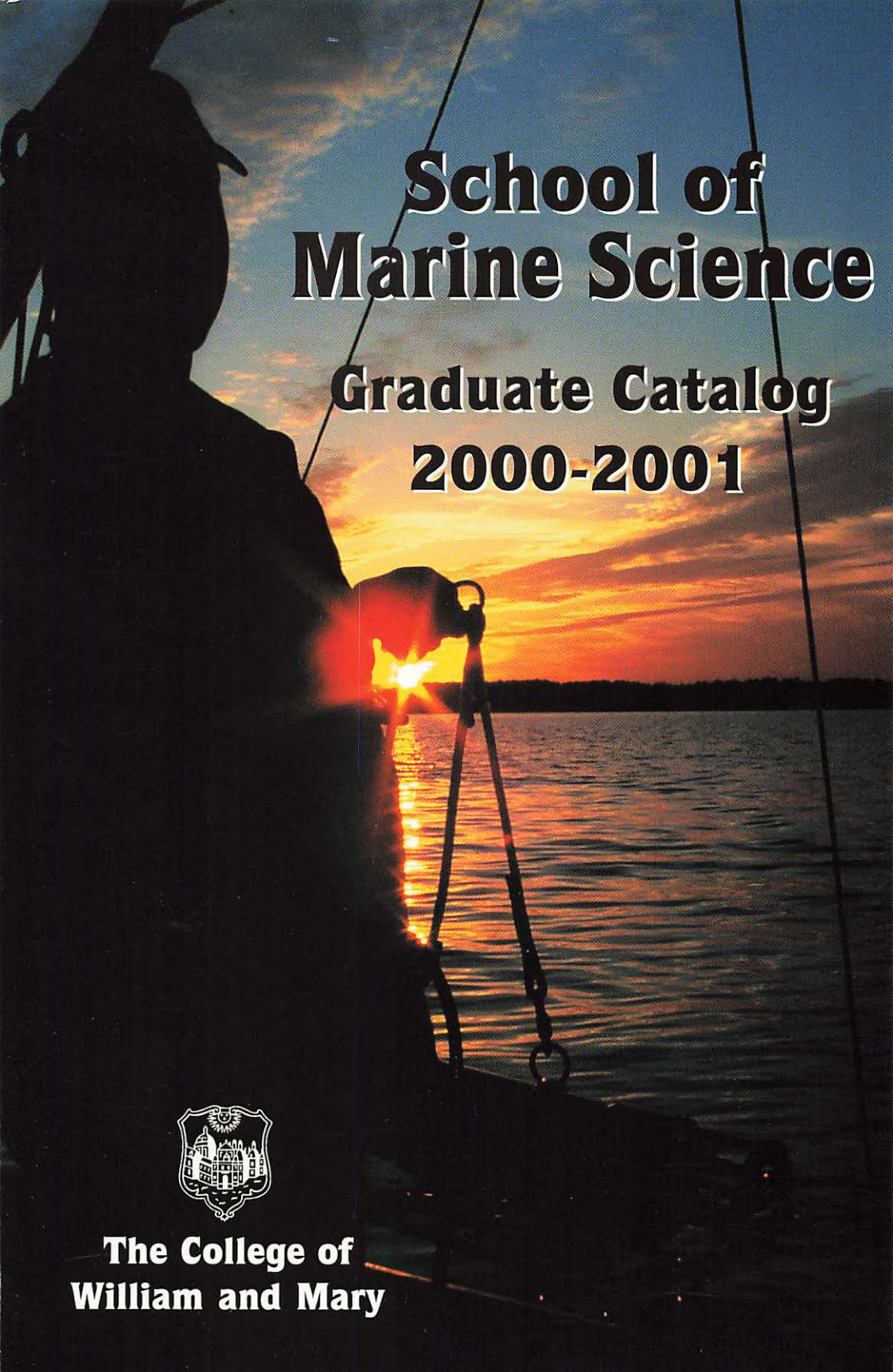

School of Marine Science

Graduate Catalog 2000-2001

The College of William and Mary

August 2000

NOTE: This catalog provides announcements for the 2000-2001 academic year. It is current until August 2001. 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

The College of William and Mary does not discriminate on the basis of race, color, religion, national origin, sex, sexual orientation, disability or age in its programs and activities. The following person has been designated to handle inquiries regarding the non-discrimination policies:

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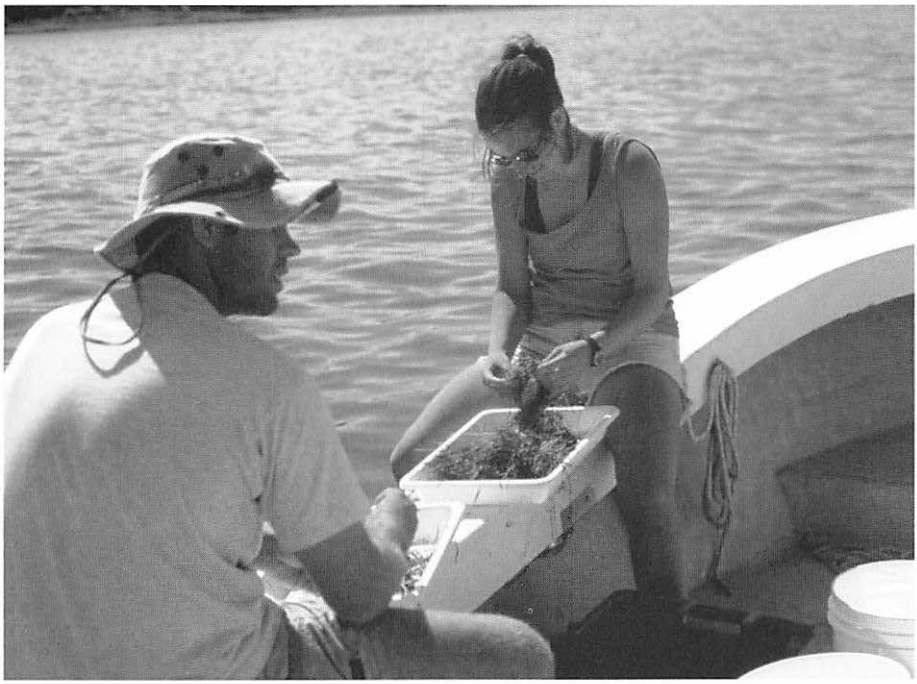
The policies in this catalogue apply to students who matriculate into the SMS graduate program in the academic year 2000-2001.

Cover photograph by Grace Battisto.

School of Marine Science

Graduate Catalog 2000 - 2001



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Contents

Calendar

Fall Semester 2000

August

28-29	Mon.-Tues.	Orientation Period
28-29	Mon.-Tues.	General Registration & Registration for Incoming SMS Students
30	Wed.	FIRST DAY OF CLASSES: 8:00 am Beginning of Add/Drop Period for 2000 Fall Semester

September

1	Fri.	Tuition and Fees for 2000 Fall Semester Due to SMS/VIMS Cashier
8	Fri.	Last Day to Drop a Class for Fall 2000 Semester Last Day to Add a Class for Fall 2000 Semester
8	Fri.	NOTICE OF CANDIDACY FOR GRADUATION Forms due to SMS Registrar for December 2000 candidates
11	Mon.	Beginning of Period for Withdrawal from a Class with Grade "W"

October

13	Fri.	Mid-Semester (for grading purposes only)
14-17	Sat.-Tues.	Fall Break
30–Nov. 3	Mon.-Fri.	Graduate Student Registration Period for Spring 2001

November

3	Fri.	Last Day to Withdraw from a Class with a Grade of "W" for 2000 Fall Semester
17	Fri.	NOTICE OF CANDIDACY FOR GRADUATION Forms due to SMS Registrar for May 2001 candidates
22	Wed.	Beginning of Thanksgiving Holiday: 8:00 am
27	Mon.	End of Thanksgiving Holiday: 8:00 am

December

8	Fri.	END OF CLASSES: 5 pm
9-10	Sat.-Sun.	Reading Period
11-12	Mon.-Tues.	Examinations
12	Tues.	LAST DAY TO SUBMIT THESES AND DISSERTATIONS FOR DECEMBER 2000 CONFERRAL OF DEGREES
13	Wed.	Reading Period
14-15	Thurs.-Fri.	Examinations
16-17	Sat.-Sun.	Reading Period
18-21	Mon.-Tues.	Examinations
18	Mon.	OFFICIAL DECEMBER GRADUATION DATE

Spring Semester 2001

January		
15	Mon.	Graduate Registration
15	Mon.	Tuition and Fees for 2001 Spring
17	Wed.	Beginning of Add/Drop Period Semester Due to SMS/VIMS Cashier
17	Wed.	FIRST DAY OF CLASSES: 8 a.m.
26	Fri.	Last Day to Drop a Class for 2001 Spring Semester Last Day to Add a Class for 2001 Spring Semester
29	Mon.	Beginning of Period for Withdrawal from Course with Grade of "W."
March		
3-11	Sat.-Sun.	Spring Break
10	Fri.	Mid-Semester (for grading purposes only)
23	Fri.	Last Day to Withdraw from Course with Grade "W" for 2001 Spring Semester
26-30	Mon.-Fri.	GRADUATE STUDENT REGISTRATION PERIOD FOR FALL 2001
April		
16-18	Mon.-Wed.	Open Drop/Add for 2001 Fall Semester
27	Fri.	END OF CLASSES: 5 pm
27	Fri.	END OF CLASSES: 5 pm
28-29	Sat.-Sun.	Reading Period
30	Mon.	LAST DAY TO SUBMIT THESIS AND DISSERTATIONS FOR MAY 2000 CONFERRAL OF DEGREES
30-May 4	Mon.-Fri.	Examinations
May		
5-6	Sat.-Sun.	Reading Period
7-9	Mon.-Wed.	Examinations
13	Sun.	COMMENCEMENT

Summer Sessions 2001

SESSION I: May 29-June 29 (Mon.-Fri.)
SESSION II: July 2-August 3 (Mon.-Fri.)

30 Apr	Mon.	Summer School Bulletins Available
30 Apr.-May 11	Mon.-Fri.	REGISTRATION FOR SUMMER SESSIONS
May 25	Fri.	NOTICE OF CANDIDACY FOR GRADUATION Forms due to SMS Registrar for AUGUST 2001 Candidates (Forms may be obtained from SMS Website)
July 27	Fri.	LAST DAY TO SUBMIT THESES AND DISSERTATIONS FOR AUG. 2001 CONFERRAL OF DEGREES
August 6	Mon.	AUGUST 2001 GRADUATION DATE

Crab dredge survey aboard the R/V Bay Eagle.

Fisheries Science students on the annual "Roanoke Round-up."

The College of William and Mary

The College of William and Mary in Virginia, founded in 1693, is the nation's second oldest institution of higher education. During its 305 year history, the College has built an eminent reputation for excellence in education. The College's commitment to a thorough, well rounded education through exploration, innovation and involvement is the source of institutional coherence. Today the College is national and international in its character and contributions. Students and faculty from diverse backgrounds are attracted to both the undergraduate programs and the various schools offering graduate studies.

The College of William and Mary is a small, residential university currently enrolling approximately 5,400 undergraduate and 2,300 graduate students. The School of Arts and Sciences offers Masters and Doctorate degrees in several departments. Graduate degrees may be pursued in three professional schools: Marshall Wythe School of Law; the School of Business Administration; and the School of Marine Science.

The College is accredited by the Southern Association of Colleges and Schools. In keeping with the College's mission as a state institution, a wide range of courses, seminars and programs both for credit and non-credit are offered on all campuses.

School of Marine Science / Virginia Institute of Marine Science

Since their founding more than 60 years ago, the School of Marine Science and the Virginia Institute of Marine Science have functioned under a tripartite mission: to conduct independent research, to provide advisory services, and to provide education in the marine sciences. From 1940 to 1961, the academic program was conducted through the Department of Biology and Marine Science of the College of William and Mary. Since 1961, the School of Marine Science has functioned as a professional graduate school of the College of William and Mary. Faculty of the School of Marine Science are appointed from the larger faculty of the Virginia Institute of Marine Science. The School of Marine Science awarded its first masters degree in 1943 and inaugurated a doctoral program in 1964. Over the past 50 years more than 500 marine scientists have earned graduate degrees from the School of Marine Science.

At present the School of Marine Science has 130 graduate students; about one-half are working on their masters theses and one-half are working on doctoral dissertations. The School receives approximately 200 applications per year from prospective students. Approximately 25 enter the program each academic year.

Statement of Purpose for the School of Marine Science

The purpose of the School of Marine Science is to provide quality education and opportunities in scholarly research to students pursuing advanced degrees in marine science. The objective of the program is to provide a fertile and stimulating learning environment in which students can pursue their studies. This is accomplished by providing a comprehensive program in the basic principles of marine science and marine resource management, and close interaction with faculty actively involved in research and management issues.

Facilities

School of Marine Science students participate in graduate studies at an active, year-round research facility with approximately 300 scientists, support technicians and staff. The 35-acre main campus of the School of Marine Science/Virginia Institute of Marine Science (SMS/VIMS) is located in Gloucester Point at the mouth of the York River, a major tributary and natural passageway to the Chesapeake Bay and Atlantic Ocean.

The Eastern Shore Laboratory offers access to embayments, salt marshes, barrier beaches and coastal waters. Located in Wachapreague, about 2 hours from Gloucester Point, this facility is an important center for research in bivalve aquaculture and houses a hatchery, a nursery facility and nearby bivalve grow-out sites. The Aquaculture Genetics and Breeding Technology Center (ABC) operates an experimental shellfish hatchery for genetics and breeding studies of hard clams, oysters, soft-shell clams, scallops and other species, and is ABC's operational base for brood stock maintenance. A seawater flume laboratory is also located on the campus.

Various service centers and special programs at the SMS/VIMS complement and enhance the student's experience.

Library: Current holdings include more than 525 journal subscriptions, 53,000 volumes and 23,200 titles in addition to topographic maps, nautical charts and scientific archives. On-line networks provide access to marine science literature, and a wealth of electronic databases offered by the State of Virginia. Students in the SMS/VIMS library have access to on-line catalogs at Swem Library on the main campus of William & Mary. In addition VIMS has a Web interface to an on-site search engine, which enables it to present local bibliographies.

Vessels: The SMS/VIMS maintains and operates a fleet of 40 vessels for research. Larger vessels are equipped with flow-through sea water and sample collection-analysis labs and electronics labs. In addition to the 65-foot R/V Bay Eagle, 44-foot R/V Langley, and 29-foot R/V Fish Hawk, there is a sizable trailerable fleet. State-of-the-art electronic systems can be transferred among the smaller boats. The diving facility includes a diver training room and classroom to support the 40-member dive team.

Information Technology and Networking Services Unit: ITNS provides technical support for all computer platforms used on campus, in addition to maintaining a campus-wide backbone network linked to Internet and several local area networks (LANs).

The Chesapeake Bay National Estuarine Research Reserve System in Virginia (CBNERRVA) maintains long-term water quality monitoring stations at each of its four Reserve sites.

Marine Advisory Service/ Virginia Sea Grant Program: Serves as a liaison between commercial and recreational marine related industries, providing them with access to the Virginia university system.

Chesapeake Bay National Estuarine Research Reserve System: VIMS is the lead agency in Virginia, with four designated sites preserved for estuarine research, monitoring, education, and conservation of key resources.

Center for Coastal Resources Management: Focuses on applied research, advisory service, and outreach activities in support of government agencies and nongovernmental organizations involved in resource management. Continuing work is conducted in tidal and nontidal wetlands, estuarine and coastal shorelines, geographic and living resource inventories, and watershed management. The Center engages in a wide variety of interdisciplinary projects and provides a forum for multi-investigator and multi-institutional applied research.

Aquaculture Breeding Center's Gloucester Point Hatchery: Experimental fish and shellfish hatchery for the Aquaculture Genetics and Breeding Technology Center maintains varieties and stocks of native and non-native oysters. A new greenhouse complex for fish culture was recently established by the Marine Advisory Program.

Analytical Service Center: The Analytical Service Center (ASC) provides nutrient, physical and sediment analysis to students, scientists and governmental agencies managing and developing diversified environmental programs as well as thesis projects. The ASC has researched, refined and developed methodologies for analysis in a wide spectrum of environmental matrices. The quality of data is the result of thorough statistical controls, documentation, and training. ASC instrumentation is state-of-the-art, with computer control interfacing, background correction and optimization for saline matrix.

Nunnally Hall: Completed in 1992, Nunnally houses the extensive fisheries collection that includes approximately 85,000 specimens representing 247 families.

Chesapeake Bay Hall: Completed in spring 1997, this facility provides an additional 60,000 sq. feet of research facilities, including labs for advanced research in chemistry, geochemistry, toxicology, pathobiology, microbiology, genetics, physiology, planktology, nutrient cycling and parasitology.

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Graduate Study Programs

The primary focus of SMS/VIMS research is coastal and marine environments from estuaries to the continental slope. In addition to teaching and conducting basic research, many of the faculty are engaged in applied research of concern to industry and management agencies. Students, therefore, often find their assistantship duties and/or research bring them in close contact with other departments at SMS and William and Mary, marine related industries, and state, regional, and federal management agencies.

Based on the primary academic and research disciplines represented at SMS/VIMS, graduate studies are offered in five areas.

Biological Sciences

The Department of Biological Sciences includes a diverse group of biologists and ecologists working in a variety of disciplines from microbiology and taxonomy to ecosystem modeling. Scientists in the department are engaged in research aimed at elucidating the temporal and spatial patterns and processes controlling benthic, nektonic, and planktonic systems in estuarine, coastal and open ocean regimes.

Major Programs

Benthic Ecology: Studies focus on the major processes governing the structure and function of benthic systems. Component processes are addressed using a variety of approaches, ranging from molecular genetic studies of evolutionary relationships among species to interdisciplinary studies of organisms or communities interacting with their environment. In most cases research is focused on benthic systems of the land-sea margins, including tidal freshwater, estuarine and coastal regions. On-going research programs include studies of processes influencing recruitment, growth and production of benthic organisms; linkages between benthic and pelagic systems through processes such as nutrient cycling and trophic transfer; functional role of benthic communities in the transport and fate of materials such as sediments, organic matter and contaminants.

Field studies on the toxic dinoflagellate Pfiesteria piscicida.

Ecosystem Modeling: The program develops and uses digital computer simulation models as an integrative and synthetic tool in ecosystem analysis. Current programs include modeling studies of both temperate and tropical seagrasses, the dynamics of littoral zones in estuaries, estuarine plankton-nutrient interactions, and watershed nutrient cycling processes with an emphasis on spatial heterogeneity. Working with hydrodynamic and water quality modelers, a general goal of the program is to develop linked models that address both basic and applied ecological management questions.

Macrophyte Ecology: Studies concentrate on submersed and emergent macrophyte species that dominate shallow subtidal and intertidal marine, brackish, and freshwater areas. Current research includes studies on plant distribution and abundance, restoration ecology, plant dispersal mechanisms, plant response to environmental variability, plant growth and productivity, carbon and nitrogen cycling and ecosystem simulation modeling. The program encourages multi-investigator and multi-institutional collaborative efforts.

Nutrient Cycling: Studies focus on 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.

Physical Biology: Interdisciplinary studies utilize methods from fluid and solid mechanics, and heat and mass transfer theory, to investigate food capture, bioenergetics, primary and secondary production, and allometry in invertebrates and algae. On-going projects include the effects of internal waves on secondary production at seamounts (Gulf of Maine), flow modulation of coral bleaching (Caribbean), organism-sediment-flow interactions (Chesapeake Bay), and impact of sponges on water column processes (Lake Baikal).

Plankton Processes: Plankton research addresses processes of primary production by phytoplankton and secondary consumption by bacteria, protozoans and zooplankton in estuarine, coastal, shelf and open ocean systems. System-wide and both short- and long-term responses to cultural eutrophication are addressed. Collaborative research aimed at understanding the links between plankton dynamics and recruitment of economically important fisheries populations are also pursued. The ecology of harmful algal blooms is of particular interest.

Research Facilities

The department is well equipped with modern laboratory and field instrumentation in support of Biological Sciences. Various laboratories are equipped with running salt water. Major equipment includes an instrument tripod with acoustic doppler velocimeters, underwater video cameras, suspended sediment sensors for *in situ* studies of organism-sediment interactions in the aquatic environment, gas chromatographs fitted with various detectors, 15N-emission spectrometer, an Alpkem auto-analyzer for ten water chemistries, computer-assisted image analysis hardware, a remote sensing imaging processor, underwater spectral radiometer, Li Cor light sensors and data loggers, spectrophotometer, sediment profile cameras, box corer and benthic grabs, underwater video, hydrolabs, radioisotope modules, an autonomous underwater vehicle, Coulter Altra flow cytometer,

and a seawater flume. A programmable light- and temperature-controlled walk-in chamber and greenhouse are available for photosynthesis-related studies.

Preparatory Studies

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 the Biological Sciences area must include in their programs the required core courses as well as MS 526. 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 that relies on modeling or theoretical mathematical formulations.

Coastal and Ocean Policy

The faculty and staff of the Department of Coastal and Ocean Policy (DCOP) pursue both basic and applied research. Studies of the structure and function of wetlands, identification and classification of land forms and land cover, and the relationship of landscape pattern and coastal system performance are among the ongoing basic research programs. Applied projects address everything from developing educational programs for resource managers, to tracing wetland ownership records, to analysis of use conflicts in coastal waters, to preparation of resource management plans for coastal parks and sanctuaries. The highlight of these efforts is their interdisciplinary character. Students working in the department will be involved in the ongoing process of synthesizing knowledge from many different fields including not only the core science disciplines but also law, economics, government and sociology.

Major Programs

The Coastal Ecosystems and Remote Sensing Program (CERSP) conducts basic and applied research on detection and characterization of changes in the coastal environment. The program emphasizes development of field and remote sensing models and algorithms necessary to assess coastal ecological phenomena.

CERSP has a variety of instruments for field and lab studies, including: field and lab spectroradiometers, fluorescence spectrophotometers, and digital multi-spectral video.

Marine Resource Economics: Studies focus on marine resource and environmental economics, resource management, statistics, game theory, risk and uncertainty, and operations research analysis. In addition, international trade, economic development, population dynamics and the economics of recreational fishing are examined.

The Ocean and Coastal Law Program (OCL) provides graduate education; advisory support to state agencies and the General Assembly; and conducts research on resource management topics pertinent to Virginia.

Research Facilities

The Department of Coastal and Ocean Policy cooperates closely with the Center for Coastal Resources Management, which operates the Comprehensive Coastal Inventory Laboratory that is a computer-based facility using Geographic Information System (GIS) and image processing software. The program also utilizes remote sensing data, satellite images and aerial photography. In addition, an up-to-date resource management/legal library is available within the department.

Preparatory Studies

DCOP is an interdisciplinary academic department. We recommend the following courses are completed prior to admission: 1 semester of basic statistics, 2 semesters of calculus or other higher math, 4 semesters of life or earth sciences (including chemistry), and 2 semesters of resource management, policy analysis, or resource economics. Strong writing and verbal communication skills also are recommended.

Typical Course of Study

The typical course of study for students in DCOP will involve completion of the SMS core curriculum, as well as advanced courses in three areas: science, policy, and quantitative methods. The science requirement can be fulfilled by any of the initial advanced courses offered in other departments (MS 520, MS 522, MS 524, MS 526, MS 528). The policy requirement will be met by MS 542 (Principles and Theory of Resource Management). The quantitative methods requirement will be satisfied by courses in other departments in subjects such as Ecological Modeling and Simulation Analysis (MS 651), Estuarine Water Quality Models (MS 617), or Multivariate Analysis and Time Series (MS 625). Additional related graduate coursework in public policy, law, economics, government and business is available on the Williamsburg campus and may be used as part of the DCOP curriculum.

Studying vegetative marsh communities.

Environmental Sciences

The Department of Environmental Sciences combines the expertise of chemists and biologists to study the fate and effects of hazardous substances and pathogenic organisms in marine, estuarine, and freshwater systems. Within the department, faculty expertise includes environmental chemistry, biochemistry, toxicology, ecotoxicology, environmental microbiology, pathobiology, histopathology, immunology, and risk assessment. Collaboration within this multidisciplinary group provides the opportunity to obtain a more complete understanding of the behavior of toxic chemicals and pathogens and their impact on the environment and organisms (from the molecular to the population level). This information can be used for ecological risk assessment and thereby made available to environmental managers in the Commonwealth, the Chesapeake Bay region and the nation in a readily usable form. Students with a variety of backgrounds can select mentors who match their interests in many areas of environmental science. We strongly encourage prospective students to contact departmental faculty in advance of application to discuss mutual research interests.

Major Programs

Environmental Chemistry: Sources, distribution, transport, fate and bioavailability of pollutants in aquatic systems are focal points of study. Specific research addresses issues such as degradation and partitioning in the environment and emerging contaminants of concern. Other interests include modeling the spatial distribution of environmental contaminants using GIS and the application of modern computer techniques to data interpretation. Interactions of toxic chemicals with aquatic life may be explored independently or in collaboration with biologists within the department. New techniques are being developed to separate, purify, and identify anthropogenic compounds and their breakdown products. Contaminants of particular interest include antifoulants such as tributyltin, petroleum hydrocarbons, pesticides, fire retardants, and detergents. (Hale, Unger)

Environmental Microbiology: This diverse program 1) focuses on the consequences of introduced indicator microorganisms (bacteria and virus) and human pathogens in waters used for recreation, aquaculture, and shellfish industries; 2) seeks to develop and validate methods for detection of allochthonous microorganisms of public health significance and to understand their fate and autecology in aquatic environments; 3) studies processes that contribute to eutrophication and microbial contamination of receiving waters; and 4) engages in collaborative research to understand the role of bacteria in diseases of feral and cultured fish. Ulcerative diseases attributed to Mycobacteria spp. and Pfiesteria spp. are the focus of current collaborative studies. (Kator, Vogelbein, Kaattari, Van Veld, Kotob)

Aquatic Toxicology: Toxicity effects are measured as 1) responses of individuals and populations to contaminated water and sediment, 2) uptake and elimination of pollutants by individual organisms, and 3) cellular, histological, subcellular, and molecular mechanisms of uptake, internal distribution, biotransformation, and clearance of hazardous chemicals. Through collaboration with the pathobiologists, the effects of chemicals on disease resistance are being identified. Linking the responses of organisms at the various levels of organization is being attempted in order to develop a basis for predicting population effects from the subcellular and molecular effects that can be

observed a concentrations below those at which ecological effects are identifiable. (Roberts, Newman, Van Veld, Vogelbein, Chu)

Pathobiology: Major projects focus on infectious and non-infectious diseases of fish and shellfish. A variety of immunological, cytological, histological, biochemical and molecular techniques are being applied to determine the mechanism(s) by which pathogens cause disease in the host organisms. These tools are also applied to investigating host defense mechanisms, and to the development of diagnostics, therapeutics and vaccines for use in aquaculture. Collaborative studies involving researchers from all departmental programs seek to understand the impact of toxic materials on host-parasite interactions. The pathobiology group has developed an Aquatic Animal Disease Diagnostic Laboratory using traditional histological, microbiological and modern molecular techniques to identify diseases observed in feral animals. (Kaattari, Faisal, Chu, Vogelbein, Shields, Mulvey, Kator, Kotob).

Ecological Risk Assessment: Risk assessment tools are applied to evaluate the risk associated with exposure to hazardous chemicals, pathogens, bacterial agents, both individually and collectively in complex mixtures. The goal is to provide a conceptual framework that will improve environmental management by allowing resource agencies to focus their limited resources on those issues of greatest importance. (Newman)

Research Facilities

Laboratories of the Department of Environmental Sciences are principally located in Chesapeake Bay Hall and Byrd Hall. The Department laboratories in Chesapeake Bay Hall are equipped with state-of-the-art instrumentation for studies of environmental chemistry, toxicology, immunology, electron microscopy and pathobiology. Instrumentation includes mass spectrometers, high-resolution gas chromatographs, high-performance liquid chromatographs, enhanced solvent and supercritical fluid extractors, graphite furnace , cold vapor, and flame atomic absorption spectrometers, scanning and transmission electron microscopes, a TLC/FID Iatroscan

Protein electrophoresis analysis of seagrasses.

lipid class composition analyzer, and electrophoretic and other analytical systems for molecular and biochemical studies including an automatic DNA sequencer, and a monoclonal antibody facility. The department maintains separate flowing estuarine water laboratories for toxicological and for disease research. In addition, there are freshwater facilities dedicated to rainbow trout. Colonies of several species of fish and invertebrates are maintained to provide test animals for toxicity studies. Improvements to these facilities are in the planning stage and are expected to be completed in 2001. Cultures of hepatocancerous and other cell lines are maintained for use in molecular study of disease. The present facilities and equipment available in the department are described in more detail on the departmental web site (www.vims.edu/env).

Preparatory Studies

Students interested in the Environmental Sciences program should possess a degree in an applicable natural science (e.g. Biology, Chemistry, Geology or related subdiscipline), typically with course work in calculus, physics and chemistry. Competence in statistics, computer experience and strong written communication skills are also viewed as highly desirable. Students contemplating application to the department are strongly encouraged to discuss their previous academic background and experience with prospective mentors listed under the major program of interest prior to application.

Typical Course of Study

The educational program of the Department of Environmental Sciences is closely related to its research activities in each core program. The Department takes a multidisciplinary approach integrating concepts of chemistry, toxicology, immunology and disease processes. The purpose of the educational program is to prepare students for careers as scientists or environmental managers. Since both research and educational programs are interdisciplinary, incoming students are expected to have strong backgrounds in biology and chemistry. Following satisfactory completion of the institutional core curriculum, students may pursue courses and research in one of five major program areas (environmental chemistry, toxicology, environmental risk assessment, environmental microbiology or pathobiology). The department offers a number of pertinent courses including Environmental Chemistry (MS 563), Aquatic Toxicology (MS 564), Principles of Pathobiology (MS 565), Diseases of Marine Organisms (MS 566), Environmental Microbiology (MS 573), Fish Histology and Histopathology (MS 638), Quantitative Ecotoxicology (MS 640) and Environmental Risk Assessment (MS 641). Students pursuing the Masters degree typically select a minimum of two departmental offerings, while PhD students will generally be expected to choose four of these courses. Students may complement this curriculum, in consultation with their mentor and research committees, with appropriate courses offered by other SMS departments and departments at the Williamsburg campus.

Fisheries Science

The Department of Fisheries Science makes substantial contributions to the Institute's research, education, and advisory service missions. Research programs at the local, national and international levels focus on investigations and assessments of fish, crab and mollusc species of commercial, recreational and ecological importance. Also included within the research framework of the department is the newly created Aquaculture Genetics and Breeding Technology Center. Collaborative research and teaching efforts are common among department faculty. In addition to furthering knowledge through publication, members of the department are expected to advise local, regional, and national management agencies, providing opportunities for students to become directly involved in fisheries management. Also available to students are highly equipped laboratories and many opportunities for field work within Chesapeake Bay and beyond.

Research Programs

Anadromous Fishes Program: Research and monitoring of the abundance, reproductive ecology, life history and exploitation of important migratory species such as striped bass and American shad that spawn in Virginia's tidal fresh waters. Studies include monitoring commercial and recreational landings, developing novel approaches to stock assessment, conducting surveys of juvenile abundance, and mark/recapture methods for estimation of fishing rates. (Olney).

Aquaculture Genetics and Breeding Technology Center: Research includes development of brood stocks in shellfish species of interest to Virginia and the region, including selective breeding (especially for disease resistance), chromosome set manipulation, and evaluation of non-native species (Allen).

Aquaculture Molecular Genetics: Research interests include molecular genetic analyses of aquaculture species and disease organisms. Emphasis is on oyster genomics, molecular phylogenetics, population genetics and the development of molecular diagnostics for protozoan pathogens (Reece).

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

Commercial Fisheries Development: Research includes gear selectivity and bycatch as well as management and regulatory strategies for seafood production, processing and utilization. (DuPaul)

Crustacean Ecology: Studies examine the behavioral ecology, population dynamics and recruitment mechanisms of the blue crab in the Chesapeake Bay and spiny lobster in the Caribbean. Emphasis on predator-prey interactions, population and fisheries modeling, ecology of natural and artificial reef systems, and ecology of tropical fish and queen conch. (Lipcius)

Morphological studies on sharks in the Fisheries Science Lab.

Finfish Ecology: Studies of the dynamics, recruitment, stock structure and life history of marine, estuarine and anadromous fishes based on sampling fisheries landings, surveys and tagging studies. Data generated by this program is directly applied to stock assessment and fisheries management by state and regional agencies. (Chittenden)

Fish and Shellfish Pathology: Ongoing research focuses on the systematics, life cycles, ecology, pathology and control of important disease agents in the Chesapeake Bay region. Current emphasis is on protozoan parasites of oysters, blue crabs, and fishes. (Burreson)

Fisheries Genetics: Examines the application of molecular genetic techniques to address problems in fisheries science. Studies focus on analysis of stock structure, use of molecular characters to identify early life history stages of marine organisms; and the evaluation of taxonomic and biogeographic hypotheses with molecular genetic information. (Graves)

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

Marine Vertebrate Ecology: Continuing studies into the comparative morphology, reproduction, and population dynamics of sharks; long term research on the distribution, migration, abundance, ecology and energetics of sea turtles; and investigations of the life history of finfish taxa (Musick).

Stock Assessment Methodology: Program involves the systematic evaluation of stock assessment procedures and the development of new mathematical models and statistical methods for studying populations and their responses to exploitation. Tagging, survey, and landings data are used to estimate population size, mortality rates, components of mortality, yield, spawning potential, and effects of changes in fishery regulations. Applications include invertebrates and vertebrates in temperate and tropical sport and commercial fisheries (Hoenig).

Systematics and Taxonomy: Taxonomically diverse studies that focus on the morphology, evolution, taxonomy and zoogeography of various vertebrate and invertebrate groups. The program promotes a total evidence approach to phylogenetic research, including molecular techniques and morphological studies of larval, juvenile and adult forms. (Musick, Olney, Graves, and Reece).

Research Facilities

The Department of Fisheries Science comprises several programs, each with a fully equipped laboratory, a variety of collection and sampling equipment, and extensive computer facilities.

The Fisheries Science Laboratory has available an Optimas image analysis system, computerized scale projectors and Biosonics digitizing system to provide automated morphometric measurements, rapid analysis of hard structures for age determination, and automated counting procedures. Automated fish measuring boards and a variety of collections are also available.

The Crustacean Ecology Program maintains the GEM Lab with two large (1800 gal) benthic mesocosm tanks monitored by IR-sensitive, computer controlled cameras with time-lapse image recorders.

The Bivalve Ecology Program's laboratory is well equipped for physiological and ecological studies with a UV-VIS spectrophotometer, centrifuges, a fluorescence microscope, compound and dissecting microscopes, and an image analysis system.

The Fisheries Genetics and Shellfish Molecular Biology Programs both maintain large laboratories with walk-in cold rooms and are fully equipped to undertake a variety of genetic analyses. Major equipment includes an automated DNA sequencer, five thermal cyclers, refrigerated centrifuges, ultracentrifuges, a vacuum concentrator, an automated x-ray developer, and several ultracold freezers.

The Shellfish Pathology laboratory has a photomicroscope, full histology laboratory and is adjacent to the electron microscope facility.

Nunnally Hall contains a fish collection with approximately 85,000 species representing 247 families. This research and teaching collection incorporates extensive holdings from Chesapeake Bay, the Middle Atlantic Bight, Appalachian freshwater habitats, and an internationally recognized collection of deep-sea fishes. The Larval Fish Laboratory houses a reference collection containing early life history stages of over 120 families of marine, estuarine and freshwater fishes. The program also has considerable plankton collection equipment, an *in situ* silhouette plankton camera and 1.5 m diameter mesocosms for *in vivo* experiments of larval fish trophic dynamics and mortality.

Two wet lab facilities are available to department 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.

Monthly surveys of juvenile fishes and crabs are conducted throughout the Bay and on three major rivers. Plankton studies, larval fish research, and reproductive studies of recreational fishes are conducted in the Bay as well as offshore.

Preparatory Studies

Students interested in graduate study in Fisheries Science should have a solid undergraduate background in biology including: physiology, biochemistry, comparative morphology or developmental biology, genetics, ecology and related topics, and evolutionary biology. College physics, chemistry (through organic) and 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 Marine Fisheries Science (MS 528) and an additional quantitative course such as Experimental and Quantitative Ecology (MS 667), Multivariate Analysis and Time Series (MS 625), or Applied Regression and Forecasting (MS 672); Stock Assessment Methods (MS 670) Among the courses offered by the Fisheries faculty are Fisheries Climatology (MS 665), Ichthyology (MS 666), Diseases of Marine Organisms (MS 566), Malacology (MS 668), Marine Fisheries Science (MS 528), Culture and Physiology of Marine Organisms (MS 571), Early Life History of Marine Fishes (MS 657), Fisheries Population Dynamics (MS 671) and Marine Molecular Genetics (MS 673).

Preparing oyster specimens for genetic analysis.

Physical Sciences

The overall objective of the Department of Physical Sciences is to generate, communicate and apply knowledge concerning the physical, chemical and geological processes that operate in the coastal ocean and estuaries. The emphasis of the physical oceanography group is the study of water properties and water movement in estuarine, coastal and continental shelf environments. Geological oceanography includes the study of the processes of sediment erosion, transport and accumulation as well as the resulting stratigraphy. Marine chemistry emphasizes the study of marine biogeochemical processes, and environmental fate and transport of natural and anthropogenic substances. Interdisciplinary studies are strongly emphasized in this department.

Major Programs

The Chemical Oceanography/Marine Geochemistry Program is comprised of a diverse faculty with numerous cross-disciplinary interests. Work is currently being conducted across groundwater, riverine, estuarine, continental margin and open ocean environments on a variety of projects intended to help us better understand the cycling of organic materials (both natural and anthropogenic) and both major and trace elements. Individual faculty and students in this program collaborate actively not only with other programs in Physical Sciences, but also with the departments of Biology, Environmental Sciences, Fisheries Science and Coastal and Ocean Policy. There is also increasing interaction with several of the departments and with the newly established Environmental Sciences and Policy cluster on the main campus of the College of William and Mary. Examples of current and on-going projects within the Chemical Oceanography/Geochemistry group include: cycling and diagenesis of dissolved and particulate organic matter in estuaries and open ocean settings; physio-chemical exchanges of organic contaminants across various aqueous and particle interfaces in groundwaters and estuaries; and sorptive/desorptive processes controlling the movement and availability of trace metals and organic contaminants in sediment matrices.

The Geological Oceanography Program conducts local and international research on a variety of both disciplinary and interdisciplinary topics. Research sites span the full range of marine/nearshore environments from the coastal plain and river floodplains, through the estuaries and across the margin to the base of the continental rise. Although much of our effort addresses questions in Chesapeake Bay and surrounding areas, federal funding supports research in many other areas in the U.S. and around the world (including China, Bangladesh, and New Guinea), which generates generic knowledge about geological phenomena in the coastal ocean. Some of the major focal areas include: sediment transport and boundary layer processes; sediment flux and fate; seabed dynamics; shoreline erosion/sand resource issues; and Quaternary stratigraphic development. Interdisciplinary research efforts involve faculty from the departments of Biological Sciences, Environmental Sciences and Coastal and Ocean Policy, as well as colleagues from other institutions worldwide.

The Physical Oceanography Program focuses on water motion in estuaries and on the continental shelf along with the associated transport of buoyancy, suspended particles, nutrients and pollutants. Physical Oceanography at VIMS is extremely interdisciplinary, with ongoing collaboration with chemists and geologists within our department,

biologists and resource managers elsewhere at VIMS, and scientists from various disciplines through the country and around the world. We have ongoing field projects in the Chesapeake Bay and its tributaries as well as on the shelves of the east and west coasts of the U.S., and we are applying three-dimensional numerical models to study circulation and associated dissolved and particulate transport in estuarine and shelf environments. Cooperative research projects are underway with scientists from countries including Korea, The Netherlands, Taiwan, and the U.K. Some of the major focal areas of scientists in our group include: wind- and buoyancy-driven circulation on the inner shelf; effects of stratification on the bottom boundary layer; the dynamics of estuarine fronts; three-dimensional modeling of estuarine sediment transport and water quality; the association of characteristic density- and tidally-driven estuarine circulation patterns with the fate and transport of pollutants; wind wave evolution in estuaries and on shelves; and the physics governing sediment transport on shelves and in the surf zone.

Research Facilities

The department maintains state-of-the-art equipment for conducting high-quality field and laboratory research. Major field equipment includes: Laser In-Situ Scattering and Transmissiometry (LISST); sea-bed hydraulic flume; a meteorological station with a precipitation collector for low-level organic contaminants; high-volume air samplers; a rotating drum surface microlayer sampler; and bottom boundary layer instrumental tetrapod systems for measuring bed stress, wave and currents, sediment resuspension, and bed-level changes. A variety of instrumentation including tide gauges, current meters, conductivity-temperature-depth (CTD) profilers, fluorometers, dissolved oxygen (DO) meters, fathometers, dual-frequency side-scan sonars, variable frequency seismic profiling systems, directional wave gauges, turbidity sensors, acoustic doppler current profilers (ADCP), and Kasten and box corers are available for field studies. Microwave and GPS navigation systems are maintained by the department for accurate positioning of research vessels.

The department houses extensive laboratory instrumentation, including: microwave-assisted solvent extraction system; large-capacity, refrigerated, programmable centrifuge; ultra-cold (-80 deg. C) freezers; Fisons EA1108 CHNS-O analyzer; UV/Vis spectrophotometer; gas chromatographs with flame ionization and electron capture detectors; two quadrupole mass spectrometers; Inductively Coupled Plasma Atomic Emission Spectrophotometer (ICP/AES); EDS system with full SEM imaging capabilities; powder x-ray diffractometer; nitrogen adsorption surface area and porosity analyzer; CHNSO elemental analyzer; high performance liquid chromatograph with UV absorbance and liquid scintillation detectors; two laboratory flumes (recirculating and annular); five intrinsic germanium gamma spectrometers; eight channel alpha spectroscopy system; X-ray radiography unit; sedigraph automatic particle analyzer; rapid sediment analyzer. Computer facilities range from laptop units for field use to work stations supporting LANs (local area networks) to the institute-wide network. Computer users have ready access to external networks. Pentium-PC, UNIX and MacIntosh systems are supported by departmental staff and by the Institute's computer center.

Preparatory Studies

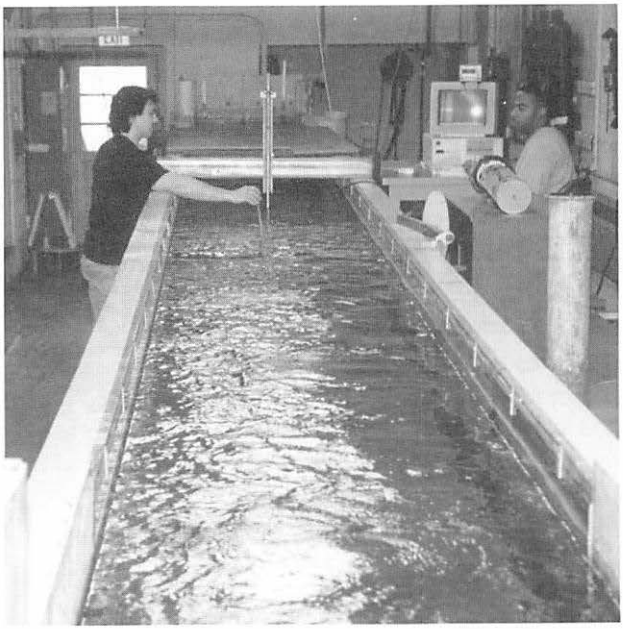
In all aspects of the Department of Physical Sciences' education and research programs, there is a heavy reliance on quantitative skills, and our incoming students therefore are expected to have a strong background in the appropriate sciences. Undergraduate majors providing preparation for graduate study in physical sciences include physics, applied mathematics, engineering, chemistry and geology. Biological science majors interested in pursuing graduate work in physical sciences are encouraged to include introductory physics and calculus through ordinary differential equations in their backgrounds.

Typical Course of Study

For students majoring in physical oceanography, required courses include Principles of Coastal and Estuarine Physical Oceanography (MS 520). Advanced courses address estuarine hydrodynamics and water quality, providing an in-depth focus on estuarine physics and its influence on biogeochemical processes. Additional courses address other advanced topics in ocean dynamics and apply three-dimensional numerical modeling to estuarine and coastal issues.

Students interested in geological oceanography may pursue tracks emphasizing sedimentary environments and stratigraphy, sediment geochemistry, or physical transport/morphodynamic processes. Courses include marine sedimentation, coastal morphodynamics, benthic boundary layers, multivariate and time-series analysis, and isotope geochronology. Students are required to take the Geological Oceanography (MS 522) course. In addition, depending on a student's particular emphasis, geological students may be required to take advanced courses in physical, chemical or biological oceanography.

Graduate students in marine chemistry may specialize in any of the various aspects of marine and environmental chemistry. Required courses include Advanced Aquatic Chemistry (MS 555) and Principles of Chemical Oceanography (MS 524). Specialized course work in other aspects of marine and environmental chemistry can be selected through recommendation of the student's thesis committee.



The freshwater flume is used for calibrating instruments before and after deployment.

Course Descriptions

Graduate 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 that the content is better presented through directed readings and one-on-one discussion. MS 691 to MS 696 are crosslisted courses taught by staff of the College of William and Mary's School of Law on the Williamsburg campus. Student wishing to take any of these courses must contact the School of Law instructor to gain permission.

501. Fundamentals of Marine Science. Fall (6) Mr. Smith, Mr. Brubaker, Mr. Bauer, Mr. Kuehl, Ms. Canuel.
An interdisciplinary overview of marine science, with emphasis on processes of open ocean systems. Topics include the physics of ocean circulation, processes influencing the vertical and horizontal distributions of properties, the chemistry of aqueous species (inorganic and organic), the influence of past and present processes on the ocean's sediments and basins, and the structure and function of pelagic communities. The course is divided into modules emphasizing physical, geological, chemical and biological aspects, with interdisciplinary aspects of a wide variety of oceanic systems, such as upwelling regions, polar systems, hydrothermal vents, and oceanic gyres, highlighted at the course's end. *Required of all students unless an exemption from a module has been obtained by taking a written exam administered by the responsible faculty member prior to the beginning of class.*

501L. Fundamentals of Marine Science Lab. Fall (1) Ms. Canuel, Staff.
A hands-on introduction to lab and field methods commonly used in marine science. The course will include exercises from the fields of biological, chemical, geological and physical oceanography. Lab exercises will be designed to complement lectures in MS 501. Sample collection and analysis will be emphasized with additional focus on data analysis and interpretation. *Required of all students unless exemption is approved by the Dean of Graduate Studies upon recommendation by the course coordinator.*

502. Coastal and Estuarine Processes, Issues and Investigations. Spring (5) Mr. Friedrichs, Mr. Orth, Ms. Schaffner.
An interdisciplinary classroom and field-based introduction to the science and management issues in the coastal ocean, including estuaries and continental shelves. The course is organized around four major themes: the unique nature of coastal and estuarine environments; sediment transport and coastal change; eutrophication and habitat quality issues; and living resources and fisheries. Students will explore these themes in depth by developing and conducting a field based project centered around class cruises in the estuary, with particular emphasis on spatial and temporal patterns of biotic and abiotic processes and their interactions. *Required of all students.*

Wet lab aboard the R/V Langley.

504. Fundamentals of Statistical Methods and Data Analysis. Fall (2) Mr. Evans. Stochastic model of observational data; introduction to probability, probability distributions, discrete and continuous; parameter estimation, confidence intervals, hypothesis testing; linear regression and analysis of variance methods, including multiple regression and dummy variables; data transformations; propagation of errors; distribution fitting; non-parametric tests. *Required of all students unless justification for exemption is approved by the Dean of Graduate Studies upon recommendation of the course coordinator.*

505. Fundamentals of Experimental Design and Sampling. Spring (1) Mr. Diaz. This course is an introduction to sampling and experimental design. Basics of the scientific methods will be reviewed and design principles explained relative to the scientific method. Selection of appropriate statistical tests for various sampling and design strategies will be covered. Probability based and exact statistical methods will be presented. *Required of all students unless justification for exemption is approved by the Dean of Graduate Studies upon recommendation of the course coordinator.*

506. Scientific Communication Skills. Spring (2) Mr. Milliman. Review of the important elements of oral and written presentation skills for communicating scientific research. Critical evaluation of literature, development of scientific questions and rationale for research, formulation of conceptual models for developing high-quality scientific research projects. Oral and written presentation skills are emphasized through written exercises and class presentations, with peer review.

520. Principles of Coastal and Estuarine Physical Oceanography. Spring (3) Mr. Friedrichs, Mr. Brubaker. Following a review of the governing equations, lectures and discussions will focus on dynamics of currents and waves on continental shelves and in estuaries. Topics to be covered include fundamentals of wind and density driven flow; aspects of fronts, mixing and secondary circulation; and time-dependent motion such as surface gravity waves, internal waves, coastally-trapped waves and tides.

522. Principles of Geological Oceanography. Fall, even years (3) Mr. Kuehl, Staff.
A brief review of the tectonic history of the oceans followed by detailed study of the ocean margins including sea-level history and nearshore geological processes in the coastal zone and continental shelf regions. The geological effects of bottom currents on oceanic sediments will be examined along with ocean basin sediment history and approaches to paleooceanography.

524. Principles of Chemical Oceanography. Spring (3) Mr. Bauer, Ms. Canuel. Prerequisite: Instructor's consent.
This course covers in a comprehensive and integrated manner the important factors controlling the chemical composition of seawater. Basic principles of chemical thermodynamics will be applied to the seawater medium and will serve to introduce contemporary, global-scale chemical processes such as the role of the oceans in global climate change. Selected topics include distributions of the biolimiting elements; chemistry of marine sediments; trace metal chemistry; marine organic chemistry; and ocean-atmosphere interactions.

526. Principles of Biological Oceanography. Spring (4) Mr. Ducklow, Mr. Duffy.
Lecture and discussion of the fundamental processes underlying primary and secondary production in marine ecosystems. Emphasis on physical processes supporting primary production, plankton dynamics, biotic interactions structuring communities, vertical and horizontal distributions, foodweb structure, ecological role of higher and lower trophic levels, and benthic-pelagic coupling. The course concludes with a survey of the major marine ecosystems.

527. 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.

528. Marine Fisheries Science. Fall, even years (3) Mr. Olney, Mr. Hoenig. 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. Lectures, laboratory hours and field trips.

529. Economic Principles of Fisheries Management. Fall (3) Mr. Kirkley.
An introduction to economic theories and principles which determine the exploitation, utilization, and management of marine fisheries. Theories and principles are presented in a graphical format, but the interpretation and understanding of policies and solutions are emphasized. The course provides a balanced understanding of the underlying economics of conflicting user groups. Methods of fisheries management and regulation are emphasized with respect to economic and social concerns.

542. Principles and Theory of Resource Management. Spring (3) Mr. Taylor and Mr. Kirkley.
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 Coastal and Ocean Policy.

543. Law and Resource Management. Spring (1-3). Fall, even years. Staff.
A course designed to examine the relationships between science, resource management, and legal concepts. The evolution of institutions, legislation, and issues related to managing resources will be explored from international, national, state, and local perspectives. Particular attention will be paid to major federal programs and statutes, significant case law, and case studies involving the interaction of special interest groups and governmental institutions at local, state, national, and international levels. A small portion of the course will be devoted to the interaction of law, science and ethics. The course is intended to function in an intimate seminar setting, with discussion and exchange of ideas being important aspects of student performance.

544. Pests and Diseases in Resource Management. Spring (3) Mr. Shields.
This course gives students a basic background in the principles and practices of pest and disease management in aquatic systems. It focuses on aquaculture and fisheries problems, but also draws on case histories in the control of human diseases and agricultural pests for comparisons. It presents the basic tenets in resource management, integrated pest management, and certain ecological principles that apply to introductions of pest and epizootics of parasite diseases. The efficacy of various control measures, practices, and regulations are also explored.

545. Marine Sedimentation. Spring, even years (3) Mr. Milliman, Staff.
Introduction to continental margin sedimentary environments with emphasis on physical, biological and chemical controls on the development of sedimentary strata over a range of spatial and temporal scales. Case studies from modern settings will be used to illustrate concepts of strata formation. Laboratory exercises include petrographic, textural and mineralogic analysis.

548. Technical and Continuing Education in Marine Science. Fall, Spring and Summer (1-3) Staff. Prerequisite: Instructor's consent.
Graduate-level instruction to public school teachers and other professionals who require postgraduate certification or special training. Courses are offered on an occasional basis as demand warrants. Instructors or teams of faculty identify a client group and formulate a course description that serves individual professional needs. Courses may include lecture laboratory components, field trips and demonstrations. An example of a course offered recently is experimental design in the marine science laboratory, a lecture and laboratory course for science teachers that addressed standards of learning in Virginia.

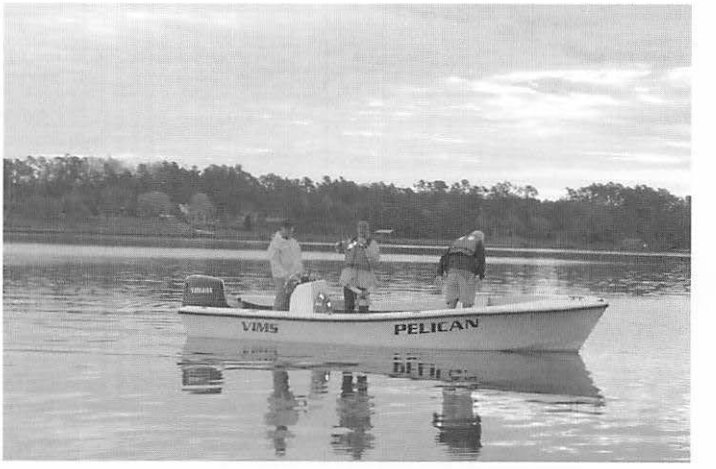
550. Rivers: Processes and Management. Spring, odd years (3) Mr. Milliman.
Rivers form the main link between land and the sea, discharging 40 thousand km3 of water and more than 20 billion tons of suspended and dissolved solids annually. Three

central themes are stressed: 1. How rivers work: the hydrologic cycle and water balance, basin character, erosion; 2. River management: land use and the impact of anthropogenic activities including river diversions; and 3. Policy: historical perspectives; legal problems. Includes several field trips.

553. Introduction to Benthic Boundary Layers and Sediment Transport. Fall, even years (3) Mr. Wright.
Physical and geological aspects of coastal and estuarine benthic boundary layers, their dynamic forcings and the associated suspension and transport of 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.

554. Principles of Numerical Computing. Fall (3) Mr. Wang and Mr. Kim.
An introduction to computer methods for mathematical computations. Topics include principles of floating-point computation, linear systems of equations, interpolation, numerical integration, ordinary differential equations, least square method, optimization and the fundamentals for partial differential equations. Two lecture hours and one hour of computer laboratory with assigned problems using MATLAB.

555. Advanced Aquatic Chemistry. Fall (3) Ms. Chisholm-Brause, Mr. MacIntyre. Prerequisites: Instructor's consent.
Discussion of the principles of chemistry focusing on the chemistry of natural water systems. Quantitative problem solving and application of computer codes will be emphasized. Topics will include: principles of chemical kinetics and thermodynamics, structure and properties of liquid water, electrolyte and polyelectrolyte solution chemistry, acid-base chemistry, carbonate equilibria, precipitation-dissolution reactions, basic coordination chemistry, and redox reactions with reference to the physical chemistry of biochemical and aquatic systems. Quantum chemistry as necessary for understanding marine phenomena, e.g. photosynthesis, hydrogen bonding, also will be presented.



Trailerable vessels provide easy access for estuarine work.

558. Biochemistry and Molecular Biology of Marine Organisms. Fall (3) Ms. Reece, Mr. Van Veld and Mr. MacIntyre.
This course will examine the molecular processes involved in the cellular biochemistry and genetics of marine organisms. Topics include the structure and function of nucleic acids and proteins, cellular organization and cell interactions and the application of recombinant DNA technologies to marine research. Comparative analysis of a variety of animals, plants, and microbial organisms in the marine environment will be undertaken.

561. Analytical Approaches in Environmental and Biogeochemical Studies. Spring (3) Mr. Hale.
Modern techniques to identify and quantify trace organic and inorganic compounds in the marine environment. Principles of extraction, purification, identification and quantification. Techniques include SFE, TLC, open column chromatography, HPLC, GC, trace metal spectroscopy and mass spectrometry. Sampling, quality assurance/control, detection limits and other concerns will be covered.

563. Environmental Chemistry. Fall (3) Mr. Unger, Mr. MacIntyre.
Overview of the major classes of environmental toxicants. Fundamentals of aquatic, atmospheric, and geo/soil chemistry. Emphasis on the environmental significance of chemical processes. Fate and transport of contaminants and how this affects bioavailability will be stressed.

564. Aquatic Toxicology. Fall (3) Mr. Van Veld.
Factors influencing the fate and behavior of major environmental toxicants in aquatic organisms. Mechanisms involved in their uptake, distribution, biotransformation and clearance. Effects of toxicants on aquatic organisms ranging from effects at the biochemical and cellular level to effects on individuals, populations and communities. Current methods of laboratory and field toxicity testing.

565. Principles of Pathobiology. Spring (3) Mr. Kaattari, Mr. Faisal, Staff.
This is a course focused on the molecular and cellular mechanisms of pathogenesis in important, emerging diseases in the medical, veterinary, and aquacultural fields. Students will learn how current molecular and cellular techniques are being applied to the resolution of a variety of infectious and non-infectious diseases. Primary focus will be on the application of these techniques to the diseases of fish and shellfish, although mammalian models will be explored to provide a more global point of view.

566. Diseases of Marine Organisms. Fall, odd years (4) Mr. Burreson and Mr. Vogelbein.
Identification, life histories, host defense mechanisms, pathology and control of non-infectious and infectious disease agents including viruses, bacteria, protozoa, helminth and arthropods in marine fishes and shellfishes. Three lecture and three laboratory hours.

567. Comparative Immunology. Spring, odd years (3) Mr. Kaattari. Prerequisites: Genetics and biochemistry, and permission of instructor. Recommended: An introductory immunology course.
Current theories and applications of molecular and cellular immunology. A comparative approach to the understanding of immune function throughout the animal kingdom. Topics include antibody and antigen structure and function, immune cell networks, major histocompatability complex and disease resistance, mechanisms of pathogen recognition and elimination, general principles of vaccine design and modification. Three hours of lecture.

568. Tissue Culture and Virus Diagnosis. Spring, odd years (3) Mr. Faisal.
Overview on the general aspects of culturing cells of aquatic animals including their biology, derivation and characterization. Discussion of the practical application for the use of tissue culture in marine science research. Special emphasis will be given to the use of tissue culture in the isolation and diagnosis of viruses. The course will provide students with an opportunity to practice culturing, maintaining and characterizing cells from marine organisms including invertebrates. Two hours of lecture and two hours of laboratory.

569. Molluscan Immunology and Pathology. Fall, odd years (3) Ms. Chu. Prerequisite: Instructor's consent.
Concept of invertebrate internal defense; structure and function of molluscan blood cells (hemocytes and phagocytes); role of humoral factors in molluscan defense; models of non-self recognition; specificity and memory. Evasion mechanisms of the parasites. Case studies in host-parasite interactions including seasonal, environmental and toxic effects. Lecture and laboratory.

570. Nutrition and Energy Reserve in Marine Organisms. Fall, even years (3-4) Ms. Chu. Prerequisite: Instructor's consent.
Biochemistry of food source; feeding strategies; energy requirements and factors affecting energy requirements; energy reserve and metabolism, including digestion, absorption, transport, deposition, and mobilization; nutritional effects on reproduction and larval ecology. Lecture and laboratory.

571. Culture and Physiology of Aquatic Organisms. Spring (3) Mr. Mann.
History and principles of culture of aquatic organisms. Physical and biological system requirements, water quality, feeding and nutrition, manipulation of reproductive biology, selection of cultured species, quarantine and disease control, current practices in finfish and shellfish culture, physiological and biochemical methods to assess condition of cultured organisms.

573. Environmental Microbiology. Fall, even years (3) Mr. Kator and Ms. Anderson.
The study of microorganisms and their activities in natural environments. Specific topics include water-borne pathogens; microbial processes in wastewaters; aquaculture, created marshes, subsurface groundwater and sediments; and methodologies for detecting microorganisms and measuring processes in a variety of environments. Attention will be focused on interactions and transformations of microbial communities and pollutants

(organic and inorganic) and will include discussion of biodegradation and bioremediation processes, biological nutrient reduction, and public health microbiology.

575. Aquatic Microbial Ecology. Fall, odd years (3) Ms. Anderson, Mr. Kator. Recommended: Organic chemistry or biochemistry.
An introduction to the role that microorganisms play in the biogeochemical cycling and production of dissolved and particulate inorganic and organic matter in freshwater and marine ecosystems. The approach will be ecological, relating environmental physiochemical properties to regulation of microbial processes, distributions, and biodiversity. Topics will include state of the art methods for detecting distributions, biomass, and activities of microorganisms in the natural environment, the energenics regulating microbial processes, microbial biochemical pathways, biodegradation, microbial interactions, and the role that microorganisms play in the foodwebs of various ecosystems. Although emphasis will be placed on marine systems, also discussed will be processes in lacustrine, riverine, and groundwater ecosystems. Readings will draw heavily on the primary literature.

576. Evolutionary Ecology. Fall, even years (3) Mr. Duffy. Prerequisites: General ecology; preferably, evolutionary biology.
A theoretical and empirical exploration of the interaction between environment and evolution of organismal structure, function, and behavior. Topics will include the evolution of life history strategies; natural selection and adaptation; sexual selection and mate choice; kin selection and sociobiology; speciation and adaptive radiation; coevolution; the paleohistory of biotic interactions; and the practical implications of evolutionary biology. Readings draw heavily from primary literature, concentrating on examples involving marine organisms.

577. Physical Biology of Marine Organisms. Spring, even years (3) Mr. Patterson.
Principles from the physical sciences (fluid and solid mechanics, mass and heat transfer theory) applied to the analysis of form, function, and evolution of marine organisms. Engineering methods and measurement techniques appropriate for investigations in physical biology will be presented.

579. Wetlands Ecology. Fall (2-4) Mr. Hershner, Mr. Perry. Prerequisite: Instructor's consent.
Structural and functional attributes of tidal and nontidal wetlands. Emphasis on analysis of wetland systems at the landscape and community level. Introduction and practical experience in common research techniques including wetland classification, vegetation mapping, functional assessment models, and field sampling techniques. Individual research projects and/or paper expected. Lectures and field trips.

582. Applied Methods of Fisheries. Fall (3-4) Mr. Chittenden.
Practice, principles, and theory of applied methods in fisheries. Sampling and data collection tools, practice, and theory. Principles and theory of age determination, estimation of abundance, reproductive biology, marking and tagging, and mark-recapture. Special topics as necessary.

590-591. Departmental Seminar in Resource Management. Fall (2) Mr. Hershner, Staff.
Guided readings of the literature with the objective of synthesizing scientific, legal, economic, and management aspects of resource management. Course format includes faculty presentations and invited speakers.

592. Seminar on Current Resource Management Issues. Spring (3) Mr. Perry.
This seminar series addresses current resource management issues specific to the Chesapeake Bay. Invited speakers will discuss various option, approaches, and techniques used to find solutions to similar issues in various terrestrial-transitional-aquatic ecosystem throughout the United States. A different topic will be addressed each year. Students will be required to participate in all seminars and discussion groups and to prepare a final paper.

599. Thesis. Fall, Spring, and Summer (hours to be arranged).
Original research in biological, physical, chemical or geological oceanography, environmental science, 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.

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.

611. Estuarine Hydrodynamics I. Spring, even years (3) Mr. Kuo. Prerequisite: MS 520.
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.

612. Estuarine Hydrodynamics II. Fall, even years (3) Mr. Kuo, Mr. Wang. Prerequisite: MS 611.
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.

613. Ocean Dynamics. Fall (3) Mr. Brubaker, Mr. Friedrichs. Prerequisite: MS 520 or Instructor's consent
Development of illustrative conceptual and analytical models to elucidate the effects of the rotation of the earth, stratification, and friction on the dynamics of oceanic motion at various scales. Topics include: wind-driven gyre circulation, coastal upwelling, turbulence in stratified flows, large-scale waves, and internal waves with and without rotational influence.

615. Hydrodynamic Modeling of Estuarine and Coastal Waters. Spring (3) Mr. Wang. Prerequisite: MS 613 or Instructor's consent.
This course will survey numerical methods for the solution of partial differential equations describing the estuarine and coastal water motion and transport. Topics include stability, accuracy, consistency and convergence analysis of numerical scheme, formulation of primitive and scalar transport equations, and the pre- and post-processing for numerical computational models. The course will involve classroom lectures, seminar readings, application of models for operational environmental prediction.

617. Estuarine Water Quality Models. Fall, odd years (3) Mr. Kuo. Prerequisite: MS 611.
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.

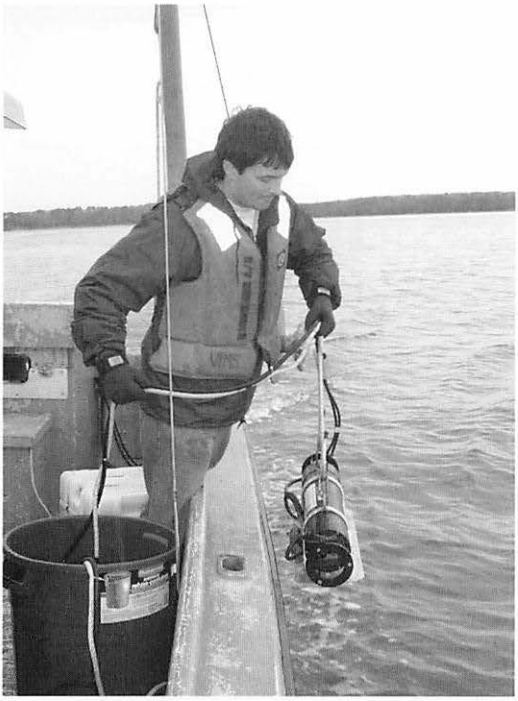
621. Coastal Morphodynamic Processes. Fall, odd years (3) Mr. Wright.
Emphasis is on the mutual adjustments between coastal depositional and erosional morphologies and the hydrodynamic processes that cause sediment transport and transport gradients. Continental shelf, surf-zone, beach, and estuarine processes will be examined. The course involves a mix of classroom lectures, seminar discussion of readings, application of computer models and analysis of field data.

623. Isotope Geochronology. Fall, odd years (3) Mr. Kuehl.
Principles of radioisotope dating techniques with emphasis on those applicable to marine settings. Equations of radioisotope decay and ingrowth will be detailed along with the geochemical systematics of each technique.

624. Ocean Waves: Theory, Measurement and Analysis. Fall, even years (3) Mr. Maa. Prerequisite: Instructor's consent.
Introduction to linear water wave theory and its applications. Topics include mechanisms of wave generation (wind waves and tides), the governing equations, wave properties, wave transformation, special cases for tidal wave propagation (e.g., Kelvin waves), wave bottom boundary layer, nonlinear properties (i.e., radiation stress). Practical applications of numerical models for wind wave generation, wave transformation, the spectrum analysis for wave measurements, and harmonic analysis for tides will be introduced and demonstrated.

625. 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.

626. Advanced Quantitative Methods for Marine Scientists. Spring (3) Mr. Evans.
Introduction to matrices. Advanced topics in regression, including multiple regression, sensitivity analysis. Non-linear function fitting techniques. Empirical eigenfunction methods with applications. Complex notation as applied to the description of sinusoidal variations. Fourier transforms, spectra and filtering.



Lowering a Laser In-situ Scattering Transmissometer (LISST) in the York River.

627. Marine Organic Geochemistry. Spring, even years (3) Ms. Canuel, Mr. Bauer. Prerequisite: Organic Chemistry
Characterization of organic carbon, nitrogen, phosphorus and sulfur in marine water column and sediments. Modern methods of organic analysis that enhance our understanding of how organic materials cycles through the oceans will be discussed. Topics include the role of organic matter in the C, N, S, and P cycles; chemical composition of marine organic matter; diagenetic transformations of organic materials; organic matter degradation and preservation; and petroleum geochemistry.

628. Chemistry of Surfaces and Interfaces. Spring, odd years (3) Ms. Chisholm-Brause.
Chemical properties and reactions at surfaces and interfaces, focusing on aquatic surface chemistry relevant to natural systems. Topics include structure and reactivity of surfaces; properties of bulk and interfacial water; chemical reactions at surfaces and interfaces; bonding mechanisms at the water/solid interface; and relevant experimental and spectroscopic methods.

629. Environmental Organic Chemistry. Fall, odd years (3) Ms. Dickhut.
Overview of partitioning, transport, and transformational processes controlling the environmental fate of organic contaminants. Fundamentals of thermodynamics and chemical kinetics relevant to organic chemical fate and transport mechanisms. Elementary mass transfer equations and application to chemical transport in the environment.

635. Immunotoxicology. Spring, even years (3) Mr. Faisal.
Mechanisms through which several classes of toxic chemicals compromise the function and phenotype of immunocompetent cells. Methods of data interpretation and extrapolation of conclusions at the organismal and population levels. Topics include principles of immunotoxicology, chemical immunomodulators or environmental concern, effects of toxic chemicals on the ontogeny of immune functions and hemopoietic organs, tiered

approach to evaluate toxic insult on the immune system, and molecular mechanisms of immunotoxicology, correlation between immunotoxicity, carcinogenicity, and susceptibility to disease. Two hours of lecture and two hours of laboratory.

638. Fish Histology and Histopathology. Spring, even years (4) Mr. Vogelbein.
Detailed examination of the normal microscopic structure and function of tissues and organs in fishes and the morphological and functional changes that occur in tissues during disease. Infectious and non-infectious diseases, including pathological changes elicited by chemical toxicants and environmental factors will be evaluated. Lab will consist of in-depth training in routine methods of paraffin histology and histochemistry. Three lecture and 3 laboratory hours. Restricted to 6 students.

640. Quantitative Ecotoxicology. Spring (4) Mr. Newman
Essential ecotoxicology principles and quantitative methods for the analysis of ecotoxicological data. Laboratory exercises will include method applications with PC-based software. Emphasis will be placed on the scientific and statistical soundness of techniques.

641. Environmental Risk Assessment. Fall (3) Mr. Newman.
Basic structure and methods for environmental risk assessment are presented for retrospective and predictive assessments. Concepts associated with ecological and human hazard and risk assessments are covered. Discussions of associated logic and methods are framed around NRC Paradigm of Problem Formulation/Hazard Identification, Effects Characterization, Exposure Characterization, and Risk Characterization.

650. Analysis of Discrete Data. Spring (3) Mr. Diaz. Prerequisite: Instructor's Consent.
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.

651. Ecological Modeling and Simulation Analysis. Fall (3) Mr. Wetzel. Prerequisite: Instructor's Consent.
Theoretical and practical aspects of conceptualizing, simulating and analyzing digital computer models of estuarine and marine ecosystems. Systems theory and control is presented in terms of ecological processes. Computer modeling project required.

652. Marine Plankton Ecology. Fall, odd years (3) Mr. Ducklow. Prerequisite: MS 524 or 526.
Contemporary topics in cellular, population, community and ecosystem level dynamics of plankton systems, including nutrients and organic matter, viruses, bacteria, phytoplankton, protists and zooplankton. Lectures and student-led discussions.

653. Marine Benthos. Spring (3) Mr. Diaz, Staff. Prerequisite: MS 526.
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.

654. Secondary Production of Invertebrates. Fall (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.

655. Methods in Aquatic Microbial Ecology. Spring, odd years (3) Ms. Anderson, Mr. Kator. Prerequisite: MS 575 or equivalent.
An advanced laboratory-oriented course covering methods used to measure microbial numbers and biomass, activity, primary production, secondary production, community metabolism, specific biogeochemical cycling, and degradation of pollutants. Methods include gas chromatography, emission spectrometry, epifluorescence microscopy, and application of stable and radioactive isotopes. Each student will design, prepare and perform a field-project utilizing methods described in the course.

656. Seagrass Ecosystems. Spring, odd years (1-2) Mr. Orth, Mr. Moore.
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.

657. The Early Life History of Marine Fishes. Fall, odd years (3) Mr. Olney. Prerequisite: MS 666 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.

658. Ecology of Marine Invertebrate Larvae. Spring, alternate years (3) Mr. Mann. Prerequisite: Instructor's consent.
A broad discussion within the marine invertebrates of the following topics: the concept of the larval form, spawning and developmental patterns, limitations on the fertilization process and embryology, the Reynolds number environment at typical larval size, feeding and nutrition in the larval size range, larval size and parental investment, larval dispersal and supply in maintaining community structure, roles of physical versus biological processes in inducing metamorphosis, early post-metamorphic survival, and larval ecology in extreme environments.

659. Phytoplankton Ecology. Fall, odd years (3) Mr. Smith. Prerequisites: MS 501 (may be taken concurrently with Instructor's consent.)
This course will examine the factors which influence the growth, losses and distributions of phytoplankton in marine systems. Topics include photosynthesis, pigmentation, productivity, biochemical fractionation, grazing, and nutrient uptake and interactions. A laboratory will introduce students to modern methods used in the study of phytoplankton such as isotopic measurements, HPLC analysis of pigments, fluorometry, and image analysis. Samples from the local estuaries will be used in the laboratories to illustrate the principles discussed in class.

664. Marine Conservation Biology. Fall (3). Mr. Lipcius.
Study and application of multidisciplinary scientific principles to the protection, enhancement and restoration of marine biodiversity (genetic, species, community and ecosystem). Ecological emphasis on the conservation of biodiversity threatened by habitat degradation and loss, overexploitation, invasive species, and global change. Discussion of social, legal, economic and political influences. Practical application through case studies and training in population viability analysis. Lectures and Laboratory.

665. Fisheries Climatology. Fall, odd years (3) Mr. Austin. Prerequisite: MS 528.
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.

666. Ichthyology. Spring (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.

667. Experimental and Quantitative Ecology. Spring (4) Mr. Lipcius.
The design, conduct, analysis and interpretation of field and laboratory experiments in ecology. Includes lectures, discussion and supervised field and laboratory projects designed to illustrate the diversity of experimental and quantitative approaches in use by ecologists. Topics include the scientific method, experimental design, the use and abuse of statistical techniques, modeling and manuscript preparation, with emphasis on topical ecological issues such as those dealing with predator-prey interactions, recruitment phenomena, environmental science (e.g., dose-response assays) and metapopulation dynamics. Lecture and laboratory.

668. Malacology. Spring, even years (3) Mr. Mann.
The fossil record and the ancestral mollusc. Structure and function of the molluscan shell. Review of molluscan taxonomy. Reproductive biology, physiology, ecology, and feeding mechanisms of the molluscs.

670. Stock Assessment Methods. Spring (4) Mr. Hoenig
Survey of methods for assessing the status of exploited populations given various combinations of data types. Emphasis is on deriving statistical methods using maximum likelihood and other analytical techniques, and on computing estimates for a variety of datasets. Use of population models to integrate information on stock status in order to determine appropriate management measures. Analysis of uncertainty in assessment results and implications of uncertainty for management. Analysis of research survey, commercial catch, fishing effort, and tagging data will be considered.

671. Fisheries Population Dynamics. Spring (3-4) 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 drawn from finfish and shellfish stocks.

672. Applied Regression and Forecasting. Spring (3) Mr. Kirkley. Prerequisite: MS 505 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.

673. Marine Molecular Genetics. Spring, (3) Mr. Graves, Ms. Reece. Prerequisite: Undergraduate Genetics or permission of instructor.
A study of the evolutionary processes responsible for the intra- and interspecific genetic relationships of marine organisms with an emphasis on the application of current molecular methodologies. 3 hrs. lecture.

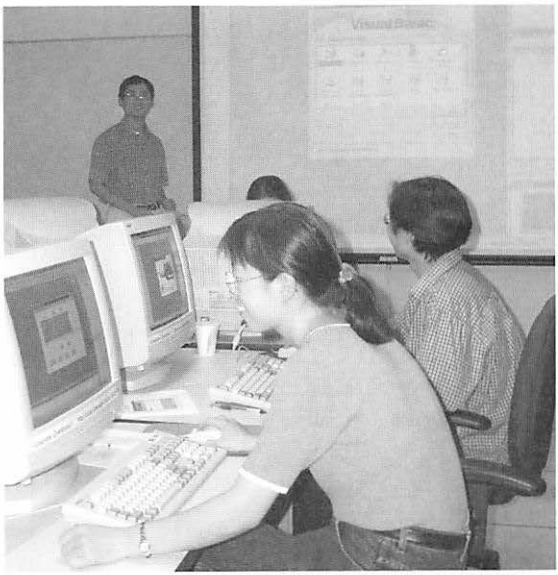
674. Marine Molecular Genetics Laboratory. Spring (2) Mr. Graves, Ms. Reece. Prerequisite: Undergraduate Genetics or permission of instructor.
Students will elucidate intra- and interspecific genetic relationships by employing a variety of molecular techniques for the analysis of proteins and nucleic acids. 5 hrs. laboratory.

685. Practical Application of Marine Resource Management Techniques. As required (1-3) Mr. Hershner, Staff.
Students participate in real world management activities under the guidance of involved faculty members and in association and consultation with members of various levels of government. May include 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. Requirements will vary depending on the 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.

690. Progress and Process - The relationships of Science and Law in determining public policy on the environment. Spring (3) Mr. Taylor.
This course is given from the perspective of the working scientist, and it is intended to provide an understanding of the relationships between the disparate cultures of science and law in the arena of public policy. We will examine the two professional cultures, their historic and ethical foundations, their place with the constitutional framework of the United States, and their origins in the Age of Reason. The dynamic tension of their respective roles in determining the outcome of environmental policy in the contemporary American context will be examined along with alternatives to the status quo. Readings, lectures and discussion.

691. (LAW 414). Toxic Torts. As required (3) Law School Staff.
Prerequisite: Consent of instructor.
A study of the legal and policy issues governing resolution of claims of harm to persons, property, or the environment arising from toxic products, substances, services, or processes. The course will explore how common law and statutory principles define the rights, duties, liabilities, and remedies of parties involved in disputes over environmental and toxic harm. Special consideration will be given to the traits that set environmental and toxic torts apart from traditional and mass torts: long latency periods, distinctive causation problems, the central role of scientific and other expert evidence, and a complicated relationship between common law and statutory environmental law.

692. (LAW 417). International Environmental Law. As required (3) Law School Staff. Prerequisite: Consent of instructor.
This course focuses on bilateral, regional and international agreements and principles governing ocean pollution, air pollution, hazardous and nuclear waste, deforestation, and other environmental problems with a global impact. The course also will address population control and food shortages under international law, especially in developing countries, and how these problems relate to international peace and security. The basic courses in public international law and environmental law are not prerequisites, but are recommended.



Students develop and teach special short courses in the Computer Lab.

693. (LAW 424). Environmental Law. As required (3) Law School Staff.
Prerequisite: Consent of instructor.
A study of the nature and causes of environmental pollution and of the main legal techniques for its control. The course will consider the common law, the environmental impact assessment process (e.g., the National Environmental Policy Act), and the basic regulatory framework for air, water and solid and hazardous waste control (the Federal Clean Air Act, Clean Water Act and Resource Conservation and Recovery Act), with attention given under each statute to the basic regulatory framework and the main policy issues presented by it. Other topics will include the role of the federal courts in reviewing agency action, new developments in federal administrative law (including current efforts at administrative law reform), natural resource management and allocation issues involved in the division of scarce resources (e.g., air and water) among competing users, toxic and hazardous substance regulation, and enforcement of environmental laws.

694. (Law 425). Land Use Control. As required (3) Law School Staff.
Prerequisite: Consent of instructor.
An analysis of the legal principles governing the use and management of land and the fundamental values underlying those principles. While focusing primarily on government regulation of land use, the course also will examine common law rules which affect the way that land is used. Topics that might be considered include judicial control of land use, zoning and the rights of landowners, zoning and the rights of neighbors, land use planning, public regulation of land development, aesthetic regulation, and the preservation of natural and historic resources.

695. (LAW 453). Administrative Law. As required (3) Law School Staff.
Prerequisite: Consent of instructor.
A study of practice in the administrative process, examining the procedures for administrative adjudication and rule making; legislative and judicial control of administrative action; and public access to governmental processes and information.

696. (LAW 467). Legislative Process. As required (2) Law School Staff.
Prerequisite: Consent of instructor.
This class focuses primarily on the structure and operations of the federal legislative process. Topics include, among others, theories of and doctrines relating to statutory construction; Congress' role in the constitutional system of government; the significance of legislative precedent; prospective and retroactive lawmaking; and the scope of particular legislative functions, including legislative drafting and confirmation and impeachment proceedings.

697. 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. Examples of projects offered in recent years include: management issues in shellfish sanitation; groundwater nutrient processes; bacterioplankton methods and techniques; pesticide analysis in environmental samples; marine molecular population

genetics; and law and policy relating to the introduction of non-indigenous plants. Subjects will be announced prior to registration and after approval by the Educational Policy Committee (EPC). Hours to be arranged with instructor prior to registration.

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. Examples of courses offered in recent years include: continental margin sedimentation; biomineralization in marine organisms; molecular markers and evolution; oligochaete biology; quantitative methods of image analysis; and organism-sediment interactions in coastal systems. Subjects will be announced prior to registration and after approval by the EPC. Hours to be arranged.

699. Dissertation. Fall, Spring and Summer (hours to be arranged).
Original research in biological, physical, chemical or geological oceanography, environmental science, 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.

Undergraduate Courses

Undergraduates can take 500-550 level courses with the permission of instructor.

330. Introduction to Oceanography. Spring, odd years (3) Mr. Bauer, Mr. Patterson.
Description of physical, chemical, biological and geological processes operating in the world ocean. The interdisciplinary nature of oceanography is emphasized, providing an integrated view of factors which control ocean history, circulation, chemistry and biological productivity

497. Problems in Marine Science. Fall, Spring and Summer (1-4) Staff.
Supervised projects selected to suit the need of the upper level undergraduate 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.

Academic Program

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 Science and Doctor of Philosophy in Marine Science. The school offers research opportunities and instruction at the graduate level in five general areas: Fisheries Science, Biological Sciences, Environmental Sciences, Physical Sciences, and Coastal and Ocean Policy.

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 can enroll in suitable 500-549 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 also may 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 Preparatory Requirements

Students who are 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 to identify an academic program that will prepare them for graduate study in marine science.

Students interested in biological sciences, environmental sciences, or 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 are particularly important.

Loading gels for oyster genomics project.

Degree Requirements

General

Students generally are bound by the requirements stated in the catalog in effect when they enter the School. The department in which the student specializes 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:

1. Successfully complete the core course requirements;
2. Be a full-time student in good standing for two consecutive semesters.

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 to the Academic Status and Degrees Committee.

Registration Requirements

All active students (i.e. those working toward completion of a degree program who have not been granted leave) must register for a minimum of nine 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. For a single semester, the student may be given research student status. This generally would be the semester in which the student completes the thesis and graduates.

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) due to medical reasons after mid-semester may apply to the Academic Status and Degrees Committee for approval. If the Academic Status and Degrees Committee approves the request, a grade (or grades) of "W" will appear on the transcript.

Students may not drop a course after the last day of classes. If a student does not complete a course for medical reasons, "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.

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; A-, 3.7; B+, 3.3; B, 3; B-, 2.7; C+, 2.3; C, 2; C-, 1.7. 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" is given to work in progress towards Masters (MS 599) or PhD (MS 699) research, since there is insufficient evidence upon 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.

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 outside of the core curriculum 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.

Transfer of Graduate Credit

On the recommendation of the Academic Status and Degrees Committee and the approval of the Dean of Graduate Studies, a regular student may apply up to 15 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. This includes courses equivalent to MS 501-505, although a command of these courses must still be demonstrated. Incoming students can petition for up to six hours of other graduate work not already applied toward another degree, but the total transfer cannot exceed 15 hours. 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.

Qualifying Exam

Each student must satisfactorily complete a qualifying examination that indicates a proficiency in the student's particular field of study. This examination is coupled with a presentation of the student's thesis/dissertation prospectus. Qualifying exams usually are completed by the end of the third semester (M.S.) or fourth semester (Ph.D.).

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. A leave of absence, however, does not extend the time limit for completion of degree requirements.

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). In the case of a grade deficiency in a core course, the student must retake the course and receive a grade of B- or better, or successfully pass a comprehensive exam. The grade of any retaken course, however, will not be counted in the student's cumulative average. 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 Academic Status and Degrees Committee 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 must have passed the following core courses: MS 501, MS 501L, MS 502, MS 504 and MS 505. Exemptions may be granted only under exceptional circumstances.

Students in Biological Sciences

MS 526.

Students in Coastal and Ocean Policy

MS 542 and distribution requirements as specified by the department.

Students in Environmental Sciences

M.S. students must take a minimum of two (2) and Ph.D. students must take a minimum of four (4) of the following courses: MS 563, MS 564, MS 565, MS 566, MS 573, MS 638, MS 640 and MS 641.

Students in Fisheries Science

MS 528.

Must take one of the following: MS 625, MS 667, MS 670 or MS 672.

Students in Physical Sciences

Required courses for the different disciplines in Physical Sciences are as follows:

Physical Oceanography: MS 520
Geological Oceanography: MS 522
Marine Chemistry: MS 524

In addition, all students in Physical Sciences must take at least one advanced course (550-level or higher) appropriate to the student's specialty (marine chemists must include MS 555).

Language Requirement

Although graduate students at the School of Marine Science are not required to demonstrate a proficiency in a foreign language, we strongly encourage them to acquire such skills. In the increasingly international arena of marine science, the experience of learning and the ability to read, write and speak a foreign language cannot be minimized. In some cases a student's advisory committee may require demonstration of foreign language skills prior to admission to candidacy.

Degree of Master of Science

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

1. The student must select a suitable major professor, who must be a faculty member of the School of Marine Science, 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. The Advisory Committee, chosen by the student and approved by the Dean of Graduate Studies, must consist of at least four members. A majority of the Committee's members must be members of the faculty of the School of Marine Science, although persons with appropriate qualifications from outside the School of Marine Science may serve on the committee. For students with a specialty in biology or fisheries science, at least one member must be from the discipline of physical or environmental science. For students with a specialty in physical or environmental science, at least one member must be from the discipline of biological or fisheries science. For students with a specialty in coastal and ocean policy, at least one member must be from another discipline within the School of Marine 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 36 credit hours of advanced work, of which at least 9 credit hours must have been earned in courses numbered 550 or above with a grade point average of 3.0 or better, are required for the M.S. degree. In addition, a student must have registered for thesis (MS 599) for at least one semester. No more than six thesis credits may be counted toward the minimum 36 credits required for the M.S.

   Credits more than seven (7) years old and earned in the program in which the student is currently enrolled will be deleted from the accumulation of credits required for a degree. Credits acquired while enrolled in previous programs here or elsewhere generally are not subject to this limitation.

5. Upon a favorable recommendation of the student's Advisory Committee and the Academic Status and Degrees Committee, followed by a majority vote of the Academic Council 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 (MS 501, MS 501L, MS 502, MS 504, MS 505) must be passed with a grade of B- or better (or successful completion of a comprehensive examination) or officially exempted, and all other courses specifically required by the student's department and Advisory Committee must be completed.

c. The qualifying examination and prospectus must be 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. Full details of this requirement can be obtained from the Office of the Dean of Graduate Studies.

7. All requirements for the degree must be completed within three calendar years after commencing graduate study. In exceptional cases, if recommended by the Academic Status and Degrees 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 are:

1. The student must select a suitable major professor, who must be a faculty member of the School of Marine Science, 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. 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 College of William and Mary. A majority of the Committee's members must be members of the faculty of the School of Marine Science, although persons with appropriate qualifications from outside the School of Marine Science may serve on the committee. For students with a specialty in biology or fisheries science, at least one member must be from the discipline of physical or environmental science. For students with a specialty in physical or environmental science, at least one member must be from the discipline of biological or fisheries science. For students with a specialty in coastal and ocean policy, at least one member must be from another discipline within the School of Marine Science.

3. 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.S. 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.

4. At least 42 credit hours of advanced work, of which at least 15 credit hours must have been earned in courses numbered 550 or above with a grade point average of 3.0 or better, are required for the Ph.D. degree. In addition, a student must have registered for dissertation (MS 699) for at least one semester. At least 9 but no more than 12 dissertation credits may be counted toward the minimum 42 credits required for the Ph.D. degree.

   Credits more than seven (7) years old and earned in the program in which the student is currently enrolled will be deleted from the accumulation of credits required for a degree. Credits acquired while enrolled in previous programs here or elsewhere generally are not subject to this limitation.

5. Upon a favorable recommendation of the student's Advisory Committee and the Academic Status and Degrees Committee, followed by a majority vote of the Academic Council 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 (MS 501, MS 501L, MS 502, MS 504, MS 505) must be passed with a grade of B- or better (or successful completion of a comprehensive examination) or officially exempted, and all other courses specifically required by the student's department and Advisory Committee must be completed.

   c. The qualifying examination and prospectus must be completed.

6. The student must present a seminar to the marine science faculty, staff and students on a dissertation topic approved by the major professor, the Advisory Committee and the Dean of Graduate Studies, and must defend this dissertation before his or her major professor and committee. The defense of the dissertation shall be separate from any other examination. Full details of this requirement can be obtained from the Office of the Dean of Graduate Studies.

7. All requirements for the degree must be completed within the following time frame:

   4 years with a Master's Degree from the School of Marine Science
   5 years with a Master's Degree from another Institution
   6 years with direct admittance (bypass Master's Degree)

   In exceptional cases, if recommended by the Academic Status and Degrees Committee, time extensions may be approved by the Dean of Graduate Studies.

8. 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, however, should be planned, conducted and reported with a view toward publication of the results in a peer-reviewed scientific journal.

General Statement of Policy

The School of Marine Science and the College of William and Mary have an Affirmative Action Policy and are committed to attracting minorities into marine science. The School's Admissions Committee considers applicants without regard to sex, race, color, religion, national origin, sexual orientation, or disability. Admissions criteria are based on past and potential academic and research performance.

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 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.

Graduate Regulations

Application for Admission

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

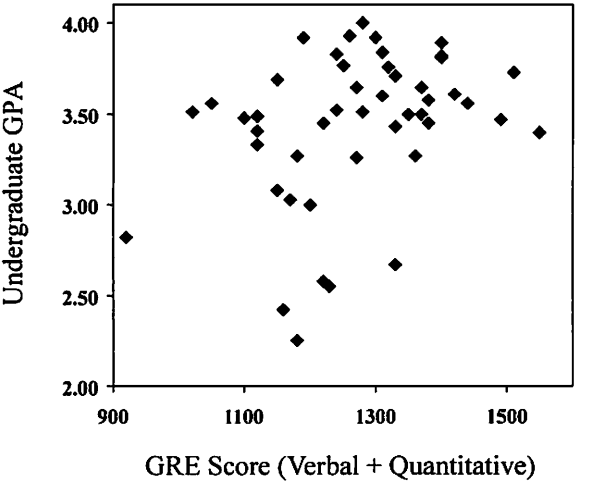
Dean of Graduate Studies
School of Marine Science
College of William and Mary
Gloucester Point, Virginia 23062

Students are encouraged to apply for admission during the winter of each calendar year, with a closing date of January 15. Applicants will be notified after 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 $30. 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 more than 5 years old are not acceptable, and the examination must be retaken. Applicants are*



GPA and GRE statistics of applicants offered admission for the Fall semester, 2000.

encouraged to take the Graduate Record Examination at scheduled dates that will allow for receipt of scores by the aforementioned closing date. Applications lacking GRE scores or other critical materials after the closing date can not be evaluated by the Faculty.

International Students

In addition to the verbal and quantitative sections of the Graduate Record Examination (GRE), 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 load 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; there were more than 141 applicants for the entering class of 2000, of which only 48 were accepted. 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 figure on the previous page shows GRE and GPA scores of applicants offered admission in Fall 2000.

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.

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 Academic Status and Degrees Committee, 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 Science or Doctor of Philosophy programs. Direct admission into the Doctor of Philosophy program is available to qualified applicants without a Master's degree. 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.

Master of Science Bypass Option

A superior student accepted into the master's program may petition for a bypass of the Master of Science degree after meeting the following requirements: (1) completion of the core course requirements for the M.S. degree (MS 501, MS 501L, MS 502, MS 504, MS 505) and any courses required by the student's department with a grade point average of at least 3.5; (2) submission of a statement by the student's advisor of the student's achievements and demonstrated potential to conduct independent research; (3) receipt of at least one draft of prospectus for the students' intended doctoral research by the Advisory Committee; and (4) recommendation by the student's Advisory Committee to bypass the master's degree. It is important that a student submit the bypass form in a timely fashion; typically, no later than the start of the third year.

Following review of the petition and supporting documents and consideration of all faculty approved requirements for bypass, the Academic Status and Degrees Committee 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.S. degree in the School of Marine Science and 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 School of Marine Science 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.

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.

For Fall 2000, the tuition and general fee for full-time students in the School of Marine Science is $2,724 per semester for residents of Virginia and $8,325 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:

$170 per semester hour for Virginia residents.

$525 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.

Field work in Wales.

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 assistantships 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 and are renewable annually for up to 3 years, contingent upon satisfactory performance. All fellowship students are expected to participate in their advisor's group activities and in a research project or program as determined jointly with their faculty advisor.

Research Graduate Student Status

Upon the recommendation of a student's major professor, advisory committee, and the Academic Status and Degrees Committee, the Dean of Graduate Studies may approve a student obtaining Research Graduate status for a single semester. This generally would be the semester in which the student completes the thesis and graduates.

The following conditions must be met:

1. The student has completed all required coursework.
2. The student is not employed significantly in any activity other than research and writing in fulfillment of degree requirements.
3. 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 adverse decisions only. 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 from 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 by each semester's due date as established by the Office of the Bursar. Any unpaid balance remaining on an individual's account after the end of the add/drop period may result in cancellation of registration. Payment must be made in U.S. dollars by cash or check made payable to the College of William & Mary. Checks returned by the bank for any reason will constitute nonpayment of fees and may result in cancellation of registration. In the event a past-due account is referred for collection, the student is required to pay all costs associated with the collection and/or litigation.

Refunds to Students Who Withdraw from the 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.

Refunds to Full-time Graduate Students Who Withdraw From College

All charges made by the College are considered to be fully earned upon completion of registration by the student.

1. No refunds will be made to a student who has been required by the college to withdraw, regardless of the date of withdrawal.
2. A full-time student who withdraws within five days following the first day of classes is entitled to a refund of all payments, less any administrative fees and/or any deposits or advanced payments which may have been required by the College as evidence of the student's intent to enroll.
3. A full-time student who withdraws within the 6th through 30th day following the first day of classes will be charged 25% of tuition and fees.
4. A full-time student who withdraws within the second thirty-day period after the first day of classes will be charged 50% tuition and fees.
5. A full-time student who withdraws after 60 calender days following the first day of classes will receive no refund.

Refunds to Part-time Graduate Students Who Withdraw From College

A part-time student at the graduate level is defined as one who is enrolled for 8 credit hours or less.

A part-time student who withdraws from the College during the add/drop period is eligible for a refund of all payments less a $50.00 administrative fee.

A part-time student who withdraws from the college after the add/drop period but within 60 days following the first day of classes will be refunded 50% of tuition.

No refunds will be made to a part-time student who withdraws after 60 days following the first day of classes, or who has been required by the College to withdraw.

Graduate Students Who Withdraw From a Course

A student who withdraws from a course(s) after the add/drop period and remains registered for other academic work will not be eligible for a refund.

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

Housing

There is no student housing on the SMS/VIMS campus, and most students live in Gloucester Point or in surrounding communities. Rental housing is plentiful, and area rents generally range from $300 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 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 can be obtained from the Office of Residence Hall Life located on the main campus (757) 221-4134, or email housng@wm.edu.

Cultural Life at William and Mary

As part of the William and Mary community, School of Marine Science 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, Va. Beach, and Richmond–are within easy driving distance of Gloucester Point. Each provides a broad array of cultural and entertainment events throughout the year.

Campus Parking

Many students drive a moto- vehicle to the SMS/VIMS campus, and parking can sometimes be at a premium. However, space is usually available in one of the many campus parking areas, including three lots near the Franklin Marine Center. All motor vehicles, including motorcycles and motorbikes, parked on SMS/VIMS property must be registered with Parking Services. 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 Parking Services.

Outdoor Life and Athletics

With SMS/VIMS' 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, 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 25 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 28 clubs, each self-governing and self-supporting and dictated simply by participants' interest in the activity. Clubs include badminton, ballroom dancing, baseball, fencing, gymnastics, women's field hockey, ice hockey, judo, men's and women's lacrosse, martial arts, outdoor racquetball, rock climbing, rowing, men's and women's rugby, running, sailing, VIMS sailing, shotokan karate, women's soccer, synchronized swimming, tae kwon do, men's and women's volleyball, ultimate frisbee, and yoga.

The use of the recreational sports facilities is included in the payment of full-time tuition. Graduate students who pay for fewer than 9 credit hours per semester may use the facilities by paying an annual activities fee. For information on the annual fee, any activity, program or service offered by Recreational Sports, the office may be contacted at (757) 221-3310.

Student Health Service

The King Student Health Center provides high-quality, primary medical care for students becoming ill or experiencing minor emergencies while away from home.

The Health Center delivers a wide variety of services, many of which are covered by the Student Health Fee included in the Tuition and General Fee. All matters between a student and the Health Center staff are confidential and, except in the case of life-threatening situations, medical emergencies, or when required by law, will not be released without the student's written consent.

Virginia State law requires all full-time students enrolling for the first time in a four-year public institution to provide a health history and an official immunization record. The College of William and Mary further requires ALL full-time students (including previously matriculated students) to submit a physical examination performed within twelve months preceding the student's enrollment or re-enrollment, as well as providing documentation of meeting he same immunization requirements. Previously enrolled students re-entering as full-time students after an absence from campus of greater than 10 years must also revalidate their immunization record. This information MUST be submitted on William and Mary's Health Evaluation Form.

Medical services are provided for all full-time students and for those graduate students certified by the Dean of their school to be doing the "equivalent of full-time work." In order to be eligible for medical care both groups of students must have paid the Student Health Fee for the current semester and have met the Health Evaluation Form requirements including a physical examination and submission of an official immunization record.

Students choosing to seek care at an off-campus site are responsible for charges incurred. Likewise, if a Health Center physician deems it medically necessary to refer a student to an off-campus specialist, this also becomes the student's financial responsibility. Students are strongly encouraged to carry health insurance to assist with the cost of health care obtained outside the King Student Health Center.

Students experiencing severe emotional or psychological distress, making a threat or a gesture of suicide, or attempting suicide, will be evaluated by the College's medical/emotional emergency response team and appropriate measures instituted. Anyone having knowledge of such circumstances should immediately contact the Dean of Students at (757) 221-2510, or the Student Health Center at (757) 221-4386.

The Student Health Center is located on Gooch Drive, south of Zable Stadium (Cary Field). Hours of operation are Monday, Tuesday, Thursday and Friday from 8:00 A.M. to 5:00 P.M.; Wednesday from 10:00 A.M. to 5:00 P.M.; and Saturday from 12 Noon to 4:00 P.M. (limited services only). Appointments with physicians and nurse practitioners may be scheduled by calling 221-2998.

Center for Personal Learning and Development

Located 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. 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. No information concerning an individual's contact with the Center will be released without the written permission of the client. The Center also does not handle problems associated with course selection, job placement, career counseling or remedial academic programs.

Career Services Center

Located in Blow Hall on the William and Mary campus, Career Services provides quality career planning and job search services. Numerous services including a comprehensive computerized career guidance system, and career library. Speakers series and seminars are provided to assist students as well.

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.

School of Marine Science
Virginia Institute of Marine Science
College of William and Mary
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