority of the committee's members must be members of the faculty of the College, although persons with appropriate qualifications from outside the College may serve on the committee. For students with a concentration in biology or marine fisheries science, at least one member must be from the discipline of physical, chemical, or geological oceanography. For students with a concentration in physical, chemical or geological oceanography, at least one member must be from the discipline of biological oceanography or marine fisheries science. For students with a concentration in marine resource management, at least one member must be from the discipline of physical, chemical or geological oceanography and at least one member must be from the discipline of biological oceanography or marine fisheries science.

4. A minimum of three years of graduate study beyond the baccalaureate is required. At least one academic year must be **or have been** spent in residence as a **full-time M.A. or Ph.D.** student of the College of William and Mary at either the Williamsburg or the Gloucester Point campus, or both, as defined in the general requirements above.

5. In addition to and separate from the comprehensive examination, the student must satisfactorily complete a qualifying examination to demonstrate factual and theoretical knowledge in the student's field of specialization and in other subject areas as required by the student's advisory committee.

6. Admission to candidacy is the same as listed in Degree of Master of Arts section except that the separate qualifying examination also must be satisfactorily completed.

7. The dissertation must be submitted to the College two weeks before the date of commencement.

8. Each candidate must present a seminar to the marine science faculty, staff and students on his or her dissertation and must successfully defend the dissertation in a final examination before it can be accepted by the College. This examination may be written or oral at the discretion of the School of Marine Science and shall be open to the faculty and to such outside persons as may be invited. This examination shall be separate from any other examination.

9. All graduate work in the School of Marine Science must be accomplished within seven calendar years after beginning work for the doctoral degree. In exceptional cases, if recommended by the appropriate faculty committee, extensions may be approved by the Dean of Graduate Studies.

10. All dissertations will be published by having a master microfilm negative made from each original dissertation. These negatives will be stored and serviced by "University Microfilms" of Ann Arbor, Michigan, and positive microfilms, or enlarged prints, will be produced to order at the standard rate for other scholars who desire access to any dissertation. Each dissertation, when submitted, must be accompanied by two copies of an abstract of not more than 350 words. This abstract, or summary, will be published in Microfilm Abstracts for national distribution. No dissertation will be accepted without this abstract. A fee for the above services must be paid by the candidate for the Doctor of Philosophy degree before it is conferred. All dissertation research should be planned, conducted and reported with a view toward publication of the results in a legitimate scientific journal.

General Statement of Policy

Within the limits of its facilities and its obligations as a state university, the College of William and Mary opens the possibility of admission to all qualified students without regard to sex, race, color, age, religion, national origin, sexual orientation, or handicap.

The facilities and services of the College are open to all enrolled students on the same basis, and all standards and policies of the institution, including those governing employment, are applied accordingly.

Senior citizens of Virginia who wish to take advantage of fee waiver privileges in order to attend courses at William and Mary are invited to contact the Office of Admissions for full details.

The College reserves the right to make changes in the regulations, charges, and curricula listed herein at any time.

Honor System

The Honor System, first established at William and Mary in 1779, remains as one of the College's most cherished traditions. It assumes that principles of honorable conduct are familiar and dear to all students and hence dishonorable acts will not be tolerated. Students found guilty of cheating, stealing, or lying are subject to dismissal. The principles of the Honor System and the method of administration are described in the Student Handbook.

Financial Information

Tuition and Fees

The College reserves the right to make changes in its charges for any and all programs at any time, after approval by the Board of Visitors.

The tuition and general fee for full-time students in the School of Marine Science is \$2,024 per semester for residents of Virginia and \$5,714 per semester for others.

Special Note: All incoming students registered for nine hours or more in 500-level courses or above, or for twelve hours or more at any level, are considered full-time students and charged the full-time rates unless qualified to be a Research Graduate Student.

Tuition for part-time students, at both the undergraduate and graduate levels, is as follows:

\$130 per semester hour for Virginia residents.

\$350 per semester hour for out-of-state students.

Regularly enrolled degree-seeking students of the College will be charged these rates during the regular session for part-time work, based on their established domiciliary status.

Rates for students who enroll in the Summer Session will be charged on the same basis.

Part-time students who are not regularly enrolled at the College of William and Mary, and for whom, therefore, no domiciliary status previously has been determined, will be charged on the basis of their satisfactorily established domiciliary status. (See statement regarding Eligibility for In-state Tuition Rate).

Auditing fees are the same as those specified for part-time students, unless the auditor is a full-time student. Permission to audit must be obtained from the instructor.

Graduate Assistantships

Graduate research and graduate teaching assistants work an equivalent of twenty hours a week. *For graduate research assistants, every effort will be made to ensure that assistantship duties are relevant to the student's course of study and research program.* Graduate assistants must satisfactorily carry out the duties assigned by the School of Marine Science, must make satisfactory progress on their programs as defined by the College degree requirements and the regulations of the School of Marine Science, and may not hold any other employment or appointment of a remunerative nature during the term of their assis-

tantships without approval of the Dean of Graduate Studies. Failure to comply with these conditions will lead to revocation of appointments.

Graduate Fellowships

A limited number of outstanding applicants are awarded fellowships that consist of "tuition remission" in addition to a graduate assistantship. These fellowships are awarded via a priority ranking system within the group which qualifies and are for up to three years depending upon satisfactory performance.

Research Graduate Student Status

Upon the recommendation of a student's major professor, advisory committee, and the Committee on Academic Status and Degrees, the Dean of Graduate Studies may approve a student obtaining Research Graduate status if the following conditions have been met:

- The student has completed all required coursework.
- The student is not employed significantly in any activity other than research and writing in fulfillment of degree requirements.
- The student is present on the campus or is engaged in approved field work related to his or her thesis or dissertation.

While classified as a Research Graduate, a student may register for a maximum of 12 credit hours of Thesis or Dissertation per regular semester upon payment of the part-time rate for only three credit hours of Thesis/Dissertation. The student may elect to utilize up to two (2) of the three paid credit hours for formal coursework.

A Research Graduate student may register for additional course credit only upon payment of the generally applicable additional part-time tuition.

A Research Graduate student is eligible for services (e.g. student health and athletic events) only if required fees are paid.

Eligibility for In-state Tuition Rate

To be eligible for the lower tuition rate available to in-state students, a student must meet the statutory test for domicile set forth in Section 23-7.4 of the Code of Virginia. Domicile is a technical legal concept, and a student's status is determined objectively through the impartial application of established rules. In general, to establish domicile students must be able to show (1) that for at least one year immediately preceding the first official day of classes their permanent home was in Virginia and (2) that they intend to stay in Virginia

indefinitely after graduation. Residence in Virginia primarily to attend college does not establish eligibility for the in-state tuition rate.

On admission to the College an entering student who claims domiciliary status is sent an application form and instructions on how to fill it out. The Office of the Registrar evaluates the application and notifies the student of its decision. A student re-enrolling in the College after an absence of one or more semesters must re-apply for domiciliary status and is subject to the same requirements as an entering student. A matriculating student whose domicile has changed may request reclassification of out-of-state to in-state; since reclassification is effective only prospectively, however, it must be applied for before the beginning of the academic semester. Any student may ask for written review of an adverse decision, but a change in classification will be made only when justified by clear and convincing evidence. All questions about eligibility for domiciliary status should be addressed to the Office of the Registrar.

Payment of Accounts

Charges for the tuition and general fee are payable in advance by the semester. Registration is not complete until all fees due the Treasurer's Office are paid. Any unpaid balance on an individual's account could result in cancellation of registration. Remittance being made by check should be drawn to the College of William and Mary. Checks returned by the bank for any reason will constitute nonpayment of fees and will result in subsequent cancellation of registration.

Refunds to Students Who Withdraw from College

Subject to the following regulations and exceptions, all charges made by the College are considered to be fully earned upon completion of registration by the student. Due to administrative procedures, refunds will not be processed until six (6) weeks after classes begin.

1. A student who withdraws within the first five-day period immediately following the first day of classes is entitled to a refund of all charges, with the exception of \$50 which shall be retained by the College to cover the costs of registration, subject to Item No. 5, below. (Such refunds shall not include any deposits or advance payments which may have been required by the College as evidence of the student's intention to enroll.)

2. A student who withdraws at any time within the next following 25 days after the first day of classes shall be charged 25% of the tuition and general fee, subject to Item No. 5 below.

3. A student who withdraws at any time within the second 30-day period after the first day of classes shall be charged 50% of the tuition and general fee, subject to Item No. 5 below.

4. A student who withdraws at any time after 60 calendar days following the first day of classes shall be charged the full tuition and general fee, subject to Item No. 5 below.

5. No refunds will be made to a student who has been required by the College to withdraw, regardless of the date of withdrawal.

6. No refunds will be made to a student who withdraws unofficially.

7. A registration fee of at least \$50 will be deducted from the amount due and paid by a part-time student who withdraws within 60 calendar days immediately following the first day of classes, except in the case of an in-state student who is registered for only one credit hour. In such a case, the student will receive no refund.

If the total amount due and paid is more than \$100, a maximum of 50% of the total will be refunded. The graduated refund policy noted for full-time students will not apply to part-time students.

No refund will be granted to a part-time student who withdraws after 60 calendar days immediately following the first day of classes; or who has been required by the College to withdraw, regardless of the date of withdrawal; or who withdraws unofficially.

At the graduate and/or law school level, a part-time student is one who is enrolled for eight (8) credit hours or less. An exception to this rule is noted under Tuition and Fees.

Withholding of Transcripts and Diplomas in Cases of Unpaid Accounts

Transcripts or any other information concerning scholastic records will not be released until College accounts are paid in full. Diplomas will not be awarded to persons whose College accounts are not paid in full.

Student Facilities and Services

Campus Parking

Many SMS students drive a motor vehicle to campus, and parking can sometimes be at a premium. However, space is usually available in one of the 16 campus parking areas, including three lots near the Franklin Marine Center. All motor vehicles, including motorcycles and motorbikes, parked on VIMS property must be registered with Administrative Services in Watermen's Hall. Registration includes the purchase of a College of William and Mary parking decal, which must be displayed on or in the vehicle. Decals are also honored on the main campus in Williamsburg. Illegally parked or unregistered vehicles are subject to citation, and students with unresolved citations are not allowed to register for classes or to receive degrees.

A full description of campus motor vehicle regulations is contained in a booklet available from Administrative Services.

Housing

There is no student housing on the VIMS campus, and most SMS students live in Gloucester Point or in surrounding communities. Rental housing is plentiful, and area rents generally range from \$250 to \$450 or more per month, depending on the accommodations. Students often elect to share housing in order to keep costs to a minimum.

A limited number of apartments for SMS graduate students are available on the Williamsburg campus. Located next to the Marshall-Wythe School of Law, the Graduate Housing Complex is within walking distance of the College's main campus and historic Colonial Williamsburg. Information and application forms may be obtained from the Office of Residence Hall Life, P.O. Box 8795, 206 James Blair Hall, Williamsburg, VA 23187-8795, (804) 221-4134.

Cultural Life at William and Mary

As part of the William and Mary community, SMS students may participate in a broad range of cultural activities on the Williamsburg campus. Under the auspices of the Committees on Concerts and Lectures and the Speakers Forum, the College provides its students opportunities to enjoy a full spectrum of public lectures and concerts. In recent years College audiences have enjoyed performances by nationally and internationally recognized theatre arts performers. In addition, the William and Mary Theatre annually presents four full-length plays in public performance. The Speakers Forum offers subscription series featuring prominent national personalities from the worlds of politics, entertainment, and the arts.

Under the sponsorship of the Fine Arts Department, the Campus Center, and the Muscarelle Museum of Art, exhibits in painting, sculpture, and architectural design, theatre and industrial arts are shown throughout the year.

Numerous small and large cities—including the major metropolitan areas of Norfolk, Virginia Beach, and Richmond—are within easy driving distance of Gloucester Point. Each provides a broad array of cultural and entertainment events throughout the year.

Outdoor Life and Athletics

With VIMS/SMS' semi-rural setting in close proximity to the Chesapeake Bay and its many tributaries, and with the Blue Ridge Mountains only a few hours' drive to the west, SMS students enjoy diverse opportunities for outdoor activities ranging from sailing, canoeing, and kayaking to biking, hiking, and both fresh- and saltwater fishing.

Graduate students regularly participate in informal and organized soccer, basketball, and other team sports, and are eligible for reduced-rate health club memberships at community fitness centers in Gloucester and nearby Newport News.

The Williamsburg campus includes the 15,000-seat capacity Cary Field stadium used for competitive football, track, soccer, and lacrosse events, as well as providing space for intramural sports. William and Mary Hall has an indoor seating capacity of 10,000 for basketball, gymnastics and track. Graduate students who pay full tuition and general fees are admitted to all athletic contests by presenting their ID cards.

The Office of Recreational Sports provides a variety of leisure pursuits to all students through intramural, sport club, informal recreation, fitness/wellness and outdoor programs. Facilities include the Student Recreation Center, Adair Gymnasium, William and Mary Hall, Lake Matoaka and various other outdoor facilities. The Recreation Center and Adair Gymnasium each have a 25-yard indoor pool. Facilities are open seven days per week during the academic year and often during the break periods. Facility schedules and procedures for checking out equipment are available at any recreational facility or the Campus Center.

Intramurals are separated into co-rec, men's and women's divisions for most activities. Play is held for each of over 30 sports/activities during the year. Informal or open recreation, generally considered "free-play," is offered in aerobics, swimming, racquetball and squash, basketball, weightlifting, canoeing and kayaking and other sports.

The Sport Club program consists of 23 clubs, each self-governing and self-supporting and dictated simply by participants' interest in the activity. Clubs include badminton, crew, cricket, cycling, ice hockey, judo, men's lacrosse, martial arts, outdoor, racquetball, rifle, men's rugby, women's rugby, running, sailing, scuba, men's soccer, women's soccer, squash, surfing, tennis and ultimate frisbee.

For information on any activity, program or service offered by Recreational Sports, the office may be contacted at 221-3310.

Student Health Service

Graduate students who have filed a history and physical examination form and carry at least nine credits per semester are eligible to use the College's student health service, which is operated on the main campus in Williamsburg. Graduate students who carry fewer than nine credits per semester are eligible to use the health service if they are certified by the Dean of Graduate Studies as "full-time equivalent" students and pay the student health fee.

Any student who has not submitted his/her health history and physical examination form by the end of his/her first semester at the College will not be permitted to register for the next semester.

The health service is housed in the King Student Health Center, which includes an out-patient clinic, a dispensary, and a limited number of beds for overnight care. A variety of services, most of which are covered by the student health fee (a portion of the tuition and general fee), are provided by the King Student Health Center.

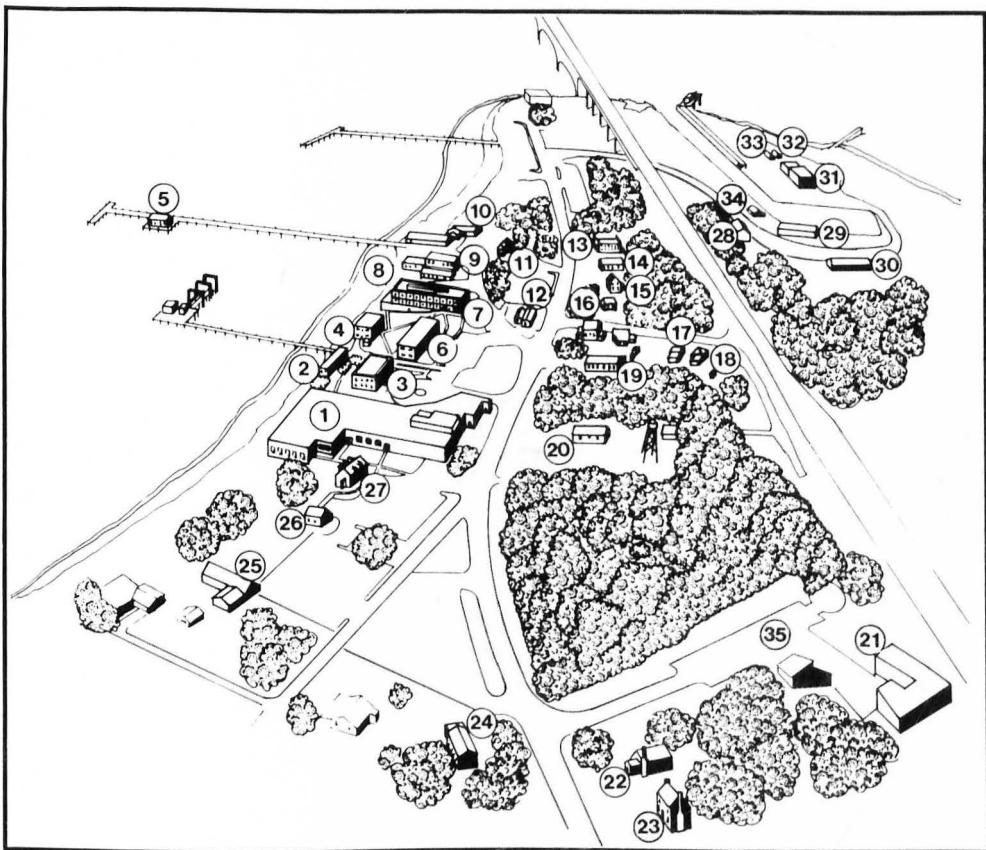
The **Center for Personal Learning and Development** on the Williamsburg campus offers professional assistance with psychological problems and problems involving social relationships and the understanding of oneself or others. Services are offered to students through individual psychotherapy, group psychotherapy, and personality testing and assessment. With the exception of national test services, all Center services are free to students. *No information concerning an individual's contact with the Center will be released without the written permission of the client.*

As a matter of policy, the Center does not deal with problems that require the prescribing of drugs, except in instances that warrant cooperative work with the Student Health Service. The Center also does not handle problems associated with course selection, job placement, career counseling, or remedial academic programs.

The Graduate Student Association

The Graduate Student Association is a voluntary organization open to all graduate students in the School of Marine Science.

The purpose of the Association is to advance the academic and social interests of its members. Officers are elected each spring for the following academic year.



The Campus of
The College of William & Mary
Virginia Institute of Marine Science
School of Marine Science

- | | | |
|-----------------------------|--------------------------------|-----------------------|
| 1. WATERMEN'S HALL | 13. HOXTON HALL | 25. PAGE HOUSE |
| 2. MARINE CULTURE LAB | 14. HOLBEN HOUSE | 26. CENTRAL RECEIVING |
| 3. MAURY HALL | 15. WHITEHOUSE | 27. CLAYTON HOUSE |
| 4. DAVIS HALL | 16. STEVENSON HOUSE | 28. FRANKLIN HALL |
| 5. FERRY PIER HOUSE | 17. MELVILLE HOUSE | 29. NEWPORT HALL |
| 6. BROOKE HALL | 18. CONRAD HOUSE | 30. BOAT SHED |
| 7. BYRD HALL | 19. COASTAL INVENTORY FACILITY | 31. OYSTER HATCHERY |
| 8. SEDIMENT LAB | 20. RALEIGH HOUSE | 32. SAV GREENHOUSE |
| 9. SERVICE CENTER & WET LAB | 21. JEFFERSON HALL | 33. TURTLE GREENHOUSE |
| 10. MAINTENANCE SHOP | 22. HALL HOUSE | 34. DIVE LOCKER |
| 11. REED HOUSE | 23. BROWN HOUSE | 35. NUNNALLY HALL |
| 12. MASEFIELD HOUSE | 24. WILLIAMS HOUSE | |

THE COLLEGE OF WILLIAM AND MARY
SCHOOL OF MARINE SCIENCE
P.O. BOX 1346
GLOUCESTER POINT, VIRGINIA 23062-1346

Non-Profit
Organization
US Postage
PAID
Gloucester Point
Virginia
Permit No.6

SCHOOL OF

MARINE

SCIENCE

1992 - 1993



1693 1993

300

William & Mary