



*The College of
William & Mary*

ENVIRONMENTAL SCIENCES

School of
Marine Science

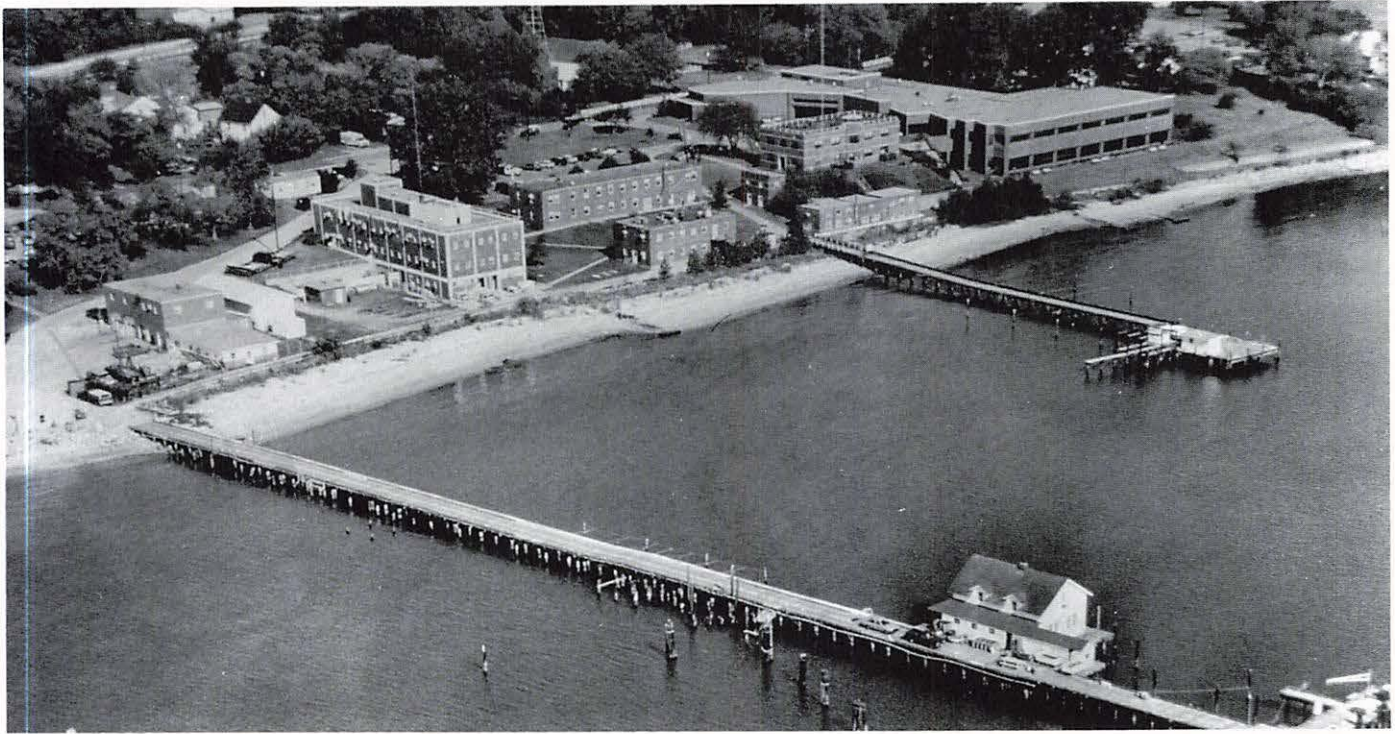
Virginia Institute
of Marine Science



*The School of
Marine Science is
one of four professional
graduate schools of the
College of William & Mary.*

*The objective of the
educational program is
to provide a fertile and
stimulating learning
environment for students
preparing for careers in
marine science.*

The School of Marine Science



The School of Marine Science/Virginia Institute of Marine Science occupies the site of Gloucester Town, a colonial settlement established in 1680. The remains of military fortifications from both the Revolutionary War and the Civil War reflect Gloucester Point's strategic location at the mouth of the York River.

Chartered in 1940, the School of Marine Science/Virginia Institute of Marine Science (SMS/VIMS) has a tripartite mission of research, education, and advisory service in marine science. This mandate established an institution that is uniquely prepared to educate the highly qualified researchers, resource managers, and educators needed for the future. Today, SMS/VIMS is the third largest marine research and education center in the country.

The School awards both Master of Arts and Doctor of Philosophy degrees. Graduate studies are offered in five areas:

- Biological Sciences**
- Environmental Sciences**
- Fisheries Science**
- Physical Sciences**
- Resource Management & Policy**

Academic programs are closely allied to the research and advisory programs of the Virginia Institute of Marine Science enabling students to participate in basic and applied science. Faculty scientists are involved in collaborative research with scientists from other institutes both nationally and internationally. In addition, researchers work closely with marine industries, policy makers, and regulatory agencies.

The Institute accommodates the interdisciplinary investigation that is essential to understanding and addressing the complex issues of

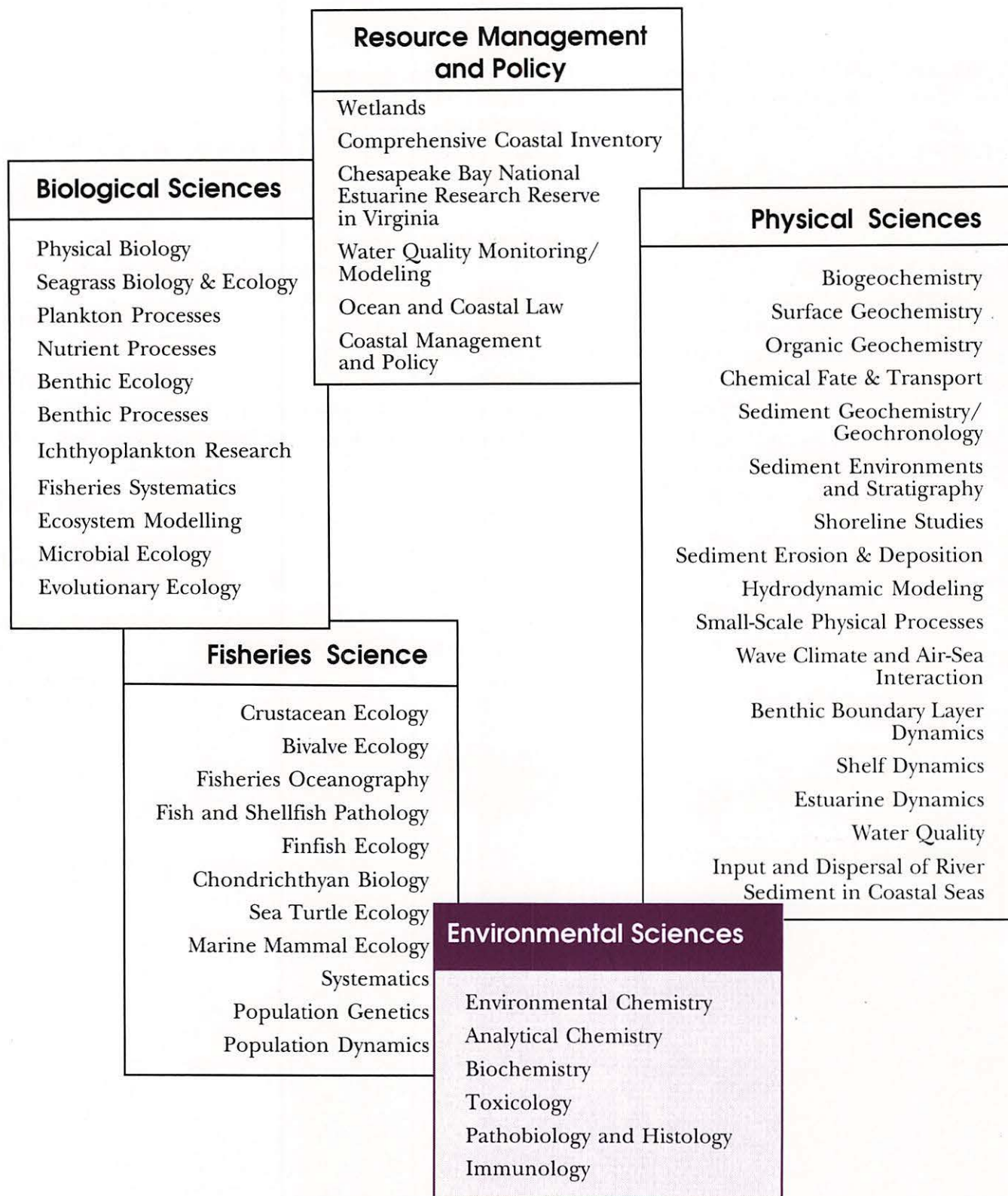
modern marine science. Faculty, researchers, and students maintain a primary affiliation in one of the five departments. However, programs and research within departments are often carried out in association with scientists from other departments. Students with specific interests in areas outside their department may arrange crossover study and research. This interactive approach enables students to work with various members of the diverse faculty and provides access to all facilities at the Institute.

*In a society
that is in-
creasing its
pressure on the
environment
and natural
resources, the
coastal, estua-
rine, and marine
environment
has become
an area of
critical concern.*



Research at SMS/VIMS encompasses all elements—land, sea, and air—that affect marine ecosystems.

Major Programs



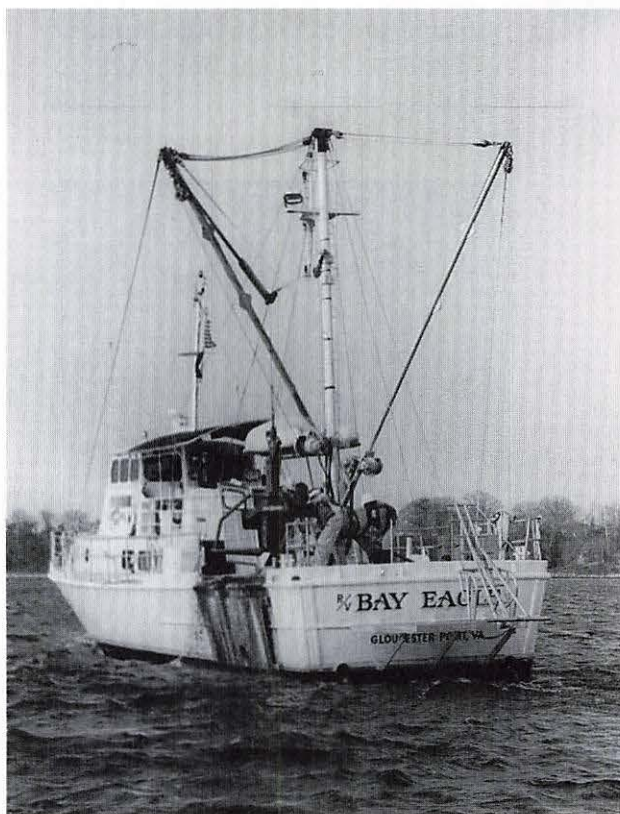
Located in Gloucester Point at the mouth of the York River, the campus has easy access to Virginia's estuaries, tidal and non-tidal wetlands as well as the Chesapeake Bay and Atlantic Ocean. The Wachapreague campus, on Virginia's Eastern Shore, is surrounded by embayments, salt marshes, barrier beaches, and coastal waters. Both locations provide ideal settings for research and teaching.

The thirty-five acre Gloucester Point campus houses six buildings with flow-through salt water systems and various laboratories that are well equipped for basic as well as specific project research. Equipment in-

cludes: a mass spectrometer, scanning and transmission electron microscopes, hydraulic flumes, an underwater video system, acoustic doppler current profilers, electromagnetic current meters, and a Geographic Information System.

A 60,000 square foot laboratory is scheduled for completion in the fall of 1995. The facility will house highly-specialized labs for advanced research in chemistry, geochemistry, toxicology, pathobiology, microbiology, genetics, physiology, planktonology, nutrient cycling, and parasitology.

*The Institute
is the
largest marine
center in
the U.S. that
is focused
on coastal
and
estuarine
science.*



Institute scientists have monitored natural, commercial, and industrial effects on the Chesapeake Bay and its estuaries for more than fifty years.

EASTERN SHORE LABORATORY

The VIMS Eastern Shore Laboratory, located in the seaside village of Wachapreague, serves as a field station for research, teaching, and advisory activities of SMS/VIMS.

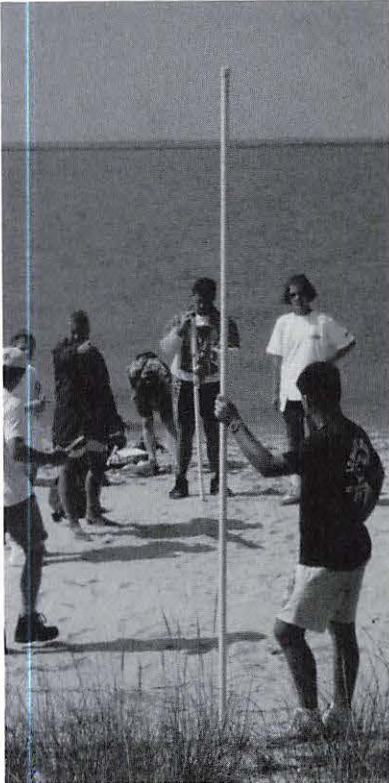
Along the approximately 100 km of its Atlantic shoreline, the Virginia Eastern Shore remains one of the least developed coastal regions in the United States, with essentially no development on its barrier islands. This pristine area is uniquely suited for field research into coastal processes. The location provides convenient access to the eastern portion of the Chesapeake Bay and the barrier island, salt marsh-lagoonal systems along Virginia's Atlantic shore.

Widely recognized for its contributions to research in bivalve aquaculture, the Lab also supports activities of scientists and students from the Gloucester Point campus

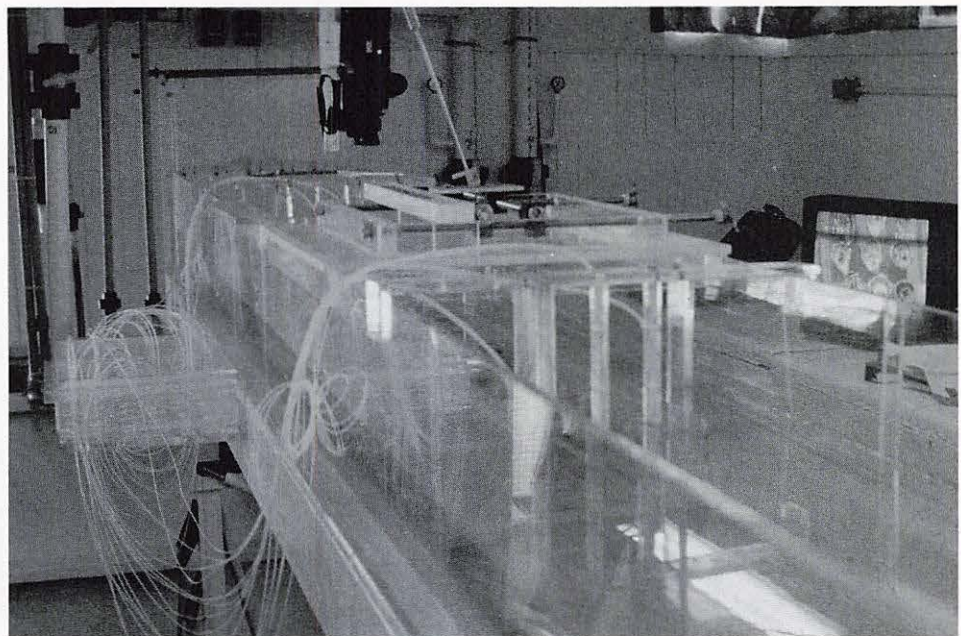
and other institutions. Recent research activities at the facility include: investigations into nitrogen cycling in salt marshes, disease transmission between mollusks, population dynamics of finfish and shellfish, chemical induction of settlement in invertebrates, and hydrodynamic characteristics of seagrass seeds.

Extensive wet laboratory facilities include running seawater tables and large holding tanks. A small hatchery for the culture of marine and estuarine organisms is especially well suited for mollusk culture. An on-site flume laboratory permits investigation of processes (hydrodynamic, sedimentological, and biological) in the benthic boundary layer.

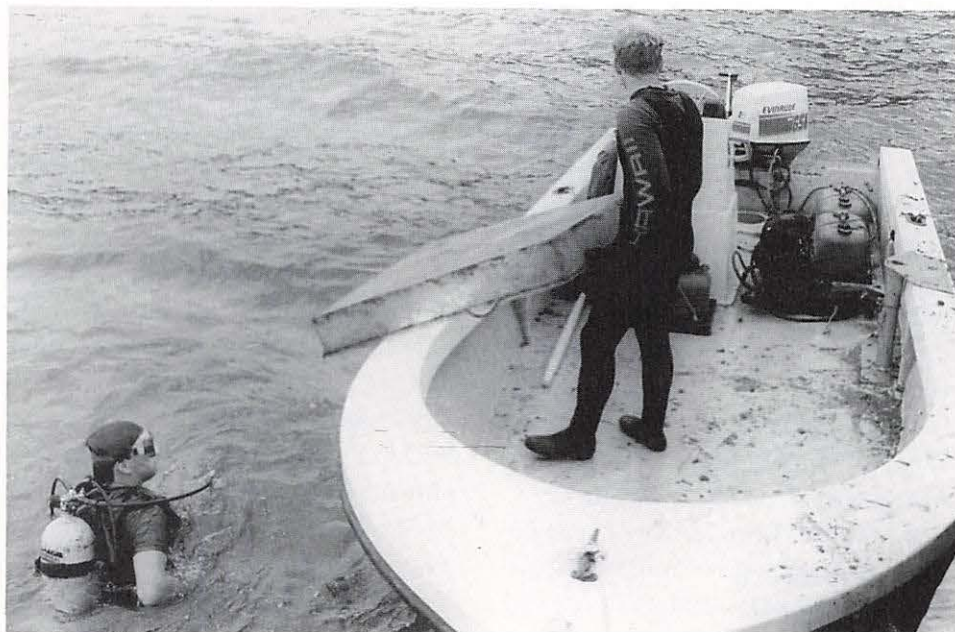
Office and dry laboratory space are available to students and visiting investigators. An on-site dormitory can accommodate up to 28 visitors.



Students from Virginia Polytechnic Institute & State University utilize facilities at the Eastern Shore Lab.



The seawater flume laboratory was designed and built by the Eastern Shore Lab faculty and staff.



More than 600 dives are logged annually by the 40-member dive team.

VESSELS CENTER

The vessels center maintains and operates a fleet of 40 vessels. The 65-foot *R/V Bay Eagle* is outfitted with a wet lab containing a flow-through seawater system, a dry lab housing electronics, and project-oriented equipment. Similarly outfitted is the 44-foot *R/V Langley*. Both vessels have Loran interface for downloading information to on board computers. In 1990, the 29-foot *R/V Fish Hawk* was specially designed and equipped to perform trawl surveys. A sizeable trailerable fleet supports estuarine and tributary research. Electronic systems can be transferred to these smaller boats, enabling precise scientific surveys to be conducted on board. A new diving facility includes a diver training room and classrooms to support the 40-member VIMS dive team. The VIMS diving program is an organizational member of the American Academy of Underwater Sciences.

LIBRARY

The library supports the Institute's mission by collecting and providing access to marine science literature, with emphasis on estuaries and the coastal zone. Currently the collection includes 521 journal subscriptions, 44,000 volumes and 19,200 titles in addition to topographic maps, nautical charts, and scientific archives. Access is provided through the card catalog as well as through the circulation terminal and personal computers. On-line networks provide access to marine science literature through *Aquatic Sciences and Fisheries Abstracts* and the *Chesapeake Bay Bibliography*, and Swem Library on the Main Campus in Williamsburg. The library workstation is networked to computers in the student User's Room.

MARINE ADVISORY SERVICES/SEA GRANT

Marine Advisory Services' (MAS) role is to be directly responsive to the needs of industry and the general public, and to provide information that will increase the public's awareness of the marine environment. MAS is associated with the Sea Grant Program, a state/federal program administered through the National Oceanic and Atmospheric Administration.

Specialists from MAS work closely with businesses, governmental agencies, educational organizations, and individuals to provide information and advice on a wide range of marine-related programs and activities.

The direction of MAS research is dictated by industry and government needs. Research has ranged from gear selectivity experiments and sea scallop biology, to technology for

soft crab shedding and clam relaying. MAS works extensively with the recreational fishery, marine trades, and the offshore pelagic fishery.

In the past few years, changing needs and opportunities—driven in part by enacted or pending regulatory measures—have presented new challenges to MAS in the areas of seafood processing, water quality, and mariculture development.

Students at MAS are generally associated with Fisheries Science or Resource Management departments. Their research has been diverse. Projects have included sea scallop biology, the socioeconomics of Virginia's recreational fishery, the food/feeding habits and trophic interaction of tuna species in Virginia's offshore waters, and the biology of recreational reefs.

Advisory scientists work closely with industry, in this case the operator of a blue crab shedding facility.



MAS maintains the aquarium that attracts more than 5,000 visitors each year.



CHESAPEAKE BAY NATIONAL ESTUARINE RESEARCH RESERVE

Since 1987, Virginia Institute of Marine Science has been the lead agency for the Reserve System in Virginia. Reserve sites are preserved for estuarine research, monitoring, education, and conservation of key resources in relatively pristine settings. Establishment of four sites began a system that will include sites on the York, Pamunkey, Potomac, Rappahannock, and James rivers, the mainstem of the Bay and the Eastern Shore. Sites of activity today are the Goodwin Islands, the Catlett Islands, Taskinas Creek, and Sweet Hall Marsh. More than 20 research projects involving investigators from several colleges and universities are currently underway. The program provides study areas for numerous graduate research projects, "outdoor classrooms," and ecology presentations.



Taskinas Creek is one of the four Reserve Sites for estuarine research.

FISH COLLECTIONS

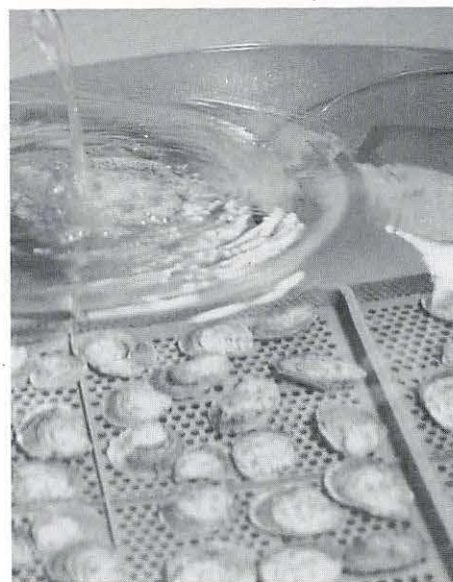
Nunnally Hall, completed in 1992, houses the extensive ichthyology collection that includes approximately 85,000 specimens in 247 families from Chesapeake Bay and contiguous waters, the continental slope and abyssal plain of the western Atlantic, and freshwater species of the southern Appalachians. More than 13,000 catalogued lots are stored on specially constructed shelving that provides access to the entire collection. The Institute also maintains a growing collection of marine and estuarine ichthyoplankton from Chesapeake Bay, Mid-Atlantic Bight, and Caribbean waters as well as a number of exotic species including a 5-foot female coelacanth from Comoros Island in the Indian Ocean. There are facilities for processing acquisitions, x-ray studies, and performing necropsies on large fishes, sea turtles and cetaceans.



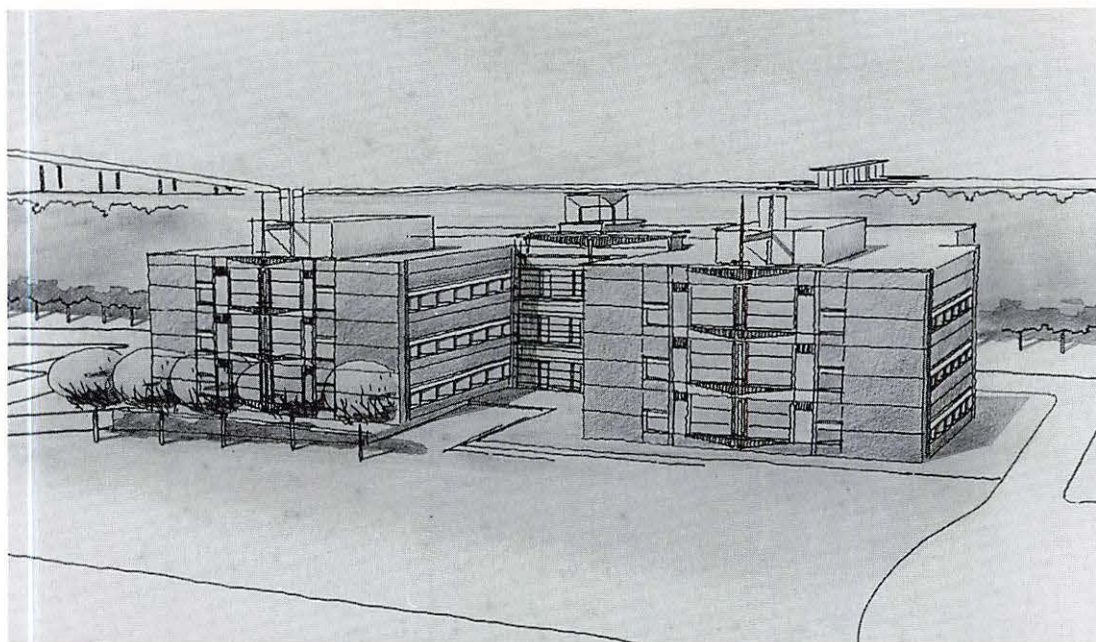
The Institute houses one of the most extensive fisheries collections on the East Coast.

OYSTER HATCHERY

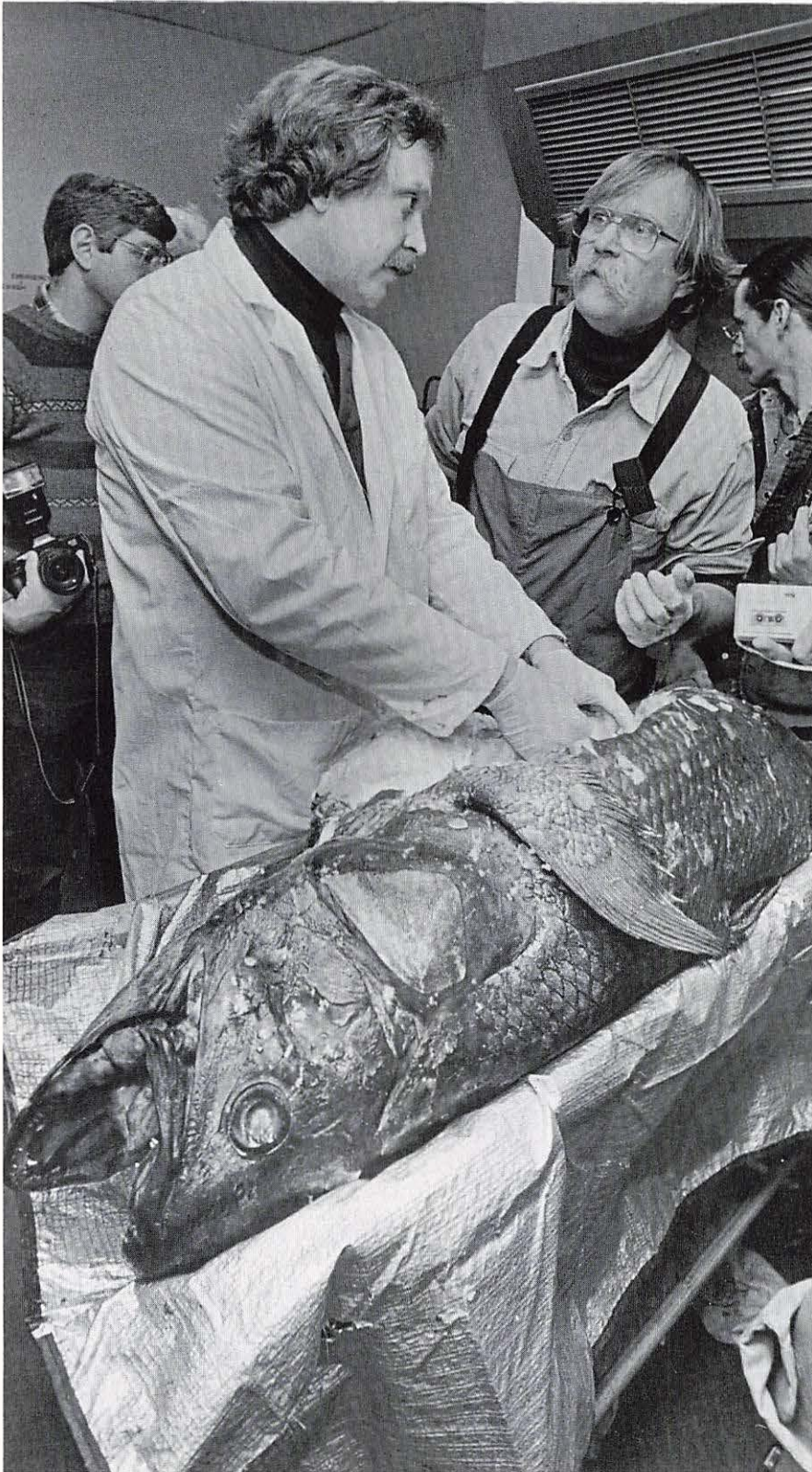
Established in 1985, the Oyster Hatchery provides breed stock (up to 2,000 at any given time) for research, conditioning, and selective breeding experiments. Specimens of any specified size are provided for class labs on a year-round basis. The hatchery is equipped with setting tanks for fertilization and a temperature controlled environment for development from larval to spat stage. Grow-out spats for oyster aquaculture are produced by the hatchery as well. In addition, the laboratory houses the largest algae culture lab on the East Coast. Four 1,000-gallon tanks, four 400-gallon tanks, state-of-the-art water temperature control and filtering systems enable the lab to produce vast quantities of virtually any kind of algae required for research or as a food source.



Oyster research ranges from cell cultures of the Perkinsus protozoan, to developing disease-resistant hybrids and oyster aquaculture.



The Marine Chemistry and Toxicology building will house specialized laboratories designed for biological and chemical research to examine the fate and effects of organic pollutants.



*The diverse faculty
is the cornerstone
of the Institute's
nationally and
internationally
recognized
education
and research
programs.*



School of Marine Science

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

John D. Milliman, Dean of Graduate Studies and Professor of Marine Science. B.S. University of Rochester; M.S., University of Washington (Seattle); Ph.D., University of Miami. Physical Sciences.

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

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

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

Eugene M. Bureson, Professor of Marine Science. B.S., Eastern Oregon College; M.S., Ph.D., Oregon State University. Fisheries Science.

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

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

Hugh W. Ducklow, Loretta & Lewis Glucksman Professor of Marine Science. A.B. Harvard College; A.M., Ph.D., Harvard University. Biological Sciences.

William D. DuPaul, Professor of Marine Science. B.S., Bridgewater State College; M.A., Ph.D., College of William and Mary. Fisheries Science.

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Stephen L. Kaattari, Professor of Marine Science. B.S., Ph.D., University of California, Davis. Environmental Sciences.

Albert Y. Kuo, Professor of Marine Science. B.S., National Taiwan University; M.S., University of Iowa; Ph.D., The Johns Hopkins University. Physical Sciences.

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Roger L. Mann, Professor of Marine Science. B.S., University of East Anglia; Ph.D., University of Wales. Fisheries Science.

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Steven A. Kuehl, Associate Professor of Marine Science. B.A., Lafayette College; M.S., Ph.D., North Carolina State University. Physical Sciences.

Romuald N. Lipcius, Associate Professor of Marine Science. B.S., University of Rhode Island; Ph.D., Florida State University. Fisheries Science.

Jerome P.-Y. Maa, Associate Professor of Marine Science. B.S., M.S., National Cheng-Kung University; Ph.D., University of Florida. Physical Sciences.

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Beverly A. Weeks-Perkins, Associate Professor of Marine Science. B.A., Winthrop College; M.S., Tulane University; Ph.D., North Carolina State University. Environmental Sciences.

James E. Bauer, Assistant Professor of Marine Science. B.A., Boston University; M.S., State University of New York, Stony Brook; Ph.D., University of Maryland. Physical Sciences.

Elizabeth A. Canuel, Assistant Professor of Marine Science. B.S., Stonehill College; Ph.D., University of North Carolina. Physical Sciences.

Catherine J. Chisholm-Brause, Assistant Professor of Marine Science. B.A., Harvard University; M.S., Ph.D., Stanford University. Physical Sciences.

Rebecca M. Dickhut, Assistant Professor of Marine Science. B.S., St. Norbert College; M.S., Ph.D., University of Wisconsin, Madison. Physical Sciences.

Linda C. Schaffner, Assistant Professor of Marine Science. B.A., Drew University; M.A., Ph.D., College of William and Mary. Biological Sciences.

Peter Van Veld, Assistant Professor of Marine Science. B.S., University of North Carolina, Chapel Hill; M.A., College of William and Mary; Ph.D., University of Georgia. Environmental Sciences.

Wolfgang Vogelbein, Assistant Professor of Marine Science. B.S., Southampton College; M.S., California State University; Ph.D., Louisiana State University. Environmental Sciences.

Virginia Institute of Marine Science

All School of Marine Science faculty are also Virginia Institute of Marine Science faculty.

Iris C. Anderson, Professor of Marine Science. B.S., Colby College; S.M., Massachusetts Institute of Technology; Ph.D., Medical College of Virginia, Virginia Commonwealth University. Biological Sciences.

Leonard W. Haas, Associate Professor of Marine Science. A.B., Dartmouth College; M.S., University of Rhode Island; Ph.D., College of William and Mary. Biological Sciences.

Mark W. Luckenbach, Associate Professor of Marine Science. B.S., University of North Carolina; Ph.D., University of South Carolina. Biological Sciences.

Craig L. Smith, Associate Professor of Marine Science. A.B., The Johns Hopkins University; Ph.D., University of Florida. Environmental Sciences.

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J. Emmett Duffy, Assistant Professor of Marine Science. B.S. Spring Hill College; M.S. University of Maine; Ph.D. University of North Carolina at Chapel Hill. Biological Sciences.

Carl H. Hobbs, III, Assistant Professor of Marine Science. B.S., Union College; M.S., University of Massachusetts. Physical Sciences.

John E. Olney, Assistant Professor of Marine Science. B.S., M.A., College of William and Mary. Biological Sciences.

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Kevin P. Kiley, Instructor in Marine Science. B.S., Tufts University; M.A., College of William and Mary. Resource Management and Policy.

Jon A. Lucy, Instructor in Marine Science. B.S., University of Richmond; M.A., College of William and Mary. Fisheries Science.

Kenneth A. Moore, Instructor in Marine Science. B.S., Pennsylvania State University; M.S., University of Virginia. Biological Sciences.

Walter I. Priest, III, Instructor in Marine Science. B.S., Virginia Military Institute; M.S., Old Dominion University. Resource Management and Policy.

Martha W. Rhodes, Instructor in Marine Science. B.S., Virginia Polytechnic Institute and State University; M.A., Medical College of Virginia, Virginia Commonwealth University. Biological Sciences.

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

Gary F. Anderson, B.S., Southampton College of Long Island University; M.A., College of William and Mary. Physical Sciences.

C. Scott Hardaway, B.A., M.S., East Carolina University. Physical Sciences.

John N. Posenau, B.A., Christopher Newport College. Physical Sciences.

Emeritus

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

Rudolf H. Bieri, Professor Emeritus of Marine Science. Dr.rer.nat. Johann Gutenberg University. Environmental Sciences.

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

George C. Grant, Professor Emeritus of Marine Science. B.S., University of Massachusetts; M.A., College of William and Mary; Ph.D., University of Rhode Island. Biological Sciences.

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

The specially equipped DeHavilland-Beaver aircraft logged 300 hours in 1993 to support various research projects.





The Department of Environmental Sciences is a diverse group of biologists and chemists who apply various methods to study the location and movement of hazardous chemicals in water, sediment, and organisms in marine systems and the effects of these chemicals on organisms. Strong emphasis is placed on the analysis of organic chemicals; fish and oyster responses to chemicals; and immunological and biochemical mechanisms of fish and oyster responses to toxic chemicals.



Fu-Lin E. Chu

Associate Professor of
Marine Science

B.S., The Chinese University of
Hong Kong;
M.S., University of Rochester;
Ph.D., College of William
and Mary

RESEARCH INTERESTS

Nutrition, energy reserves, and metabolism in marine organisms are my primary research interests. In my laboratory, also, are ongoing studies on oyster diseases; host-parasite interaction; molluscan immunology and pathology.

CURRENT PROJECTS

- Disease processes and transmission dynamics of *Perkinsus marinus* in American oysters (*Crassostrea virginica*).
- Role of oyster lysosomal enzymes in disease resistance.
- Role of sediment associated pollutants in infectious disease susceptibility in the eastern oyster, *Crassostrea virginica*.
- Nutritional requirements and microencapsulated diets for hybrid striped bass larvae.

CURRENT STUDENTS

Sureyya Ozkizilcik, Ph.D., Feeding and nutrition of striped bass (*Morone saxatilis*) larvae.

Aswani Volety, Ph.D., A study of the histozoic oyster parasite, *Perkinsus marinus*. I. Disease processes in American oysters (*Crassostrea virginica*), II. Biochemistry of *Perkinsus marinus*.

Tong Li, M.A., Effects of sediment-sorbed pollutants on oyster hemocyte function.

Lance Garrison (co-advisor with R. Lipcius), M.A., The impact of predation and nutritional stress on the survival of the zoea of two species of brachyuran crabs employing different dispersal strategies.

SELECTED PUBLICATIONS

Chu, F.-L. E. and R. C. Hale. 1994. Relationship between pollution and susceptibility to infectious disease in the eastern oyster, *Crassostrea virginica*. *Marine Environmental Research*, (in press).

Ozkizilcik, S. and F.-L. E. Chu. 1994. Evaluation of omega-3 fatty acid enrichment of *Artemia nauplii* used as food for striped bass *Morone saxatilis* (Walbaum) larvae. *J. World Aquaculture Soc.*, (in press).

Chu, F.-L. and J. La Peyre. 1993. *Perkinsus marinus* susceptibility and defense-related activities in eastern oysters, *Crassostrea virginica*: temperature effect. *Dis. in Aquat. Org.*, 16:223-234.

Chu, F.-L. and J. La Peyre. 1993. Development of disease caused by the parasite, *Perkinsus marinus* and defense-related hemolymph factors in three populations of oysters from the Chesapeake Bay. *J. Shellfish. Res.*, 12:21-27.

Chu, F.-L., J. La Peyre, and C. Burreson. 1993. *Perkinsus marinus* infection and potential defense-related activities in eastern oysters, *Crassostrea virginica*: salinity effect. *J. Invert. Pathol.*, 62:226-232.

RESEARCH INTERESTS

My interests are in studying the basic mechanisms associated with the pathogenesis of disease in aquatic animals. I am particularly interested in examining the processes associated with immunocompetent cells in organism protection.

CURRENT PROJECTS

- Immunosuppression in fish due to exposure to high levels of polycyclic aromatic hydrocarbons.
- Recognition and defense responses of oysters to the extracellular products of the protozoan pathogen, *Perkinsus marinus*.
- Activation of xenobiotics by leukocytes and hemopoietic organs of aquatic animals.

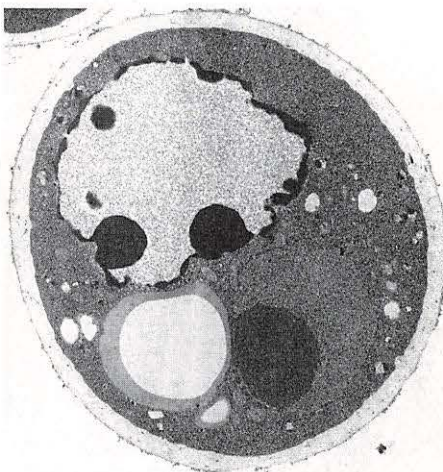
CURRENT STUDENTS

Kathleen Garreis, M.S., Role of environmental factors in determining the virulence of *Perkinsus marinus*.

Christopher D. Williams, Ph.D., (co-advisor with R. Huggett), Chemically-induced cataracts in fish.

Heather Yarnell, M.S., Molecular aspects of *Perkinsus marinus* pathogenesis.

Dr. Jerome F. La Peyre, Postdoctoral Fellow, Virulence factors of *Perkinsus marinus*.



Perkinsus marinus, a deadly pathogen of oysters, was cultured for the first time by Dr. Jerome La Peyre in my laboratory.

SELECTED PUBLICATIONS

Faisal, M., and S. Demmerle-Sami. 1994. Polycyclic aromatic hydrocarbons modulate the molecular synthesis in hemocytes of the Eastern oyster (*Crassostrea virginica*). In: J. S. Stolen and T. C. Fletcher (eds.), Modulators of Fish Immune Responses, Vol. 1, SOS Publication, Fair Haven, pp. 235-246.

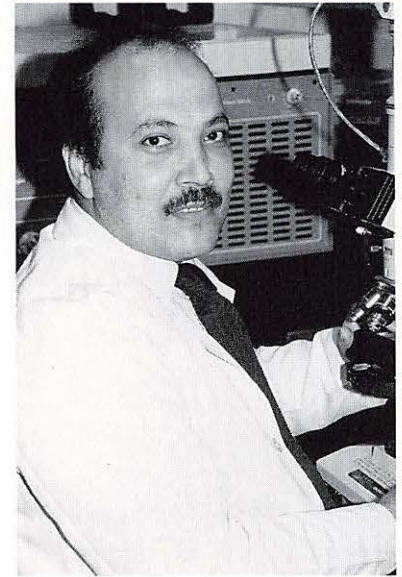
LaPeyre, J. F., M. Faisal and E. M. Bureson. 1993. *In vitro* Propagation of the Protozoan *Perkinsus marinus*, a Pathogen of the Eastern Oyster, *Crassostrea virginica*. *J. Eukaryotic Microbiol.*, **40**:304-310.

Faisal, M. and R. J. Huggett. 1993. Effects of Polycyclic aromatic hydrocarbons on the activity of lymphocytes of the spot, *Leiostomus xanthurus*. *Mar. Environ. Res.*, **35**:121-124.

Williams, C. D., M. Faisal and R. J. Huggett. 1992. Polynuclear aromatic hydrocarbons and fish lens cataract: Effects of benzo(a)pyrene-7,8-dihydrodiol on the macromolecular synthesis in cultured cells. *Mar. Environ. Res.*, **34**:333-337.

Faisal, M., M. S. M. Marzouk, C. L. Smith, and R. J. Huggett. 1991. Proliferative responses of spot (*Leiostomus xanthurus*) leukocytes to mitogens from a polycyclic aromatic hydrocarbon contaminated environment. *Immunopharmacol. Immunotoxicol.*, **13**:311-328.

Faisal, M., B. A. Weeks, W. K. Vogelbein and R. J. Huggett. 1991. Aberration in natural cytotoxic activity of anterior kidney leukocytes in *Fundulus heteroclitus* exposed to toxic chemicals. *Vet. Immunol. Immunopathol.*, **29**:339-351.

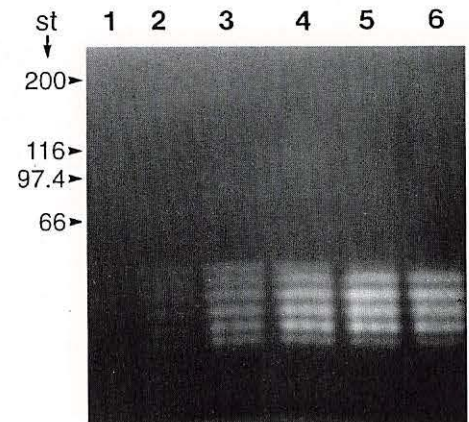


Mohamed Faisal

Associate Professor of
Marine Science

B.V.Sci., M.V.Sci, Cairo
University;
D.V.M., Ph.D., University of
Ludwig-Maximilian
at Munich

Perkinsus marinus produces potent proteases that digest a wide variety of proteins including oyster tissue (shown as transparent bands in this SDS-PAGE electrophoresis gels).





Robert C. Hale

Associate Professor of
Marine Science

B.S., B.A., Wayne State
University;
Ph.D., College of William
and Mary

RESEARCH INTERESTS

My primary research interest is in examining the fate and effects of anthropogenic compounds in the environment, especially with regard to interactions with living systems.

CURRENT PROJECTS

- Development of supercritical fluid extraction (SFE) for the analysis of nonpolar marine environmental pollutants.
- Impact of polycyclic aromatic hydrocarbons on disease susceptibility in the eastern oyster.
- PCBs and chlorinated pesticides in fishes of Virginia waters.

CURRENT STUDENTS

Kathryn Gallagher, Ph.D., (co-advisor with P. Van Veld), Examination of the distribution of polychlorinated terphenyls and their effect on mixed function oxygenase activity in teleosts.

Jennifer Gundersen, Ph.D., Comparison of analytical methods for the determination of paper mill effluent components and an examination of the physical and chemical properties of these environmental contaminants.

Mary Rybitski, Ph.D., Effects of PCBs on the early development of amphibians.

Padma Venkatraman, M.A., Effects of a water soluble fraction, derived from creosote, on the mysid shrimp.

Laurent Mezin, M.A., (co-advisor with W. Vogelbein), Mucus production and associated hemoglobin as an early indicator of environmental stress in teleosts.

Judith Thames, M.A., Microbial degradation of polychlorinated terphenyls.

SELECTED PUBLICATIONS

Smith, W. H., R. C. Hale, J. Greaves, and R. J. Huggett. 1993. Trace organochlorine contamination of the forest floor of the White Mountain National Forest, New Hampshire. *Environ. Sci. Technol.*, **27**:2244-2246.

Gallagher, K., R. C. Hale, J. Greaves, E. O. Bush and D. A. Stillwell. 1993. Trophic level distribution of polychlorinated terphenyls in aquatic species inhabiting a tidal creek. *Ecotoxicol. Environ. Safety*, **26**:302-312.

Mothershead, R. F. II and R. C. Hale. 1992. Influence of ecdysis on the accumulation of polycyclic aromatic hydrocarbons in field exposed blue crabs. *Mar. Environ. Res.*, **33**:145-156.

Hale, R. C. and J. Greaves. 1992. Invited Review: Chromatographic methods for the analysis of persistent chlorinated hydrocarbons. *J. Chromatogr.* **580**:257-278.

Hale, R. C., J. Greaves, K. Gallagher and G. Vadas. 1990. Novel chlorinated terphenyls in sediments and shellfish of an estuarine environment. *Environ. Sci. Technol.*, **24**:1727-1731.

RESEARCH INTERESTS

I am especially involved in research to examine the transport, fate, and effects of toxic chemicals in aqueous systems. My research includes the role of biomarkers (biochemical and physiological responses to stress) in environmental risk assessments.

CURRENT PROJECTS

Dr. Huggett is presently on a leave of absence. He was nominated by President Clinton to the position of Assistant Administrator for Research and Development at the Environmental Protection Agency. His responsibilities include overseeing the EPA's network of research laboratories. The position began in July 1994.

CURRENT STUDENTS

Christopher D. Williams, Ph.D., (co-advisor with M. Faisal), Investigations into the mechanism(s) of cataract formation in sciaenid fish species from the Elizabeth River, Chesapeake Bay, VA.

Cynthia A. Horton-Williams, M.A., (co-advisor with W. Vogelbein), Toxicity resistance in mummichog (*Fundulus heteroclitus*) from a chemically contaminated environment.

SELECTED PUBLICATIONS

Smith, W. H., R. C. Hale, J. Greaves and R. J. Huggett. 1993. Trace organochlorine contamination of the forest floor of the White Mountain National Forest, New Hampshire. *Environ. Sci. Technol.*, **27**(10):2244-2246.

Espourteille, F. A., J. Greaves and R. J. Huggett. 1993. Measurement of tributyltin contamination of sediments and *Crassostrea virginica* in the southern Chesapeake Bay. *Environ. Toxicol. Chem.*, **12**(2):305-314.

Huggett, R. J., R. A. Kimerle, P. M. Mehrle, Jr. and H. L. Bergman (editors). 1992. *Biomarkers: Biochemical, Physiological, and Histological Markers of Anthropogenic Stress.*, Lewis Publishers, Boca Raton, FL, 347 pp.

Huggett, R. J., P. A. Van Veld, C. L. Smith, W. J. Hargis, Jr., W. K. Vogelbein and B. A. Weeks. 1992. The effects of contaminated sediments in the Elizabeth River. In: G. A. Burton, Jr., (ed.), *Sediment Toxicity Assessment*, Lewis Publishers, Chelsea, MI, pp. 403-430.

Huggett, R. J., M. A. Unger, P. F. Seligman and A. O. Valkirs. 1992. Assessing and managing tributyltin risks in the United States. *Environ. Sci. Tech.*, **26**(2)232-237.



Robert J. Huggett

*Professor of
Marine Science*

*M.S., Scripps Institution
of Oceanography;
Ph.D., College of
William and Mary*



Stephen L. Kaattari

Professor of
Marine Science

B.S., Ph.D., University of
California, Davis

RESEARCH INTERESTS

Comparative immunology of fish and shellfish is my broad area of interest. This includes investigating immunochemistry, cellular and developmental immunology, immunotoxicology, vaccines, immunodiagnostics, and mechanisms of infectious disease pathogenesis.

CURRENT PROJECTS

- Examination of the molecular and cellular mechanisms of carcinogen-induced immune dysfunction.
- Development of homozygous clones of trout as models for biomedical research.
- Development of immunodiagnostics for oyster pathogens.
- Study of oyster immune defense mechanisms.
- Development of *Fundulus heteroclitus* as a model species for immunotoxicological studies.

CURRENT STUDENTS

David Shapiro, Ph.D., Immunology and molecular immunology of carcinogen-induced immune dysfunction in trout.

John Hansen, Ph.D., Recombinase activator gene function in trout.

Dr. Christopher Ottinger, Postdoctoral Fellow, Effects of aflatoxin exposure on immune responses in trout.

SELECTED PUBLICATIONS

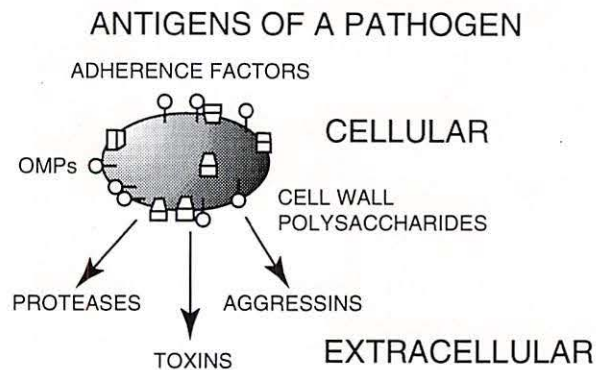
Piganelli, J. B., J. A. Zhang, J. M. Christensen, and S. L. Kaattari. 1994. Enteric coated microspheres as an oral method for antigen delivery to salmonids. *Fish Shellfish Immunol.*, 4:179-188.

Kaattari, S. L., M. Adkinson, D. Shapiro and M. R. Arkoosh. 1994. Mechanisms of immunosuppression by aflatoxin B₁. In: *Modulators of Fish Immune Responses, Models for Environmental Toxicology/Biomarkers, Immunostimulators*. SOS Publications, Fair Haven, NJ, I:51-156.

Castillo, A., C. Sanchez, J. Dominguez, S. L. Kaattari and A. J. Villena. 1993. Ontogeny of IgM and IgM-bearing cells in rainbow trout. *Develop. Comp. Immunol.*, 17:419-424.

Kaattari, S. L. 1992. Fish B. lymphocytes: Defining their form and function. In *Annual Review of Fish Diseases*. Pergamon Press, New York, NY, 2:161-180.

DeKoning, J. and S. Kaattari. 1992. An improved salmonid lymphocyte culture medium for *in vitro* antibody production and mitogenesis. *Fish Shellfish Immunol.*, 2:275-285.



RESEARCH INTERESTS

My research focuses on examining the remediation of sediment-associated toxicity with resins. In addition, I am involved in studies on the effects of chlorination in marine environments; exposure methodologies for marine and estuarine fish and macroinvertebrates.

CURRENT PROJECTS

- Use of carbon resins for the removal of non-polar organic compounds from pore water in contaminated sediments and reduction in sediment toxicity to amphipods.
- Field evaluation of carbon resin to remediate contaminated sediments to allow macroinvertebrate recruitment.
- Body burdens of PAHs and TBT in clams from throughout the Elizabeth River, VA.
- Sediment toxicity near point source discharges in Virginia estuaries.
- Biogenic toxins as a source of variability in toxicity of natural waters in the Chesapeake Bay system.

SELECTED PUBLICATIONS

Sved, D. W. and M. H. Roberts, Jr. A novel use for the continuous-flow serial diluter: Aquatic toxicity testing of contaminated sediments in suspension. *Water Res.*, (in press).

Roberts, M. H., Jr., R. J. Huggett, P. F. DeLisle, M. E. Bender and H. Slone. 1993. Tributyltin bioconcentration from solution and suspended sediments by oysters with a comparison to uptake in a field experiment. *In: Tributyltin: Fate and Effects*, M. Champ and P. Seligman (eds.), 17: (in press).

DeLisle, P. F. and M. H. Roberts, Jr. 1993. The effect of salinity on cadmium toxicity in the estuarine mysis *Mysidopsis bahia*: Roles of osmoregulation and calcium. *Mar. Environ. Res.* 37:47-62.

Sved, D. W., P. A. Van Veld, and M. H. Roberts, Jr. 1992. Hepatic EROD activity in spot, *Leiostomus xanthurus*, exposed to creosote-contaminated sediments. *Mar. Environ. Res.*, 34:189-193.

Roberts, M. H., B. B. Casey, C. S. Strobel and E. Wilkins. 1990. Field evaluation of the effect of chlorinated treated sewage on settlement of oysters (*Crassostrea virginica*, Gmelin) and barnacles (*Balanus* sp.). *In: Water Chlorination: Environmental Impact and Health Effects*, R. L. Jolley, L. W. Condie, J. D. Johnson, S. Katz, R. A. Minear, J. S. Mattice, and V. A. Jacobs (eds.), Lewis Publishing, Inc. Chelsea, MI, 6:435-452.



Morris H. Roberts, Jr.

Chair of Department

*Professor of
Marine Science*

*B.A., Kenyon College;
M.A., Ph.D., College of
William and Mary*



Craig L. Smith

Associate Professor
of Marine Science

A.B., The Johns Hopkins
University;
Ph.D., University of Florida

RESEARCH INTERESTS

My areas of interest are: organic geochemistry, chemistry of oil pollution, and diagenesis of organic compounds in marine sediments. I am especially interested in applications of computer programming in automated chemical analysis; search and retrieval programming for monitoring of toxic organic compounds; and metals in the marine, estuarine, and riverine environments.

CURRENT PROJECTS

- Use of relative retention index system in gas chromatographic assay of PCB and pesticide contaminated fish samples from Virginia rivers.
- Use of relative retention index system in gas chromatographic assay of PCB and PAH contaminated sediment samples from Chesapeake Bay and its tributaries.
- Sediment contamination mapping database for PAHs, PCBs and metals. Integration of chemical analytical data and other information into an Institute-wide database system, with graphical interface and inter-related meta-data.
- Effects of PAH contaminated environments on organisms, including tumor induction. Association of specific compounds with observed effects.

SELECTED PUBLICATIONS

Huggett, R. J., P. A. Van Veld, C. L. Smith, W. J. Hargis, W. K. Vogelbein and B. A. Weeks. 1992. Effects of Contaminated Sediments in the Elizabeth River, *In: Sediment Toxicity Assessment*, G. Allen Burton, Jr. (ed.), Lewis Publishers, Chelsea, MI, pp 403-430.

Faisal, M., M. S. M. Marzouk, C. L. Smith, and R. J. Huggett. 1991. Mitogen Induced Proliferative Responses of Lymphocytes from Spot (*Leiostomus xanthurus*) Exposed to Polycyclic Aromatic Hydrocarbon Contaminated Sediments., *J. Immunopharmacol. Immunotoxicol.*, **13**(3):311-328.

Van Veld, P.A., D. J. Westbrook, B. R. Woodin, R. C. Hale, C. L. Smith, R. J. Huggett, and J. J. Stegeman. 1990. Induced cytochrome P-450 in intestine and liver of spot (*Leiostomus xanthurus*) from a polycyclic aromatic hydrocarbon contaminated environment. *Aquatic Toxicology*, **17**:119-132.

Bieri, R. H., C. Hein, R. J. Huggett, P. Shou, H. Slone, C. L. Smith, and C. W. Su. 1986. Polycyclic Aromatic Hydrocarbons in Surface Sediments from the Elizabeth River Subestuary. *Int. Journal of Environ. Anal. Chem.*, **26**:97-113.

Voudrias, E. A. and C. L. Smith. 1986. Hydrocarbon Pollution from Marinas in Estuarine Sediments. *Estuarine, Coastal, and Shelf Science*, **22**:271-284.

RESEARCH INTERESTS

My research focuses on the ways in which the chemical and physical behavior of aquatic pollutants affects their fate and bioavailability to marine organisms.

CURRENT PROJECTS

- Characterization of zinc chemistry at a dredge spoil site.
- Relating sediment contamination to prevalence of liver tumors in feral estuarine fish.
- Development of laboratory techniques to expose organisms to dissolved and particle associated hydrophobic organic compounds.
- Long term monitoring of the fate of TBT and Kepone in Chesapeake Bay.

CURRENT STUDENT

Michael Chasey, M.A., (co-advisor with W. MacIntyre), Chemical factors controlling the fate of zinc at a dredge spoils pond site.

SELECTED PUBLICATIONS

Diaz, R. J., L. J. Hansson, R. Rosenberg, P. C. Gapcynski and M. A. Unger. 1993. Rapid sedimentological and biological assessment of hydrocarbon contaminated sediments. *Water, Air, and Soil Pollution*, **66**:251-266.

Huggett, R. J., M. A. Unger, P. F. Seligman and A. O. Valkirs. 1992. The marine biocide tributyltin: assessing and managing the environmental risks. *Environ. Sci. and Tech.*, **26**:232-237.

Hall, L. W., Jr., M. C. Ziegenfuss, S. J. Bushong, J. A. Sullivan and M. A. Unger. 1992. *In situ* striped bass contaminant and water quality studies in the Potomac River and upper Chesapeake Bay in 1989. *Aquat. Toxicol.*, **22**:181-222.

Bushong, S. J., M. C. Ziegenfuss, M. A. Unger and L. W. Hall, Jr. 1990. Chronic tributyltin toxicity experiments with the Chesapeake Bay copepod, *Acartia tonsa*. *Environ. Toxicol. Chem.*, **9**:359-366.

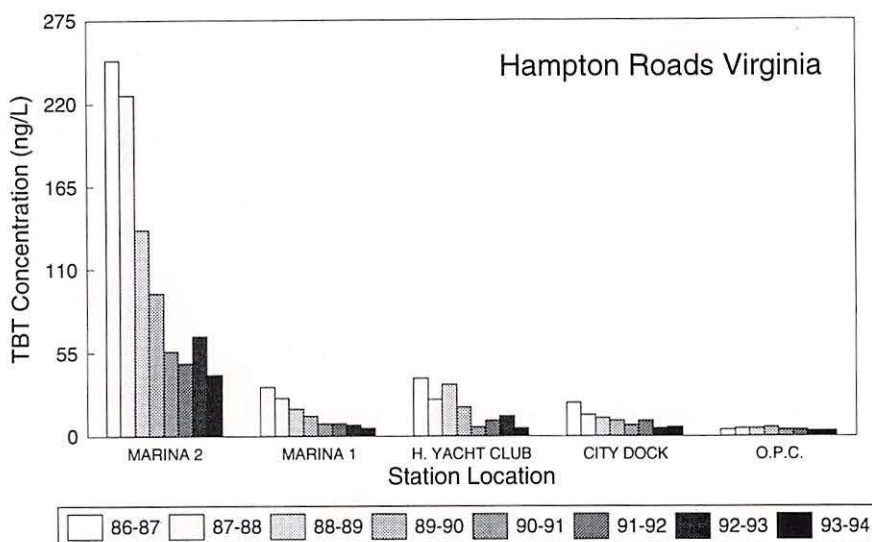
Unger, M. A., W. G. MacIntyre and R. J. Huggett. 1988. Sorption behavior of tributyltin on estuarine and freshwater sediments. *Environ. Toxicol. Chem.*, **7**:907-915.



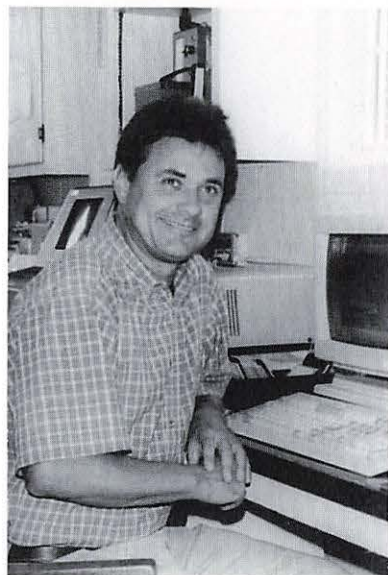
Michael A. Unger

*Assistant Professor
of Marine Science*

*B.S., Michigan State University;
M.S., Ph.D., College of
William and Mary*



*Tributyltin (TBT) research at VIMS has included analytical method development and fate and effects studies. Trends in TBT concentrations have been documented since legislation restricting the use of TBT antifoulant paints was enacted in the late 1980's. Current research is examining the effects of low concentrations of TBT on oysters (*Crassostrea virginica*).*



Peter Van Veld

Assistant Professor
of Marine Science

B.S., University of
North Carolina, Chapel Hill;
M.A., College of William
and Mary;
Ph.D. University of Georgia

RESEARCH INTERESTS

Biochemical responses and the manner in which aquatic organisms adapt to pollution exposure are my primary areas of interest. Related research includes studies on the biochemical factors influencing toxicant fate and effects.

CURRENT PROJECTS

- Biochemical and reproductive effects of pulp mill effluents in aquatic organisms.
- Biochemical adaptations in pollution-resistant organisms.
- Tissue-specific patterns of enzyme induction as a tool to evaluate toxicant uptake routes in aquatic organisms.

CURRENT STUDENTS

Peter Cooper, Ph.D., P-glycoprotein expression in a population of pollution tolerant finfish.

Susan L. Armknecht, M.A., (co-advisor with W. Vogelbein), Cross resistance to the cyanobacterial toxin nodularin in a population of pollution tolerant killifish *Fundulus heteroclitus*.

Kathryn Gallagher, Ph.D., (co-advisor with R. Hale), Responses of cytochrome P450 to polychlorinated terphenyls in mummichog (*Fundulus heteroclitus*).

SELECTED PUBLICATIONS

Bankey, L. A., P. A. Van Veld, D. L. Borton, L. Lafleur and J. J. Stegeman. Responses of cytochrome P4501A in freshwater fish exposed to bleached kraft mill effluent in experimental stream channels. *Can. J. Fish. Aquat. Sci.*, (in press).

Gallagher, K., P. A. Van Veld, R. Hale and J. J. Stegeman. Induction of cytochrome P4501A in the mummichog (*Fundulus heteroclitus*) by polychlorinated biphenyls. *Environ. Toxicol. Chem.*, (in press).

Di Giulio, R., B. Benson, B. M. Sanders and P. A. Van Veld. Xenobiotic metabolism and biochemical effects. In: *Fundamentals of Aquatic Toxicology*, G. Rand, (ed.), Hemisphere Publishing, Cambridge, (in press).

Stegeman, J. J., M. Brouwer, R. T. Di Giulio, L. Forlin, B. A. Fowler, B. M. Sanders and P. A. Van Veld. 1992. Molecular responses to environmental contamination: Enzyme and protein systems as indicators of chemical exposure and effect. In: *Biomarkers: Biochemical, Physiological, and Histological Markers of Anthropogenic Stress*, R. J. Huggett, R. A. Kimerle, P. M. Mehrle, Jr. and H. L. Bergman, (eds.), Lewis Publishers, Boca Raton, Florida, 6:235-335.

Van Veld, P. A., W. K. Vogelbein, R. Smolowitz, B. R. Woodin and J. J. Stegeman. 1992. Cytochrome P-4501A1 in hepatic lesions of a teleost fish (*Fundulus heteroclitus*) collected from a polycyclic aromatic hydrocarbon contaminated site. *Carcinogenesis*, 13:505-507.

RESEARCH INTERESTS

My research focuses on understanding the pathobiology of pollution/disease associations in aquatic animals. I am particularly interested in the relationship between chemical exposure and the development of cancer in fishes.

CURRENT PROJECTS

- Validation of two estuarine fishes as histological indicators of pollution in eastern and southern U.S. estuaries. Field and laboratory studies designed to evaluate the utility of *Fundulus heteroclitus* and *F. grandis* as sentinels of pollution in coastal estuaries. Emphasis is on the use of histopathological endpoints of toxicant exposure.
- Exposure mechanisms and uptake routes of lipophilic organic toxicants by finfish. Laboratory study designed to evaluate the impact on *Fundulus heteroclitus* of exposure to benzo[a]pyrene via aqueous, dietary and sediment uptake routes.

CURRENT STUDENTS

Cynthia A. Horton-Williams, M.A., (co-advisor with R. Huggett), Toxicologic and genetic aspects of acute toxicity resistance in a population of mummichog, *Fundulus heteroclitus*, inhabiting a creosote-contaminated site and exhibiting a high prevalence of cancer.

Susan L. Armknecht, M.A., (co-advisor with P. Van Veld), Quantitative evaluation of toxicity resistance to an algal toxin (nodularin) in a natural population of mummichog that has evolved a genetic resistance to the acute

toxicity of creosote. This study will examine the potential relationship between nodularin resistance and a P-glycoprotein-mediated drug efflux mechanism active in multi-drug resistance of tumors.

Laurent C. A. Mezin, M.A., (co-advisor with R. Hale), Morphometric assessment of changes in the mucus coat of mummichog, *Fundulus heteroclitus* exposed to creosote-contaminated sediments.

SELECTED PUBLICATIONS

Vogelbein, W. K. and J. W. Fournie. 1994. The ultrastructure of normal and neoplastic exocrine pancreas in the mummichog, *Fundulus heteroclitus*. *Toxicologic Pathology*, 22:248-260.

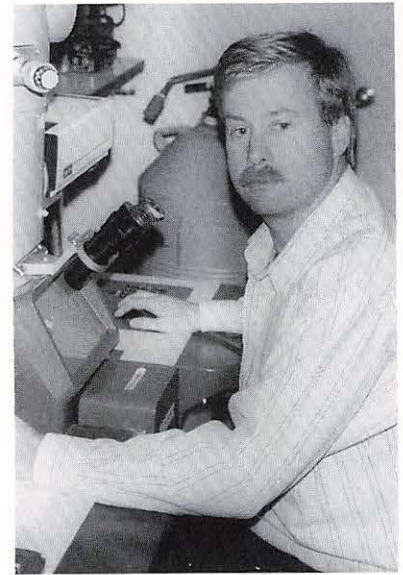
Fournie, J. W. and W. K. Vogelbein. 1994. Exocrine pancreatic neoplasms in the mummichog (*Fundulus heteroclitus*) from a creosote contaminated site. *Toxicologic Pathology*, 22:237-247.

Gassner, G., W. K. Vogelbein, and M. Line. 1992. Magnetic resonance detection of environmentally induced hepatic lesions in *Fundulus heteroclitus*. *Mar. Environ. Res.*, 34:7-10.

Van Veld, P. A., W. K. Vogelbein, R. Smolowitz, B. R. Woodin, and J. J. Stegman. 1992. Cytochrome P-4501A1 in hepatic lesions of a teleost fish (*Fundulus heteroclitus*) collected from a polycyclic aromatic hydrocarbon contaminated site. *Carcinogenesis*, 13:505-507.

Van Veld, P. A., U. Ko, W. K. Vogelbein, and D. J. Westbrook. 1991. Glutathione S-transferase in intestine, liver, and hepatic lesions of mummichog (*Fundulus heteroclitus*) from a creosote-contaminated environment. *Fish Physiol. Biochem.*, 9(4):369-376.

Vogelbein, W. K., J. W. Fournie, P. A. Van Veld and R. J. Huggett. 1990. Hepatic neoplasms in the mummichog *Fundulus heteroclitus* from a creosote-contaminated site. *Cancer Res.* 50:5978-5986.



Wolfgang K. Vogelbein

**Assistant Professor of
Marine Science**

**B.S., Southampton College;
M.S., California State University;
Ph.D., Louisiana State University**



Beverly A. Weeks-Perkins

Associate Professor of Marine Science

*B.A., Winthrop College;
M.S., Tulane University;
Ph.D., North Carolina State University*

RESEARCH INTERESTS

As an immunotoxicologist specializing in the study of aquatic organisms, I am interested in host-parasite interactions and disease resistance in fish and bivalves. My research efforts have concentrated on the effects of pollutants, such as polynuclear aromatic hydrocarbons, on cellular immune responses.

CURRENT PROJECTS

- Comparison of host resistance of the American oyster, *Crassostrea virginica* and the Pacific oyster, *Crassostrea gigas*, to the protozoan *Perkinsus marinus*.
- Investigation of the role of immunological mechanisms as distinguishing features of increased disease resistance in fish and oysters.
- Development of new techniques to study the effects of toxicant exposure on the formation of reactive oxygen species in fish phagocytes.

CURRENT STUDENT

Nantarika Chansue, Ph.D., Effects of pesticides on cellular immune responses in tiger shrimp.

SELECTED PUBLICATIONS

Weeks-Perkins, B. A. and A. E. Ellis. 1994. Chemotactic responses of Atlantic salmon (*Salmo salar*) macrophages to virulent and attenuated strains of *Aeromonas salmonicida*. *Fish Shellfish Immunol.*, (in press).

Kelly-Reay, K. and B. A. Weeks-Perkins. 1994. Determination of the macrophage chemiluminescent response in *Fundulus heteroclitus* as a function of pollution stress. *Fish Shellfish Immunology*, 4(2):95-105.

Bodhipakshs, N. and B. A. Weeks-Perkins. 1994. The effects of methyl parathion on phagocytosis and respiratory burst activity of tiger shrimp (*Penaeus monodon*). In: Modulators of Fish Immune Responses, J. S. Stolen and T. C. Fletcher, (eds.), SOS publications, Fair Haven, N.J., pp. 11-22.

Weeks, B. A., D. P. Anderson, A. J. Goven, A. Fairbrother, G. Peters, A. P. DuFour and G. P. Lahvis. 1992. Immunological biomarkers to assess environmental stress. In: Biomarkers: Biochemical, Physiological and Histological Markers of Anthropogenic Stress, R. J. Huggett, et al., (eds.), Lewis Publishers, Inc. Boca Raton, FL, pp. 211-234.

Seeley, K. R. and B. A. Weeks. 1991. Altered phagocytic activity of macrophages in oyster toadfish from a highly polluted subestuary. *J. Aquat. Anim. Health*, 3:224-227.

DEPARTMENTAL EQUIPMENT AND FACILITIES

The department has a wide range of modern equipment plus specialized facilities for animal maintenance and toxicity testing to support faculty and students. Shared equipment use among programs is common.

The chemistry laboratories are equipped to characterize organic chemicals in diverse matrices. Soxhlet extractors and a supercritical fluid extractor are used to prepare samples. Gel permeation chromatography is used for purification. Analytical instruments include HPLCs, an infrared spectrophotometer, and gas chromatographs equipped with flame ionization, electron capture, electrolytic conductivity, flame photometric, and thermionic specific detectors. A magnetic sector and two quadrupole instruments with electron ionization and chemical ionization capabilities are available. Samples are introduced by gas chromatograph, solids probe or fast atom bombardment.

The biology laboratories have light microscopes inverted microscopes, and a fluorescence microscope. The electron microscopy laboratory has a Zeiss CEM-902 Transmission Electron Microscope and an Amay 1000 Scanning Electron Microscope. Ancillary equipment includes an ultramicrotome, glass knife maker, critical point dryer, and a vacuum evaporator. The histopathology laboratory can conduct routine paraffin histology, high resolution light microscopy, plastic histology, and immunocytochemistry.

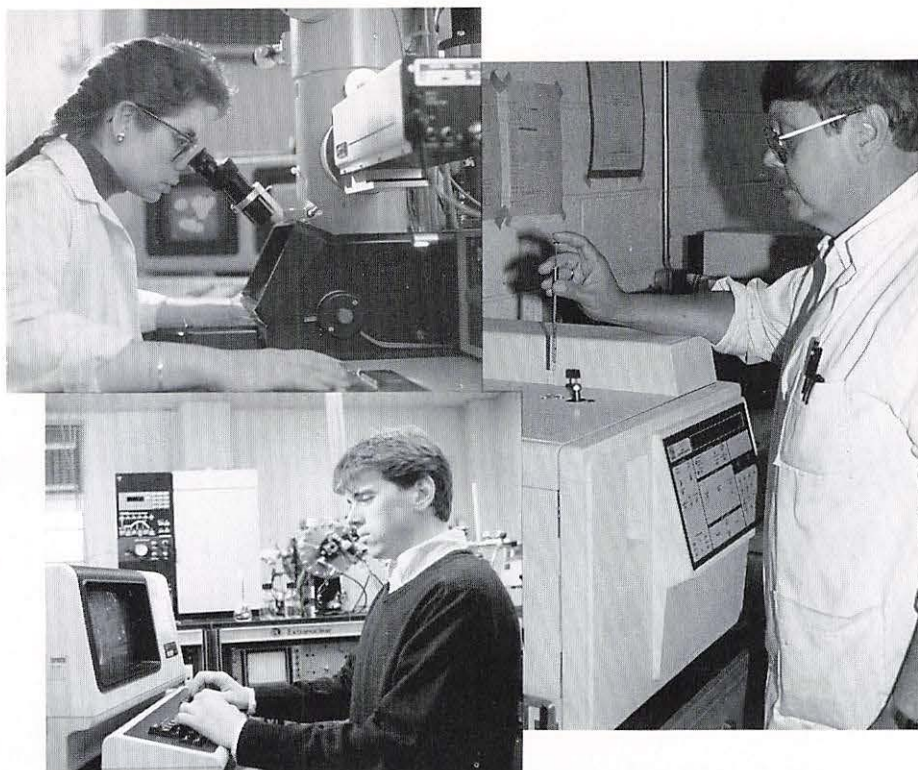
The immunology laboratories have laminar flow biosafety cabinets, dual chambered, CO₂ tissue culture incubators (37°C, 28°C and 17°C) and ultrapure water systems. Radiomet-

ric methods are supported by beta and gamma counters, and a radiomatic HPLC with radioisotope detector system. Also available are scanning densitometers, microplate readers, cell harvesters, a lipid analyzer, high speed refrigerated centrifuges, and equipment for IEF and 2-D electrophoresis and western blotting. A mouse colony is maintained for the production of monoclonal antibodies.

The biochemistry laboratory can analyze for various protein and enzyme systems involved in the biotransformation of toxic organic substances. Equipment for electrophoretic separation of proteins and nucleic acids, and immunoblot and radioimmune assays are included. Other equipment in this laboratory includes a dual beam UV/VIS scanning spectrophotometer, a liquid scintillation counter, and laser densitometer. A recently established

molecular biology laboratory is equipped with a high speed centrifuge, a thermocycler and associated equipment for performing the polymerase chain reaction, and sequencing apparatus.

A saltwater laboratory provides filtered estuarine water in sufficient quantities for static or flow through toxicity studies with toxic substances in sediment, suspended sediment or dissolved in water with serial dilution as needed. Circular and rectangular fiberglass tanks as well as glass aquaria are available for holding animals before and during testing. Culture facilities exist for invertebrates as well as fishes. A cold room houses a 1200 gal recirculating freshwater system to hold trout for the immunology group. A separate facility is available to maintain oysters and for producing *Perkinsus marinus* infected oysters.





ADMISSION POLICY

Applicants are encouraged to visit the campus and contact faculty members about specific research interests, funding opportunities, and program information. Admission to the School of Marine Science is highly competitive, and admissions procedures are designed to provide adequate information for objective evaluation by the faculty.

Applicants are required to submit:

- 1) One copy of the completed application form;
- 2) A non-refundable processing fee of \$20. This fee is not credited to the student's account;
- 3) Three 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); and
- 6) International students whose primary language is not English are required to submit GRE-TOFEL scores.

Requests for application forms as well as additional information should be directed to:

**Dean of Graduate Studies
School of Marine Science
Virginia Institute of Marine Science
College of William & Mary
P.O. Box 1346
Gloucester Point, VA 23062
(804) 642-7105
Fax (804) 642-7097**

GENERAL INFORMATION

Located in historic Tidewater Virginia, Gloucester Point is within 20 minutes of Williamsburg and Hampton/Newport News, Virginia. Major metropolitan areas of Norfolk, Virginia Beach, and Richmond are within easy driving distance. The semi-rural location offers diverse opportunities for outdoor activities from sailing, windsurfing, canoeing, and kayaking to biking, hiking, fresh and salt water fishing. SMS students may participate in a broad range of cultural and athletic activities on the nearby William & Mary campus.

A limited number of apartments for SMS graduate students are available on the William & Mary campus in Williamsburg. There are no housing facilities on the VIMS campus; however, most students live in Gloucester Point and surrounding communities. Rental housing is plentiful and rates are reasonable. It is advisable for students to have access to transportation as most living quarters are not within convenient walking distance of the campus.





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