bulletin of
Duke University
2002-2003
Nicholas School of the Environment
and Earth Sciences
Marine Laboratory
The Mission of Duke University

The founding Indenture of Duke University directed the members of the university to “develop our resources, increase our wisdom, and promote human happiness.”

To these ends, the mission of Duke University is to provide a superior liberal education to undergraduate students, attending not only to their intellectual growth but also to their development as adults committed to high ethical standards and full participation as leaders in their communities; to prepare future members of the learned professions for lives of skilled and ethical service by providing excellent graduate and professional education; to advance the frontiers of knowledge and contribute boldly to the international community of scholarship; to foster health and well-being through medical research and patient care; and to promote a sincere spirit of tolerance, a sense of the obligations and rewards of citizenship, and a commitment to learning, freedom, and truth.

By pursuing these objectives with vision and integrity, Duke University seeks to engage the mind, elevate the spirit, and stimulate the best effort of all who are associated with the university; to contribute in diverse ways to the local community, the state, the nation, and the world; and to attain and maintain a place of real leadership in all that we do.
The information in this bulletin applies to the academic year 2002-2003 and is accurate and current, to the extent possible, as of August 2001. The university reserves the right to change programs of study, academic requirements, teaching staff, the calendar, and other matters described herein without prior notice, in accordance with established procedures.

Duke University does not discriminate on the basis of race, color, national and ethnic origin, disability, sexual orientation or preference, gender, or age in the administration of educational policies, admission policies, financial aid, employment, or any other university program or activity. It admits qualified students to all the rights, privileges, programs, and activities generally accorded or made available to students. The university also does not tolerate harassment of any kind.

Questions, comments or complaints of discrimination or harassment should be directed to the Office of the Vice-President for Institutional Equity, (919) 684-8222. Further information, as well as the complete text of the harassment policy, may be found at http://www.duke.edu/~equity/.

Duke University recognizes and utilizes electronic mail as a medium for official communications. The university provides all students with e-mail accounts as well as access to e-mail services from public clusters if students do not have personal computers of their own. All students are expected to access their e-mail accounts on a regular basis to check for and respond as necessary to such communications, just as they currently do with paper/postal service mail.

Information that the university is required to make available under the Student Right to Know and Campus Security Acts may be obtained from the Office of University Relations at 684-2823 or in writing to 615 Chapel Drive, Box 90563, Duke University, Durham, North Carolina 27708.

Duke University is accredited by the Commission on Colleges of the Southern Association of Colleges and Schools (1866 Southern Lane, Decatur, Georgia 30033-4097; telephone number 404-679-4501) to award baccalaureates, masters, doctorates, and professional degrees.

**DUKE UNIVERSITY UNDERGRADUATE HONOR CODE**

An essential feature of Duke University is its commitment to integrity and ethical conduct. Duke's honor system helps to build trust among students and faculty and to maintain an academic community in which a code of values is shared. Instilling a sense of honor, and of high principles that extend to all facets of life, is an inherent aspect of a liberal education.

As a student and citizen of the Duke University Community:

- I will not lie, cheat, or steal in my academic endeavors.
- I will forthrightly oppose each and every instance of academic dishonesty.
- I will communicate directly with any person or persons I believe to have been dishonest. Such communication may be oral or written. Written communication may be signed or anonymous.
- I will give prompt written notification to the appropriate faculty member and to the Dean of Trinity College or the Dean of the School of Engineering when I observe academic dishonesty in any course.
- I will let my conscience guide my decision about whether my written report will name the person or persons I believe to have committed a violation of this code.
- I join the undergraduate student body of Duke University in a commitment to this Code of Honor.
Contents

University Administration 4
Marine Laboratory Administration 4
Academic Administration 4
Advisory Board 4
Support Staff 5
Duke/University of North Carolina Oceanographic Consortium Staff 5
Calendar 7

General Information
The Nicholas School of the Environment and Earth Sciences 8
The Marine Laboratory 9
Location and Natural Environment 10
The Beaufort Experience 10
Teaching and Research Facilities 10
Marine/Freshwater Biomedical Center 12
Duke/UNC Oceanographic Consortium 13
Marine Sciences Education Consortium 13

The Faculty

Programs of Study
General Information 22
Course Offerings 23
Beaufort to Bermuda Semester 24
Application for Enrollment 26
Programs at Duke that Relate to the Marine Laboratory 26
Undergraduate Degree Programs 26
Professional Degree Programs 27
Graduate Degree Programs 28
Integrated Toxicology Program 29

Admission and Registration
Fall and Spring Semester Programs 30
Summer Program 31
Immunization Requirement 33
Transcripts 33

Financial Information
Fall and Spring Semester Programs 34
Fall and Spring Refunds 35
Summer Program 36
Summer Refunds 38
Check Cashing 38
Financial Assistance 38

Additional Information for Visiting Scholars and Researchers 42
Course Descriptions 46
Application Forms 59

The 2002-2003 Marine Laboratory Bulletin is on the web at:
http://registrar.duke.edu/bulletins/Marinlab/
University Administration

GENERAL ADMINISTRATION

Nannerl Overholser Keohane, Ph.D., President
Peter Lange, Ph.D., Provost
Ralph Snyderman, M.D., Chancellor for Health Affairs and Executive Dean, School of Medicine
Tallman Trask III, M.B.A., Ph.D., Executive Vice-President
John F. Burness, A.B., Senior Vice-President for Public Affairs and Government Relations
John J. Piva, Jr., B.A., Senior Vice-President for Alumni Affairs and Development
H. Clint Davidson, Jr., M.B.A., Vice-President for Human Resources
Sally M. Dickson, J.D., Vice-President for Institutional Equity
Michael J. Mandl, M.A., Vice-President for Financial Services
Larry Moneta, Ed.D., Vice-President for Student Affairs
Thruston B. Morton III, B.A., President of Duke Management Company
Robert S. Shepard, Ph.D., Vice-President for University Development
N. Allison Haltom, A.B., Vice-President and University Secretary
David B. Adcock, J.D., University Counsel
R. Sanders Williams, M.D., Vice-Chancellor for Academic Affairs and Dean of the School of Medicine
William J. Donelan, M.S., Vice-Chancellor for Health Affairs and Executive Vice-President/Chief Financial Officer, Duke University Health System
Michael Israel, M.P.H., Vice-Chancellor for Health Affairs and Chief Executive Officer, Duke University Hospital
Steven Rum, M.S., Vice-Chancellor for Development and Alumni Affairs
Jean Gaillard Spaulding, M.D., Vice-Chancellor for Health Affairs
Robert L. Taber, Ph.D., Vice-Chancellor for Science and Technology Development
R.C. “Buckey” Waters, M.A., Vice-Chancellor for Special Projects
Gordon D. Williams, B.A., Vice-Chancellor for Medical Center Operations and Vice-Dean for Administration and Finance, School of Medicine
William H. Willimon, S.T.D., Dean of the Chapel
Joseph L. Alleva, M.B.A., Director of Athletics

Administration of the Nicholas School of the Environment and Earth Sciences Marine Laboratory

William H. Schlesinger, Dom
Michael K. Orbach, Director
Dan Rittschof, Assistant Director
Bruce H. Corliss, Director, Duke/University of North Carolina Oceanographic Consortium
Celia Bonaventura, Director, Marine/Freshwater Biomedical Center
Gail W. Cannon, Academic Services Manager
Dianne R. Gagnon, Departmental Business Manager
William D. Hunnings, Jr., Technical and Information Services Manager
Quentin M. Lewis, Jr., Marine Operations Manager
Howard L. Weckerle, Facilities Management Manager

Academic Administration

Michael K. Orbach, Ph.D., Professor in the Practice of Marine Affairs and Policy, Nicholas School of the Environment and Earth Sciences; Director, Marine Laboratory; and Director, Coastal Environmental Management Program
Daniel Rittschof, Ph.D., Associate Professor of Zoology; Assistant Director, Marine Laboratory; and Director of Graduate Studies–Nicholas School of the Environment and Earth Sciences
Richard B. Forward, Ph.D., Professor of Zoology and Director of Undergraduate Studies–Nicholas School of the Environment and Earth Sciences

Advisory Board

Elsa Ayers, Greensboro, North Carolina
James H. Bailey, Jr., Anchorage Marina, Atlantic Beach, North Carolina
Richard H. Biersly, Morehead City, North Carolina
Charles F. Blanchard, Blanchard, Jenkins & Miller PA, Raleigh, North Carolina
Lillian Wootten Bland, Goldsboro, North Carolina
Mabel Bugg, Raleigh, North Carolina
F. Nelson Blount Crisp, Blount & Crisp, Greenville, North Carolina
Hugh Cullman, Beaufort, North Carolina
Sylvia Earle, Deep Ocean Engineering, San Leandro, California
Robert W. Estill, Raleigh, North Carolina
John T. Garbutt, Jr., Durham, North Carolina
Cecil L. Goodnight, Carolina Power & Light Company, Raleigh, North Carolina
C. Howard Hardesty, Jr., Andrews & Kurth, Washington, D.C.
Robert G. Hardy, Cornerstone Ventures L.P., Houston, Texas
Mary Price Taylor Harrison, Beaufort, North Carolina
Susan Hudson, Wainwright Farms, Wilson, North Carolina
Sandra Taylor Kaupe, Palm Beach, Florida
William A. Lane, Jr., Dunspaugh-Dalton Foundation, Inc., Coral Gables, Florida
Henry O. Lineberger, Jr., Raleigh, North Carolina
Tom McMurray, Washington, D.C.
Elizabeth Thrower, Vero Beach, Florida, and Nantucket, Massachusetts
Stephen Wainwright, Durham, North Carolina
Wayne P. Wilbanks, Wilbanks, Smith & Thomas, Norfolk, Virginia (Chairman)

Support Staff
Timothy W. Boynton, Data Processing Specialist
Sean Connor, Chef/Manager
Claudia O. Davis, Housekeeper
Mamie Ellison, Housekeeper
Guilia Ferruzzi, Research Technician
Margaret J. Forward, Artist Illustrator
Hazel George, Food Service Aide
Dana L. Gillikin, General Maintenance Mechanic Senior
Paula Gillikin, Research Technician
Gerald O. Godette, Research Technician
Michael W. Golden, General Maintenance Mechanic Senior
Anna Hilting, Data Technician
Ellen D. Jones, Staff Assistant
Jamie Kelly, Research Technician
Donna M. Lynk, Staff Specialist
Catherine McClellan, Research Technician
Matia Michaelson, Administrative Secretary
W. Lanier Mitchum, Captain, R/V Susan Hudson
Stella Morris, Housekeeper
James M. Murray, Housekeeper
Sylvester Murray, Assistant Head Cook
Helen E. Nearing, Coordinator of Academic Programs
Linda Nichols, Staff Specialist
Olinda Nolen, Housekeeper
Patricia M. Nolin, Staff Specialist
Rick Patterson, General Maintenance Mechanic (C/L)
Jeffrey E. Priddy, Data Processing Specialist
Robin Siewers, Research Technician
David M. Talbert, Interim Librarian
Sophia D. Turnage, Staff Specialist
Danielle Waples, Research Technician
Belinda B. Williford, Staff Assistant to the Director, Marine Laboratory, and to the Chair of the Coastal Systems Science and Policy Division
Hugh C. Willis, Chief Mate, R/V Susan Hudson

Duke/University of North Carolina Oceanographic Consortium Staff
Bruce H. Corliss, Director of the Duke/University of North Carolina Oceanographic Consortium
Dwight B. Arrants, Diving Safety Officer/Marine Technician, R/V Cape Hatteras
Karen D. Ashley, Staff Specialist
Donny L. Baber, Cook/Messman, R/V Cape Hatteras
Robert A. Daniels, A.B. Seaman, R/V Cape Hatteras
Mitchell A. Dixon, First Assistant Engineer, R/V Cape Hatteras
Stephen E. Dixon, A.B. Seaman, R/V Cape Hatteras
Shae Keller, Marine Technician
Quentin M. Lewis, Jr., Marine Operations Manager
Robert J. Lipscomb, Steward/Cook, R/V Cape Hatteras
Larry N. Morris, Assistant Marine Superintendent/Second Mate, R/V Cape Hatteras
Dale H. Murphy, Chief Mate, R/V Cape Hatteras
John L. Nelson, Bosun, R/V Cape Hatteras
Richard C. Ogus, Master, R/V Cape Hatteras
Timothy G. Shaw, Marine Technician, R/V Cape Hatteras
Mark E. Smith, Chief Engineer, R/V Cape Hatteras
Joseph F. Ustach, Executive Officer
Marine Laboratory Calendar

Summer 2002
May 13—First summer term begins
June 14—First summer term ends
July 8—Second summer term begins
August 9—Second summer term ends

2002

August
26  Fall term begins

September
6  Drop/ Add ends

October
11-16 Fall break
30  Registration begins for spring semester, 2003

November
22  Registration ends for spring semester, 2003
23  Drop/ Add begins
27  Thanksgiving recess (begins at 12:40 p.m. Wednesday)

December
2  Classes resume at 8:00 a.m.
14  Fall term ends

2003

January
8  Spring term begins
22  Drop/ Add ends

February
28  Session 1 of Beaufort to Bermuda ends

March
13  Session 2 of Beaufort to Bermuda begins
26  Registration begins for fall semester, 2003

April
11  Registration ends for fall semester, 2003
19  Drop/ Add begins

May
3  Spring term ends
12  First summer term begins

June
13  First summer term ends

July
7  Second summer term begins

August
8  Second summer term ends

__________

1 The dates in the calendar are tentative and subject to change.
General Information
The Nicholas School of the Environment and Earth Sciences

Duke University's Nicholas School of the Environment and Earth Sciences is unique among American universities, offering a distinctive combination of multidisciplinary graduate and professional degree programs, as well as opportunities for undergraduate study and continuing professional education. Inaugurated in 1991, the Nicholas School of the Environment and Earth Sciences builds on Duke's historically strong base in environmental science, economics and policy, the marine sciences, forestry, and geology. It combines the Duke University Marine Laboratory (in the Division of Coastal Systems Science and Policy), Division of Earth and Ocean Sciences, and the former School of Forestry and Environmental Studies, all of which have established reputations for excellence dating from 1938.

The Duke Marine Laboratory

The Duke Marine Laboratory is both a campus of Duke University and a unit within the Nicholas School of the Environment and Earth Sciences. Its mission is education and research in basic ocean and coastal ecosystem processes, coastal environmental management and policy, marine biotechnology and marine biomedicine.

Programs at the Marine Laboratory are central to the Nicholas School of the Environment and Earth Sciences' mission to provide interdisciplinary educational and research opportunities addressing an area of vital concern—the quality of the Earth's environment and the sustainable use of its natural resources. Oceans dominate the Earth's surface and greatly affect daily life. Oceans regulate climate, play a critical role in the hydrologic cycle, sustain a large portion of the Earth's plant and animal species, supply food and mineral resources, and inspire the aesthetic nature of humankind. Ocean studies are central to the resolution of global environmental problems related to the impacts of humans on ecological systems, biodiversity, climate change, coastal land management, environmental quality, and environmental health.

During the 1930s, Dr. A. S. Pearse and colleagues from Duke University were attracted to Pivers Island and its surrounding abundance of marine life for their summer field studies. The island afforded an excellent location for a field station and through the subsequent efforts of Dr. Pearse and others, the land was acquired for the Duke University Marine Laboratory. By 1938 the first buildings were erected. Originally, the laboratory served only as a summer training and research facility. Today, the Marine Laboratory operates year-round to provide educational, training, and research opportunities to about 3,500 persons annually, including undergraduate, graduate and professional students enrolled in the university's academic programs; visiting student groups who use the laboratory's facilities; and scientists who come from North America and abroad to conduct research. A seminar/lecture series features many distinguished scientists from across the nation and abroad.

The resident faculty represent the disciplines of oceanography, marine biology, marine biomedicine, marine biotechnology, and coastal marine policy and management.

The Duke Marine Laboratory is a member of the National Association of Marine Laboratories (NAML), a nonprofit organization of over 90 members providing a variety of academic, research, and public service programs. These laboratories are unique...
"windows on the sea," providing information on the rich environmental mosaic of coastal habitats where land meets sea. Their "sense of place" encourages wise local land management and protection of our precious natural resources.

**Location and Natural Environment**

The Duke Marine Laboratory is situated on Pivers Island within the Outer Banks of North Carolina, only 150 yards across the channel from the historic town of Beaufort. A bridge connects the island with US Highway 70, making the laboratory readily accessible by automobile. Airline service via regional airports (New Bern, Kinston, and Jacksonville) is also available.

Beaufort is the third oldest town in the state and is surrounded by fishing and agricultural communities. The area is well known for its historic and scenic attractions as well as being a seaside resort. Cape Lookout National Seashore Park and the Rachel Carson Estuarine Research Reserve are within easy boating distance.

The area's system of barrier islands, sounds, and estuaries is rich in flora and fauna, and other diverse habitats, including rivers, creeks, mud flats, sand beaches, dunes, marshes, peat bogs, cypress swamps, bird islands, and coastal forests, making the area a haven for both nature lovers and those interested in the pursuit of marine science.

The laboratory is within range of both the temperate and tropical species of biota. The edge of the Gulf Stream oscillates between 30 and 40 miles offshore, with reefs on the wide continental shelf. A great variety of phytoplankton, seaweeds, seagrasses, and marsh grasses may be found in the area. Common animals include the blue crab, squid, shrimps, snails, clams, ctenophores, jellyfish, hydroids, sponges, polychaetes, sea urchins, starfish, brittle stars, sand dollars, skimmers, terns, gulls, herons, sea turtles, dolphins, and many species of fish. All provide ample opportunity for study and research and are readily accessible on foot, by car, or by boat.

The Beaufort-Morehead City area provides location for six other laboratories that collectively house one of the higher concentrations of marine scientists in the nation. These are the University of North Carolina's Institute of Marine Sciences, the Center for Marine and Science Technology, the North Carolina State University Seafood Laboratory, the North Carolina Aquarium at Bogue Banks, the North Carolina Division of Marine Fisheries, and the National Oceanic and Atmospheric Administration's National Marine Fisheries Service, Beaufort Laboratory. This concentration of marine scientists provides a critical mass for the pursuit of science and education.

**The Beaufort Experience**

The Marine Laboratory is an academic community, and the self-sufficient nature of its residential life serves well those who wish to study or to conduct research. The academic programs are limited to eighty students per regular academic semester (spring or fall) and one hundred per summer term, offering an unparalleled small-group learning experience. Although recreational opportunities are ample, the distractions are limited, allowing both student and researcher to become totally involved in the pursuit of marine science. Both students and researchers alike find that the Marine Laboratory has an invitingly open, friendly, and relaxed atmosphere that draws many back year after year. This community feeling, the potential for total immersion in learning, and the beauty of the natural environment have contributed to what is called "The Beaufort Experience."

**Teaching and Research Facilities**

The Marine Laboratory's modern physical plant consists of 23 buildings, including four dormitories, a large dining hall, one residence, a student commons, a storehouse for ship's gear, classroom laboratories, six research buildings, and a maintenance
complex. The Marine Laboratory operates the R/V Susan Hudson, a 57-foot fully-equipped coastal oceans research vessel, and is the home port for the R/V Cape Hatteras, a 135-foot oceanographic research vessel operated for the NSF by the Duke/University of North Carolina Oceanographic Consortium.

The laboratory also maintains an electronics shop, a workshop, a stockroom, and a purchasing department.

**Research Laboratories.** Each research laboratory building is air-conditioned and equipped with running seawater through a PVC system. There are tanks, water tables, aquaria, autolavves, ovens, and outdoor continuous-flow growth facilities. In addition to commonly used laboratory equipment, the following are available: refrigerated centrifuges, fluorometers, spectrophotometers, balances, pH meters, both compound and inverted microscopes equipped with cameras and Nomarski optics, both fume and laminar flow hoods, liquid scintillation counter, constant temperature equipment, and HPLC.

**Computing Facilities.** The Duke Marine Laboratory houses a Sun Sparc station as well as two Duke University public access clusters, MAC and IBM-PC, all connected to the Internet. Available for use are thirteen 586-based workstations and two MACs with word processing and statistics programs.

**I.E. Gray Library-Auditorium.** Located in the building are the 1,917-square-foot auditorium with stage, the library, one seminar room, and a Duke University public access computer cluster. The auditorium has a seating capacity of approximately 200 and is suitable for lectures, seminars, symposia, and small regional or national meetings. Inquiries concerning use of auditorium or seminar room space should be addressed to Dianne Gagnon (252) 504-7525 or drg@duke.edu.

**Library Facilities.** The Pearse Memorial Library, a branch library of the Duke library system, provides access to print and electronic resources that support interdisciplinary education and research with a primary focus on the marine environment. Electronic resources include online bibliographic databases for searching the scientific literature, a rapidly increasing number of online full-text journals, and the Duke online catalog. The library currently subscribes to 60 research journals and maintains holdings of approximately 23,000 volumes. An NT workstation with laser printing capability and a general access photocopier are provided for public use. Study space is available for approximately 30 individuals.

The library actively participates in interlibrary loan and document delivery arrangements with the triangle universities and other national and international academic institutions and research centers. Additional cooperative agreements exist with the National Ocean Service Center for Coastal Fisheries and Habitat Research, the University of North Carolina Institute of Marine Sciences, the University of North Carolina at Wilmington, and East Carolina University.

**Natural History Resource Center.** The Natural History Resource Center (NHRC) preserves and disseminates knowledge concerning ecological systems and the distribution and abundance of marine plants and animals. The center consists of an extensive reference collection of marine organisms (the museum), a library of taxonomic references and ecological publications, a large outdoor seawater facility, and a research laboratory designed to facilitate the collection, preservation and identification of marine organisms. The center provides students, researchers and lay persons with advice on the natural history of North Carolina's marine ecosystems. Dr. William Kirby-Smith is the director.

**Research Vessels.** The R/V Susan Hudson is USCG certified to carry passengers for hire to 100 miles. This 57-foot, welded aluminum vessel is powered by twin diesels to a speed of 16 knots. It is fully equipped for light duty oceanographic research, including an SHE 25 CTD with PAR meter, fluorometer and transmissometer. Funding from the National Science Foundation and the Office of Naval Research has provided for many research instruments that are available to visiting investigators. A marine technician is...
available to facilitate cruises. Inquiries concerning use of the research vessel should be directed to Karen D. Ashley (252) 504-7583 or karen.ashley@duke.edu.

Marine Laboratory students and researchers also have access to the R/V Cape Hatteras, operated for the NSF by the Duke/University of North Carolina Oceanographic Consortium.

MARINE/FRESHWATER BIOMEDICAL CENTER

The Marine/Freshwater Biomedical Sciences Center of Duke University is a problem-oriented center that is nationally and internationally recognized for its contributions to environmental health. It integrates unique facilities and faculty expertise available on the Beaufort and Durham campuses of Duke University and applies this powerful collective strength to challenging problems of human and environmental health significance, with a focus on the adverse effects associated with the toxicity of metals and free radicals. Research advances by center investigators increase the understanding of underlying toxic mechanisms, so that good human and environmental health choices can be made.

The center is distinguished by its record in biotechnology, its interdisciplinary programs, and its effectiveness in advancing marine and freshwater model systems for mechanistic studies. It is unique in its intellectual setting, providing a bridge between Duke's nationally recognized School of Medicine, Nicholas School of the Environment and Earth and Ocean Sciences, and the Marine Laboratory. In its physical setting it draws effectively on the institutes and industries of the Research Triangle of North Carolina. Through its interactive workshops and outreach efforts, the center communicates research findings on marine and freshwater aspects of environmental health problems to the clinical and research arms of the medical community, policymakers and the public at large.

The specific aims of the center are to:

- Support and enhance the distinctive mechanistic research programs of center investigators, drawing on the physical and intellectual resources of the Beaufort and Durham campuses of Duke University and other North Carolina institutions.
- Provide a cohesive framework for interdisciplinary interactions, information exchange and innovative technological development for improved environmental health research.
- Aid in the development and use of marine and freshwater model systems for mechanistic human and environmental health studies, with a focus on metal and free-radical toxicity.
- Enhance the application of state-of-the-art facilities and methodologies to both individual and collective environmental-health research programs.
- Provide community outreach and education that informs scientists, policymakers and the public at large about environmental health issues and research advances.

Feasibility studies are conducted to explore the advantages of various experimental approaches and to encourage innovative research.

Students interested in working with members of the center's participating faculty should direct their first inquiry to the Admissions Office, Duke Marine Laboratory, 135 Duke Marine Lab Road, Beaufort, North Carolina 28516-9721; telephone (252) 504-7502. It should be noted, however, that the center does not grant degrees. Graduate students are enrolled in the degree program of the respective department or school of their mentor.

Researchers may direct their inquiries to the office of the Marine/Freshwater Biomedical Center, telephone (252) 504-7591. Dr. Celia Bonaventura serves as center director.
DUKE/UNIVERSITY OF NORTH CAROLINA OCEANOGRAPHIC CONSORTIUM

The Duke/University of North Carolina Oceanographic Consortium operates a 135-foot oceanographic research vessel, the R/V Cape Hatteras. The ship operates both on the continental shelf and in the deep sea in the western North Atlantic, concentrating in the region between Nova Scotia and the Caribbean. The ship is a member of the academic research fleet supported by the National Science Foundation for the purpose of providing oceanographic research opportunities to investigators.

R/V Cape Hatteras is used for training at sea by the universities that make up the Oceanographic Consortium (Duke, North Carolina State, UNC-Chapel Hill, UNC-Wilmington, UNC-Greensboro, and East Carolina). The consortium also manages the acquisition and maintenance of oceanographic instrumentation used aboard R/V Cape Hatteras, and holds annual meetings of ocean sciences staff from member institutions at the Duke University Marine Laboratory. Inquiries concerning use of the research vessel should be directed to Quentin M. Lewis, Jr. (252) 504-7580 or quentin@duke.edu.

MARINE SCIENCES EDUCATION CONSORTIUM (MSEC)

The Marine Sciences Education Consortium (MSEC) was developed to provide a formal curriculum in the marine sciences, including supervised research, to member institutions. Such institutions are liberal arts colleges or universities attended by students who are preparing for careers in the marine sciences or who have a strong liberal arts interest in the oceans but for whom no specialized programs in the marine sciences are available. MSEC students have access to the spring, summer, and fall programs at the Duke Marine Laboratory.

Currently, member institutions include Albright College, Allegheny College, Augustana College, Denison University, the Five Colleges Coastal and Marine Sciences Program (Amherst College, Hampshire College, Mount Holyoke College, Smith College, and the University of Massachusetts), Furman University, Gettysburg College, Hampden-Sydney College, Hood College, Ithaca College, Juniata College, Kenyon College, Lees-McRae College, Macalester College, Miami University, North Carolina State University, University of Notre Dame, Oberlin College, Presbyterian College, University of Richmond, Trinity College, Washington and Lee University, Wittenberg University, and the College of Wooster.

Members join upon invitation and mutual agreement. Inquiries from interested institutions are welcome and requests to join the MSEC will be considered. Such inquiries should be addressed to the Director, Duke University Marine Laboratory, 135 Duke Marine Lab Road, Beaufort, North Carolina 28516-9721.
The Faculty and Their Programs

The faculty of the Marine Laboratory have primary appointments in the Division of Coastal Systems Science and Policy (CSSP) within the Nicholas School of Environment and Earth Sciences at Duke University. Faculty members from other divisions of the school that have linkage to the Marine Laboratory hold secondary appointments. Coastal Systems Science and Policy addresses both basic and applied sciences and the application of that science to the rapidly increasing problems of the coastal and marine environments.

Richard T. Barber, Ph.D., Harvey W. Smith Professor of Biological Oceanography, Nicholas School of the Environment and Earth Sciences; B.S., Zoology and Botany, Utah State University; Ph.D., Biological Science, Stanford University.

Dr. Barber’s research investigates the interrelationship of large-scale thermal dynamics and ocean basin productivity, emphasizing (1) how biological and physical processes contribute to the exchange of carbon dioxide between the ocean and the atmosphere and (2) how the “biological pump” transfers carbon into the deep sea. He also investigates the role of a single micronutrient, iron, in the regulation of primary production and the outbreak of marine diseases and harmful algal blooms.


Celia Bonaventura, Ph.D., Professor of Cell Biology, Nicholas School of the Environment and Earth Sciences; B.A., Zoology, San Diego State University; Ph.D., Biochemistry, University of Texas, Austin.

Structure/function relationships of oxygen and electron-transport proteins continues to be Dr. Celia Bonaventura's primary area of research, with an increasing focus on environmental perturbations of structure and function. Her research makes use of structural assays and complementary measurements of rapid reaction kinetics and equilibria of red cells and hemoglobin, using UV/VIS and fluorescence spectroscopy and novel methods of spectroelectrochemistry. Her work has led to an increased understanding of molecular adaptations in the respiratory proteins. She is currently gathering base-line data on arthropod and molluscan hemocyanins and on hemoglobins isolated from finfish (bluefish, spot and trout) and from marine mammals (manatees and bottlenose dolphins). Her comparative studies with hemoglobins, hemocyanins and cytochrome c oxidase isolated from marine organisms illustrate aspects of environmental toxicity associated with exposure to free radicals and metals. Representative papers are listed below.


Larry B. Crowder, Ph.D., Stephen Toth Professor of Marine Biology, Nicholas School of the Environment and Earth Sciences; B.A. Biology and Mathematics, California State University-Fresno; M.S., Ph.D., Zoology, Michigan State University.

Dr. Crowder’s research centers on predation and food web interactions, mechanisms underlying recruitment variation in fishes, and on population modeling in conservation biology. He has studied food web processes in estuaries and lakes and has used observational, experimental and modeling approaches to understand these interactions in an effort to improve fisheries management. He co-directed the South Atlantic Bight Recruitment Experiment (SABRE) and continues to conduct research on the life histories of estuarine-dependent fishes. He continues to conduct model and statistical analysis to assist in endangered species management for both aquatic (sea turtles) and terrestrial species (red-cockaded woodpeckers). Recently he has begun developing more extensive programs in marine conservation including research on bycatch, nutrients and low oxygen, marine invasive species and integrated ecosystem management.


Richard B. Forward, Ph.D., Lee Hill Snowden Professor of Zoology, Nicholas School of the Environment and Earth Sciences; B.S., Biology, Stanford University; Ph.D., Biology, University of California, Santa Barbara.

Dr. Forward and his students investigate the behavior and physiology of estuarine and coastal zooplankton. This includes the photobehavior, photophysiology, biological rhythms, diel vertical migration, and horizontal migration of crustacean and fish larvae. Laboratory studies determine the effects of temperature, salinity, and feeding on phototaxis and geotaxis, salinity perception, and polarized light perception. Field studies have looked at horizontal and vertical distributions as related to environmental factors. Recent studies involve the cues for metamorphosis of crustaceans and the behavior underlying selective tidal-stream transport of crustaceans.


The Faculty and Their Programs 17
William W. Kirby-Smith, Ph.D., Associate Professor in the Practice of Marine Ecology, Nicholas School of the Environment and Earth Sciences; B.S., Biology, University of the South; Ph.D., Zoology, Duke University.

Dr. Kirby-Smith's research interests involve marine ecology and invertebrate zoology. His recent research projects include the following: (1) ecology of rock outcrop communities on the continental shelf; (2) effects of salt marsh modifications on plant, invertebrate, fish and bird communities; (3) influence of pine plantation drainage on water quality and benthic invertebrates in receiving estuarine headwaters; (4) effects of agricultural development upon hydrology, water quality and biology in estuarine headwaters; and (5) the fate of fecal coliform bacteria in storm water runoff and estuarine headwaters. Additional research interests include the physiology of suspension feeding and its ecological consequences in estuaries.


David R. McClay, Jr., Ph.D., Professor of Zoology, Neurobiology, and Immunology; B.S., Zoology, Pennsylvania State University; M.S., Zoology, University of Vermont; Ph.D., Zoology, University of North Carolina, Chapel Hill. [Resident on the Durham campus.]

Three areas of major focus of our work have been: 1) to study mechanisms of fertilization using the sea urchin egg as a model system. We have noticed that heavy metals block specific steps in the fertilization sequence. This has given us a targeted approach to study specific molecular steps in that sequence. 2) We are examining contributions of cell adhesion during two important morphogenetic cell rearrangements in embryos. At gastrulation there is a dramatic series of molecular changes in adherens junctions and focal contacts in mesoderm cells. At ingressation these cells switch adhesive structures and invade the blastocoel. Later, endoderm cells rearrange to form the archenteron, and in the process both adherens junctions and focal contacts are altered. We have cloned cadherins, catenins, moesin and integrins to study these rapid morphogenetic changes that involve an epithelial-mesenchymal cell conversion and convergent-extension cell rearrangements. These studies focus on the sequence of events involved in that switch from an epithelial cell to a mesenchymal cell, and in the sequence through which the primitive gut is formed. 3) We study the number of cell signaling events that have been associated with cell rearrangements and pattern formation early in sea urchin development. The cell-signaling contributions of ß-catenin, and Notch are being studied in molecular detail. These molecules, through their signaling pathways, transmit inductive signals that control early lineage specification events and later morphogenetic properties.


Patricia D. McClellan-Green, Ph.D., Research Scientist, Nicholas School of the Environment and Earth Sciences and Assistant Research Professor, Department of Environmental and Molecular Toxicology, N. C. State University; B.S., M.S., Biology, East Carolina University; Ph.D., Toxicology, North Carolina State University.

Dr. McClellan-Green’s research focuses on the study of natural and man-made toxins in the marine environment and their effects on the metabolic activities of marine organisms. Her current research projects include (1) examination of the molecular and biochemical pathways involved in endocrine disruption, (2) determining the mechanisms of PAH and PCB mediated gene regulation in fish and other organisms, (3) the isolation and characterization of various cytochrome P450s in marine species, and (4) the effects of marine dinoflagellate toxins on cellular metabolism.


Michael K. Orbach, Ph.D., Professor of the Practice of Marine Affairs and Policy, Nicholas School of the Environment and Earth Sciences; B.A., Economics, University of California, Irvine; M.A., Ph.D., Cultural Anthropology, University of California, San Diego.

Dr. Orbach’s research interests are in the application of social and policy sciences to coastal and ocean policy and management. His work uses a cultural, or human, ecology perspective to analyze human behavior in coastal and ocean environments. His current research projects include (1) the development and application of limited entry and effort management systems to marine fisheries; (2) the formation and socioeconomic impact of marine minerals policy; (3) marinemammal and endangered species-fisheries conflicts; and (4) citizen involvement in coastal and ocean policy. Dr. Orbach specializes in the application of social science to the policy and management process.


Joseph S. Ramus, Ph.D., Professor of Biological Oceanography, Nicholas School of the Environment and Earth Sciences; A.B., Ph.D., Botany, University of California, Berkeley.

Dr. Ramus's research includes the study of natural and anthropogenic forcing of phytoplankton biomass, productivity and community structure in coastal plains estuaries. The research seeks a match between ecological response and the temporal frequency of physical drivers, the phasing of phytoplankton dynamics with external oscillators. The temporal frequencies of particular interest are the synoptic (weather fronts) and event (nor'easters and hurricanes) scales. These scales are being captured with fully automated sensing of relevant properties from ferries plying routes on the Pamlico Sound, its tributaries and inlets, the FerryMon program. Of special interest is the impact of land use change and management action on ecological response relative to natural perturbation.


Andrew J. Read, Ph.D. Rachel Carson Assistant Professor of Marine Conservation Biology, Nicholas School of the Environment and Earth Sciences.

B.Sc., M.Sc., Ph.D., Zoology, University of Guelph.

Dr. Read's research interests are in the ecology and conservation biology of marine mammals. His work focuses on how dolphins and porpoises obtain prey in a three-dimensional environment and how energy is partitioned among the competing demands of growth, maintenance and reproduction. Dr. Read also studies the impacts of human activities on populations of marine mammals and attempts to find solutions to such conflicts, particularly between marine mammals and commercial fisheries. This work involves examination of the behavior of animals around nets, modification of fishing practices to reduce mortality, and demographic analyses of the effects of removals. He is particularly interested in the development and application of new conservation tools to resolve such conflicts.


Daniel Rittschof, Ph.D., Associate Professor of Zoology, Nicholas School of the Environment and Earth Sciences; B.S., Ph.D., Zoology, University of Michigan.

Dr. Rittschof's research interests involve chemical communication systems. His studies include external and internal molecular mediation of behavior (chemical ecology). The driving theme of the work is the evolution of chemical communication systems and their components. At present, test systems are marine and include crustaceans (true crabs, hermit crabs and barnacles), molluscs and fish. Studies span the gamut from practical (nontoxic antifouling coatings, fish
foods and fish feeding stimulants) to purely basic (larval release pheromones, designer peptides with biological activity, hermit crab shell attractant cues, hormonal control of feeding behavior, and enzymatic activities in crustacean and gastropod saliva).


General Information

In today's competitive world, students seek education not only for self-enrichment, but also for career enhancement. Ocean studies can fulfill both needs. The orderly exploitation of the earth's remaining frontier, the oceans, requires not only marine scientists, but increasingly requires managerial, legal, business, and political leaders who understand the oceans. Exploration and research must now be complemented by development, regulation, and conservation.

The programs of study offered at the Duke University Marine Laboratory serve undergraduate majors in the natural sciences or environmental sciences and policy, as well as other undergraduates who have an interest in these areas of study and who have adequate preparation. The semester programs (fall and spring) and summer term courses are open to qualified undergraduates, graduate students, and individuals who already hold an undergraduate or graduate degree. The academic programs are not open to high school students. Students from any college or university may apply. For participation in a semester program, it is advised that students have completed introductory college courses in biology, chemistry, and mathematics before attending. Prerequisites are specified in the individual course descriptions.

Graduate students may also participate in the fall or spring semesters and summer terms. The 200-level courses are intended for graduate and advanced undergraduate students.

The programs provide students with an opportunity to live and study at the Duke Marine Laboratory year-round. The programs emphasize small class size, independent research, and integrated classroom, laboratory, and field experience. Students have daily access to a specialized faculty, modern scientific equipment, and the surrounding natural marine environment.

Over the last six decades, approximately 5,000 students from over 300 institutions of higher learning have taken course work at the Duke University Marine Laboratory. Thousands more have utilized the laboratory's facilities for field trips.

Inquiries concerning the programs of study at the Marine Laboratory may be addressed to: Admissions Office, Duke University Marine Laboratory, 135 Duke Marine Lab Road, Beaufort North Carolina 28516-9721; telephone 252-504-7502 or ml_admissions@env.duke.edu. Also please see the Marine Lab's web page for more information: http://www.env.duke.edu/marinelab/. The Director of Undergraduate Studies and the Director of Graduate Studies are available for consultation.

Course Offerings

The following lists courses normally taught at the laboratory during the designated semester or summer term. For course descriptions and credits, see the course section of this bulletin. Courses numbered 100 to 199 are undergraduate courses. Courses numbered 200 and above are graduate level; however, some 200-level courses are open to undergraduates. Laboratory courses are designated with an (L) appended to the course number; seminars are normally designated with an (S); exceptions, however, occur. Because course offerings are subject to change, students should consult the university course schedule before registration.
THE BEAUFORT TO BERMUDA SEMESTER

The Duke Marine Laboratory (Beaufort, N.C.) in partnership with the Bermuda Biological Station for Research (Ferry Reach, Bermuda) offers a one-semester international study in environmental science and policy at two distinctive locations: Beaufort in the North Carolina barrier islands with its marshlands, estuaries, continental shelf, and the Gulf Stream; Bermuda with its coral reefs and subtropical mid-ocean environment in the Sargasso Sea. Emphasis is placed on the rigorous application of the natural and social sciences to the contrasting marine ecosystems and to basic processes and human interventions in the coastal and oceanic systems. The program draws from two marine laboratory traditions in experiential learning for undergraduates and from the expertise of two resident faculties.

The program occurs only during the spring semester and is designed for undergraduates and graduates who have adequate preparation in the natural and social sciences. Students reside at each campus for one-half semester. During the compressed seven-week session at each campus, they take two intensive courses selected from the curriculum offered at each campus. One group begins the program in Beaufort; the other in Bermuda. At mid-semester the groups trade campuses. Enrollment is limited. Early application is strongly recommended.

For further information, contact the Admissions Office (252/ 504-7502, ml admissions@env.duke.edu) or the Beaufort-2-Bermuda web page http://www.env.duke.edu/marinela bermpg1.html.
FALL SEMESTER

Conservation Biology and Policy (BIOLOGY 109/ ENVIRON 209)
Analysis of Ocean Ecosystems (BIOLOGY 123/ ENVIRON 293)
Marine Mammals (BIOLOGY 126/ ENVIRON 226)
Marine Ecology (BIOLOGY 129L/ BIOLOGY 203L/ ENVIRON 219L)
Physiology of Marine Animals (BIOLOGY 150L/ BIOLOGY 253L/ ENVIRON 228L)
Marine Invertebrate Zoology (BIOLOGY 176L/ BIOLOGY 274L/ ENVIRON 295L)
Coastal Ecosystem Processes (BIOLOGY 219L/ ENVIRON 224L)
Environmental Biochemistry (CELLBIO 243/ ENVIRON 243)
Seminar in Ocean Sciences (ENVIRON 256S)
Marine Policy (ENVIRON 276/ PUBPOL 197)
Modern and Ancient Oceanic Environments (EOS 113/ 213)
General Physics (PHYSICS 53L)
Research Independent Study (BIOLOGY 297, 298; ENVIRON/ EOS 191/ CELLBIO 210)
Tutorials (BIOLOGY 193T)
Independent Study for Nonmajors (EOS 195)
Graduate research and tutorial courses in various departments are also available.

SPRING SEMESTER

Beaufort Courses

Biological Oceanography (BIOLOGY 114L/ ENVIRON 292L)
Sensory Physiology and Behavior of Marine Animals (BIOLOGY 156L/ ENVIRON 253L)
Marine Invertebrate Zoology (BIOLOGY 176L/ BIOLOGY 274L/ ENVIRON 295L)
Human Impact on the Natural Environment (BIOLOGY 295S)
The Biology of Nitric Oxide: A Global Perspective (BIOLOGY 295S)
Estuarine Ecosystem Processes (ENVIRON 208)
Coastal Ecotoxicology and Pollution (ENVIRON 225L)
Seminar in Ocean Sciences (ENVIRON 256S)
Conservation Biology of Marine Mammals (ENVIRON 267S)
Marine Fisheries Policy (ENVIRON 273)
Professional Writing and Self-editing (ENVIRON 298.09)
Seminar in Coastal Environmental Management (ENVIRON 298.02)
Beach and Island Geological Processes (EOS 202)
Research Independent Study (BIOLOGY 297, 298; ENVIRON/ EOS 192/ CELLBIO 210) Student must remain in Beaufort the entire term.
Tutorials (BIOLOGY 193T)
Graduate research and tutorial courses in various departments are also available.

Bermuda courses

Biological Oceanography (BIOLOGY 114L/ ENVIRON 292L)
Marine Microbial Ecology (BIOLOGY 127L)
Marine Ecology (BIOLOGY 129L/ BIOLOGY 203L/ ENVIRON 219L)
Marine Biodiversity (BIOLOGY 132S)
Molecular Approaches to Questions of Physiology, Ecology and Evolution in the Marine Environment (BIOLOGY 133S/ ENVIRON 133S)
Marine Invertebrate Zoology (BIOLOGY 176L/ BIOLOGY 274L/ ENVIRON 295L)
Climate Change: A Global Perspective (ENVIRON 121)
Climate Related Hazards and Humanity (ENVIRON 122S)
Remote Sensing and Long-term Environmental Monitoring (ENVIRON 125)
Current Topics in Oceanography and Marine Biology (ENVIRON 132S)
A Scientist’s Perspective on Environmental Principles, Policy, and Legislation (ENVIRON 140)
FIRST SUMMER TERM
Marine Biology (BIOLOGY 10L)
Biological Oceanography (BIOLOGY 114L/ ENVIRON 292L)
Physiology of Marine Animals (BIOLOGY 150L/ BIOLOGY 253L/ ENVIRON 228L)
Biochemistry of Marine Animals (BIOLOGY 155L/ BIOLOGY 255L/ ENVIRON 229L)
Marine Invertebrate Zoology (BIOLOGY 176L/ BIOLOGY 274L/ ENVIRON 295L)
Field Botany (BIOLOGY 241L)
Molecular and Cellular Processes in Marine Organisms (CELLBIO 244L/ ENVIRON 244L)
General Physics (PHY 53L)
Research Independent Study (BIOLOGY 297,298; ENVIRON/EOS 191/CELLBIO 210)
Tutorials (BIOLOGY 193T)
Graduate research and tutorial courses in various departments are also available.

SECOND SUMMER TERM
Conservation Biology and Policy (BIOLOGY 109/ ENVIRON 209)
Biology and Conservation of Sea Turtles (BIOLOGY 125L/ ENVIRON 227L)
Marine Mammals (BIOLOGY 126L/ ENVIRON 226L)
Marine Ecology (BIOLOGY 129L/ BIOLOGY 203L/ ENVIRON 219L)
Marine Invertebrate Zoology (BIOLOGY 176L/ BIOLOGY 274L/ ENVIRON 295L)
Barrier Island Ecology (BIOLOGY 218L/ ENVIRON 218L)
Marine Policy (ENVIRON 276/PUBPOL 197)
Research Independent Study (BIOLOGY 297,298; ENVIRON/EOS 192/CELLBIO 210)
Tutorials (BIOLOGY 193T)
Graduate research and tutorial courses in various departments are also available.
Additional courses may be offered.

Application for Enrollment
Application forms for enrollment in semester programs or summer terms at the Marine Laboratory are found at the back of this publication or online at http://www.env.duke.edu/marinelab/mlforms.html. Admission to Marine Laboratory programs does not constitute admission to undergraduate, professional, or graduate degree programs at Duke University. For further information, see the chapter on admission and financial aid in this bulletin.

Students seeking admission to degree programs at Duke should write or call the appropriate school or department admissions office.

Programs Offered at Duke that Relate to the Marine Laboratory

UNDERGRADUATE DEGREE PROGRAMS
Information and application materials on undergraduate degree programs offered at Duke are found in the Bulletin of Information for Prospective Students and the Bulletin of Duke University-Undergraduate Instruction, including information on available majors and financial aid. To obtain application materials and information, contact: Office of Undergraduate Admissions, 2138 Campus Drive, Duke University, Box 90586, Durham, North Carolina 27708-0586; telephone 919-684-3214.

Undergraduate majors that relate to ocean studies are listed below and detailed in the Bulletin of Duke University-Undergraduate Instruction; additional information is also available as follows:
Biology Major. (An area of concentration in marine biology may include a semester or summer session at Duke Marine Laboratory): Director of Undergraduate Studies in Biology, Biological Sciences Building, Duke University, Box 90324, Durham, North Carolina 27708-0324; telephone 919-660-7320.

NOTE: Duke students are directed to literature in the Office of Undergraduate Studies, Biology Major Program (Biological Sciences Building) for information about requirements fulfilled by courses at the Marine Laboratory for the biology major.

Environmental Sciences and Policy Major. (Field experiences may include a semester or summer session at Duke Marine Laboratory): Director of Undergraduate Studies, Nicholas School of the Environment and Earth Sciences, A134 Levine Science Research Center, Duke University, Box 90328, Durham, North Carolina 27708-0328; telephone 919-613-8060.

Earth and Ocean Sciences Major. A course track in the Earth and Ocean Sciences major can be tailored to student’s interests in the areas of coastal processes, marine geology, or oceanography. Director of Undergraduate Studies, Division of Earth and Ocean Sciences, Old Chemistry Building, Duke University, Box 90230, Durham, North Carolina 27708-0230; telephone 919/684-5902; web site http://www.eos.duke.edu.

PROFESSIONAL DEGREE PROGRAMS
The Nicholas School of the Environment and Earth Sciences offers a Master of Environmental Management (M.E.M.) degree with a program concentration in Coastal Environmental Management described below. Additionally, students in other professional degree programs within the Nicholas School of the Environment and Earth Sciences often take courses offered at the Marine Laboratory.

Professional Program Applications: Enrollment Services, Nicholas School of the Environment and Earth Sciences, A142 Levine Science Research Center, Duke University, Box 90330, Durham, North Carolina 27708-0330; telephone 919-613-8070.

Coastal Environmental Management
The Coastal Environmental Management program is offered under the Master of Environmental Management degree. The program provides an educational background in ocean science and coastal ecosystems and in natural resources and environmental policy as it applies to coastal and marine issues. Students may use electives and additional course work to accommodate a second emphasis in one of the other program concentrations offered within the school.

The program provides a scientifically rigorous understanding of global, national, and local physical and biological coastal environments and processes and the human behaviors and policies that affect, and are affected by, those environments and processes. The specific aim of the program is to train scientifically informed professionals to fill coastal policy and management, research, or advocacy positions in federal and state agencies, industry, consulting firms, and nonprofit organizations. The program also provides a firm foundation for future Ph.D. studies.

The first year of the program is usually spent on the Durham campus fulfilling the required courses in areas such as natural resource economics, general environmental policy, ecology, and methodological skills. The second year is usually spent in residence at the Duke Marine Laboratory in Beaufort taking courses in the natural, social and policy sciences specific to the coastal and marine environment, and focusing on the production of the master’s project. The Marine Laboratory provides an ideal setting for the study of natural and social scientific phenomena in the coastal and marine environment, and for interaction with coastal and marine constituencies and policy makers in the application of science to policy. Potentials for participation in the policy-making process are emphasized throughout the program.
Core Courses. ENVIRON 270L Resource and Environmental Economics; ENVIRON 276 Marine Policy; one additional policy course; one ecology course; and two ocean science courses.

Coastal Environmental Management Program Information. Dr. Michael K. Orbach, Director, Coastal Environmental Management Program, or Gail Cannon, Program Coordinator, Duke University Marine Laboratory, 135 Duke Marine Lab Road, Beaufort, North Carolina 28516-9721; telephone (252) 504-7605; gcannon@duke.edu. Web address http://www.env.duke.edu/marinelab/mlgrmem.html.

GRADUATE DEGREE PROGRAMS

Graduate students from all academic disciplines are encouraged to study at the Marine Laboratory year-round. Graduate degree candidates may take advantage of course work in the marine sciences as well as coastal and marine policy, an active seminar program, and facilities supporting dissertation research.

Resident graduate students may represent the Department of Biology, Department of Cell Biology, Department of Earth and Ocean Sciences, and Department of the Environment as well as the Toxicology and Ecology Programs. Ordinarily, dissertation advisors are resident as well. Although residency of the advisor is not necessary to study at the Marine Laboratory, sources of funding are contingent upon having an advisor from the laboratory’s resident faculty. Students in graduate programs may elect to spend one year or more at the Durham campus before taking residence at the Marine Laboratory; however, residence in Durham is not a requirement.

The Marine Laboratory awards 9-month fellowships which pay a stipend, tuition, and fees. Some fellowships require students to serve as a teaching assistant for two courses for each academic year’s payment. Tuition credits obtained from fellowship support may be applied to courses given both at the Marine Laboratory and the Durham campus, regular semesters and summer terms.

Application should be made through the Graduate School to the relevant department or program. Additional information is available from the director of graduate studies in the department of interest (see below), as well as from the director of graduate studies at the Marine Laboratory. Also, consult the current Duke Graduate School Bulletin of Information for Graduate Studies, the Bulletin of Duke University-Graduate School, and the Bulletin of Duke University-Medical School.

Within the Duke Graduate School, specialization in marine science may be conducted through the following departments: Biology (Ph.D.; A.M. or M.S. degree may be taken by students en route to the Ph.D.), Cell Biology (Ph.D.); and Environment (Ph.D.; M.S. available as part of a Ph.D. program; Ph.D. may include focus on coastal and marine policy).

Graduate School Applications. Office of Graduate Admissions, Graduate School, 127 Allen Building, Duke University, Box 90063, Durham, North Carolina 27708-0063; telephone 919-684-3913 or www.gradschool.duke.edu.

For further information on Graduate Programs:

Biology. Director of Graduate Studies, Department of Biology, 104 Biological Sciences Building, Duke University, Box 90338, Durham, North Carolina 27708-0338; telephone 919-684-3649.

Cell Biology. Director of Graduate Studies, Department of Cell Biology, Duke University Medical Center, Box 3011, Durham, North Carolina 27710; telephone 919-684-5465.

Earth and Ocean Sciences. Director of Graduate Studies, Division of Earth and Ocean Sciences, Duke University, Box 90230, Durham, North Carolina 27708-0230; telephone 919-681-8077.
**Ecology Program.** Director, Ecology Program, Duke University, Box 90340, Durham, North Carolina 27708-0340; telephone 919-660-7400.

**Environment.** Director of Graduate Studies, Nicholas School of the Environment and Earth Sciences, A 308 Levine Science Research Center, Duke University, Box 90328, Durham, North Carolina 27708-0328; telephone 919-613-8002.

**Marine Laboratory.** Director of Graduate Studies, Duke University Marine Laboratory, 135 Duke Marine Lab Road, Beaufort, North Carolina 28516-9721; telephone 252-504-7502.

**Integrated Toxicology Program.** Director, Integrated Toxicology Program, Box 90328, Duke University, Durham North Carolina 27708-0328; telephone 919-613-8024, richd@duke.edu or visit the ITP website http://www.duke.edu/web/toxicology/.

**INTEGRATED TOXICOLOGY PROGRAM**

Duke University offers an interdisciplinary doctoral and postdoctoral program in biomedical and environmental toxicology with the Integrated Toxicology Program (ITP). ITP faculty represent the Departments of Biochemistry, Cellular and Molecular Biology, Chemistry, Medicine, Neurobiology, Pathology, Pharmacology, Psychiatry, Psychology, and the Nicholas School of the Environment and Earth Sciences (Durham and Marine Laboratory campuses). Students seeking admission to the program as a Ph.D. candidate make initial application to the Graduate School for admission to a specific department and indicate on their application the Integrated Toxicology Program for special field. For further information contact Dr. Richard T. Di Giulio phone (919/613-8024) richd@duke.edu or visit the ITP website http://www.duke.edu/web/toxicology/.

Research in environmental toxicology in the Nicholas School of the Environment and Earth Sciences focuses on molecular and biochemical aspects of pollutant metabolism, adaptation, and modes of toxic action. The majority of this work employs freshwater, marine, and terrestrial organisms as toxicological models. The goals are to achieve fundamental understanding of processes governing the fates and effects of contaminants in ecosystems, and to elucidate linkages between ecosystem and human health. Training in environmental toxicology is available to professional students through the Master of Environmental Management (M.E.M.) program in Environmental Toxicology, Chemistry and Risk Assessment in the Nicholas School of the Environment and Earth Sciences.
Admission and Registration
Fall and Spring Semester Programs

The semester programs are designed for qualified college undergraduate and graduate students who wish to enroll in courses offered during the spring or fall. Students from any college or university may apply. Students intending to apply to the semester programs should have completed college courses in introductory biology, chemistry, and mathematics. Applications should be received by December 1 for spring semester, by April 1 for fall semester and one month before each summer session. Applications are considered in the order in which they arrive and will be considered after the deadline if space is available.

For undergraduates, a full program of study ordinarily consists of courses totaling four course credits.

SEMESTER PROGRAM ADMISSION

Duke Undergraduate Students. Duke students must submit the semester program application (found at the back of this publication or online at http://www.env.duke.edu/ marinelab/ mlforms.html) to the Admissions Office of the Marine Laboratory prior to Duke’s registration period for the desired semester. Notification of admission will be sent to the applicant as well as the Office of the University Registrar. Students will then need to register via the web at the normal designated time.

Duke Graduate Students. Students enrolled in a graduate degree program at Duke who wish to enroll in semester program courses offered at the Marine Laboratory should notify the Marine Laboratory Admissions Office of such intent and specify the courses of enrollment prior to Duke’s registration period for that semester. Students will then need to register via the web at the normal designated time.
Non-Duke Undergraduate Students. Non-Duke students must submit the semester program application (found at the back of this publication or online at http://www.env.duke.edu/marinelab/mlforms.html) and a current academic transcript to the Admissions Office of the Marine Laboratory. Upon receipt of these credentials, the application will be processed for admission and notification will be sent to the applicant. Students will be categorized as nondegree (unclassified) students and registered for the specific semester at Duke.

Summer Program

Summer courses offered at the Marine Laboratory are open to qualified college undergraduates, graduate students, and individuals who already hold an undergraduate or graduate degree. The summer program is not open to high school students.

Introductory-level courses are numbered below 100; advanced-level courses are numbered 100 and above. The predominant prerequisites for the summer courses are introductory college biology and/or chemistry. Other prerequisites may be required and are listed in the specific course description.

Individuals interested in enrolling in courses offered during the first summer term are advised to submit their application and supporting credentials during late fall or early winter to assure space in the desired course. Many courses reach maximum enrollment early in the admissions process.

Individuals may apply for admission to one or both of the summer terms.

Summer Credit. The summer session credit does not mean degree credit at Duke University unless the student has been admitted as a degree candidate by one of the colleges or schools of Duke University. Other students will be categorized as nondegree (unclassified) students for the summer only. A student taking a course for credit will receive a grade after completing all of the required work and taking the final examination.

Summer Minimum Enrollment. Some courses are offered subject to minimum enrollments. Should it become necessary to withdraw a course not having adequate enrollment, every effort will be made to place the student in his or her second course choice.

Summer Maximum Enrollment. If a course reaches maximum enrollment, subsequent applicants will be placed on a waiting list. Applicants should list first and second choice course preferences on their application. It is advisable for students applying to the first summer term to apply during late fall or early winter.

Summer Maximum Course Load. Students register for only one course during the first summer term. However, during the second summer term students are encouraged, but not required, to register for Conservation Biology and Policy (BIO 109/ENV 209) and one additional course.

SUMMER PROGRAM ADMISSION

The summer application (found at the back of this publication or online at http://www.env.duke.edu/marinelab/mlforms.html) must be submitted to the Marine Laboratory Admissions Office by all individuals applying to undergraduate and graduate courses or graduate graded research to be conducted at the Marine Laboratory. All non-Duke applicants must submit a current academic transcript to complete the application. All Duke applicants applying for a summer tuition scholarship must submit a current transcript to complete their summer application. These credentials may be sent separately or together.

Upon receipt of all credentials, the application will be processed for admission and notification will be sent to the applicant. Applicants are encouraged to apply early to allow for adequate processing time and to gain admission in the desired course(s). Upon acceptance, payment of the required deposit(s) is essential to reserve space in a course as well as room and board accommodations.

Duke students will register via the web at the appropriate time.
Immunization Requirement (Semester and Summer Programs)

The North Carolina immunization law requires students attending a college or university in the state to be immunized against the following diseases: mumps, measles, rubella, tetanus, diphtheria, and, if under 18 years of age, polio. In addition, if you were born in, or in the past 5 years traveled to, high risk countries a tuberculosis test is required. Students from institutions other than Duke are required to present proof of these immunizations in accordance with the instructions contained in the Student Health Services form provided with the student's admissions materials. Prior to the student’s first day of classes this form should be completed and returned in the addressed envelope provided. Duke University cannot permit a student to attend classes unless the required immunizations have been obtained. For more details: http://healthydevil.studentaffairs.duke.edu/immunizations.html.

Transcripts of Academic Work Conducted at the Marine Laboratory (Semester and Summer Programs)

Non-Duke students are charged a one-time $30 fee (fall or spring term) or $15 fee (summer term) for transcripts. Transcript requests should not be directed to the Marine Laboratory. To request transcripts, use the following form: http://registrar.duke.edu/registrar/transcri.htm. Faxed requests may be sent 24-hours daily to (919) 684-4500 (a cover sheet is not necessary), or mail the following information to the Office of the University Registrar, Box 90054, Durham, NC 27708-0054: name, social security number, home institution, term and year of attendance at Marine Lab, address to which the transcript should be sent, and written signature.

Transcripts may be withheld for an individual whose student loan account is past due.
Financial Information
The semester program figures quoted in this section are based on costs applicable in academic year 2001-2002 and are projections in some cases; they may be subject to change without prior notice.

**Fall and Spring Semester Programs**

Costs for undergraduate students, per semester:

- **Tuition**: $13,000
- **Room and board**: 3,630
- **Books (estimated)**: 450
- **Health fee**: 239
- **Student activity fee**: 60
- **Transcript fee for non-Duke students**: 30
- **Airfare (if attending Beaufort to Bermuda program)**: varies
- **Insurance policy (if attending Beaufort to Bermuda program)**: 30
- **Key deposit**: 10
- **Phone deposit (long distance privileges)**: 20

**Room and Board.** All dormitory occupants must supply their own linens, blankets, towels, and pillows. A key deposit of $10 (per semester) will be charged each person occupying a room. This deposit will be refunded at the time of departure and return of key.

**Full board** provides for three meals each day. No credit will be allowed for meals that are missed. However, board is adjusted for holidays (i.e., students may stay in the dormitory during breaks and Thanksgiving holidays but the dining hall is not open). Rooms are paid for from the term's beginning to end.

**Books.** Books, if required by the instructor, will be available after arrival.

**Payment of Tuition and Fees.** The Office of the Bursar (Duke University, Durham campus) will issue statements to registered students for tuition, fees, and other charges approximately four to six weeks prior to the beginning of classes each semester. The *Amount Due Now* on the statement is payable by the due date which is normally one week prior to the beginning of classes. Inquiries can be made at the bursar's office by facsimile at 919/ 684-3091, by telephone at 919/ 684-3531, or e-mail at bursar@duke.edu. Office hours are from 9:00 a.m. to 4:00 p.m., Monday through Friday. As part of the admission agreement with Duke University, a student is required to pay all statements as presented. If full payment is not received, a late payment charge as described below will be assessed on the next statement and certain restrictions as stated below will be ap-
plied. Failure to receive a statement does not warrant exemption from the payment of tuition and fees nor from the penalties and restrictions. Nonregistered students will be required to make payment for tuition, fees, required deposits, and any past due balance at the time of registration. Payments should be sent to the address indicated on the invoice and not to the Duke Marine Laboratory.

**Late Payment Charge.** If the amount due now on a statement is not received by the statement due date, the next statement will show a penalty charge.

**Restrictions.** An individual will be in default if the total amount is not paid in full by the due date. A student in default will not be allowed to register for future semesters, to receive a transcript of academic records, have academic credits certified, or receive a diploma at graduation. In addition, an individual in default may be subject to withdrawal from school and have the account referred to a collection agency.

**Refunds**

**Fall and Spring.** In the case of withdrawal from the university, students or their parents may elect to have tuition refunded or carried forward as a credit for later study according to the following schedule:

<table>
<thead>
<tr>
<th>Withdrawal</th>
<th>Refund</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before classes begin</td>
<td>Full amount</td>
</tr>
<tr>
<td>During first or second week</td>
<td>Full amount</td>
</tr>
<tr>
<td>During third, fourth, or fifth week</td>
<td>60 percent</td>
</tr>
<tr>
<td>During sixth week</td>
<td>20 percent</td>
</tr>
<tr>
<td>After sixth week</td>
<td>None</td>
</tr>
</tbody>
</table>

Tuition charges paid from grants or loans will be restored to those funds on the same pro rata basis and will not be refunded or carried forward. In addition to tuition, the schedule also applies to other Marine Laboratory fees. Consult the *Bulletin of Duke University-Undergraduate Instruction* for additional information.

**Summer Program**

The following charges are applicable for undergraduate and graduate 2002 summer registration, per term.

<table>
<thead>
<tr>
<th>Tuition</th>
<th>$600/ s.h.</th>
</tr>
</thead>
<tbody>
<tr>
<td>each one and one-half course (6 s.h.)</td>
<td>3,600</td>
</tr>
<tr>
<td>each course (laboratory-4 s.h.)</td>
<td>2,400</td>
</tr>
<tr>
<td>each course (nonlaboratory-3 s.h.)</td>
<td>1,800</td>
</tr>
<tr>
<td>Health fee</td>
<td>80</td>
</tr>
<tr>
<td>Room and board</td>
<td>1,275</td>
</tr>
<tr>
<td>Transcript fee for nonDuke students</td>
<td>15</td>
</tr>
<tr>
<td>Key deposit</td>
<td>10</td>
</tr>
<tr>
<td>Phone deposit (long distance privileges &amp; use fee)</td>
<td>25</td>
</tr>
<tr>
<td>Books (estimated)</td>
<td>200</td>
</tr>
</tbody>
</table>

**Auditing Fees.**

1. With permission of the instructor and the director, students registered for a full program (6-7 s.h.) may audit nonlaboratory courses. No extra charge is made.

2. Students carrying less than a full program (6-7 s.h.) may be granted permission by the instructor and the director to audit a course, but must pay half the university fee for the course.

**Room and Board.** Reservations are made on a first-come, first-served basis. Upon acceptance in a course, students will be sent an acceptance/reservation form which
should be promptly returned to the Marine Laboratory along with the required deposits.

All dormitory rooms are air-conditioned. Occupants must supply their own linens, blankets, towels, and pillows. Full board provides for three meals each day. There will be no credit allowed for missed meals.

Books. Books, if required by the instructor, will be available at registration.

Deposits.

1. Course Deposit. Upon acceptance in a course, a nonrefundable deposit of $150 (per course) is required to ensure a reservation in that course. If the student properly registers for the course and attends, the deposit will be credited to tuition.

2. Room and Board Deposit. A $100 deposit (per summer term) is required to ensure a reservation for room and board. If the student properly registers, the deposit will be credited to the room and board charge. The deposit is refundable if, PRIOR to the beginning of the term, a student who has previously made a room and board reservation notifies the Marine Lab in writing that he/she is withdrawing from the course. The deposit is nonrefundable if a student who has previously made a room and board reservation at the Marine Laboratory subsequently decides to attend the term but not utilize Marine Lab room and board facilities (although he or she will still attend the course) and does not notify the Marine Laboratory at least two weeks prior to the beginning of the term.

3. Key Deposit. A key deposit of $10 per summer term will be charged each person occupying a dormitory room. This deposit will be refunded at time of departure and return of the key.

4. Phone Deposit. Each student requesting a personal phone code for making long distance calls is required to make this $20 deposit. It will be refunded when all personal phone charges are paid in full.

Payment of Tuition and Fees. Beginning in early April the Office of the Bursar will mail bills every two weeks to current Duke students enrolled for Summer Session. The bill due date will be two weeks from the date of the bill. Students will also be able to view their bills on the web. Problems meeting these deadlines should be discussed with the Office of the Bursar and the student’s academic dean prior to the start of the term.

The Summer Session Office will enclose a statement of charges with the confirmation of registration letter sent to all visiting students, Duke graduates, and incoming Duke first-year students. Payment for Terms I and II charges will be due on or before the Friday before the term begins.

Summer Session retains the right to withdraw students from classes if they never attend, have not paid tuition and fees, or if they have failed to clear with the bursar by the end of the drop/add period (the third day of classes in any term). Those withdrawn for these reasons will be billed the health fee and an administrative withdrawal fee of $225 (per 6 semester hour course), $150 (per 3-4 semester hour course), or $75 (per 2 semester hour course). Students who, subsequent to withdrawal, clear with the Duke Bursar’s Office may, with written permission of their academic dean, be reinstated in their classes as originally registered. The administrative withdrawal fee will stand and the student will be liable for full tuition and fees. Students who are unable to meet these deadlines should consult with the Bursar’s Office and their academic dean (in the case of Duke University students) prior to the deadline.

Students who plan to pay for summer tuition and/or fees, or a portion thereof, through other than personal means or scholarship support provided by Duke Marine
Laboratory, such as student loans or other types of financial assistance not provided by the Marine Laboratory, should notify the Duke Bursar prior to the payment due date and specify their form of payment. Such students should mail copies of any documents, such as approved student loans, etc., which relate to the payment of Duke Marine Laboratory summer tuition and fees to the Duke Bursar.

**Summer Term Refunds—Drop or Administrative Withdrawal Charges and Refund of Tuition and Fees.** Students who will not be attending a summer term or course for which they have registered must officially drop the course(s) prior to the beginning of the term whether or not they have paid tuition and fees. Students who fail to drop the course(s) prior to the beginning of the term will be charged $225 (per 6 semester hour course), $150 (per 3-4 semester hour course), or $75 (per 2 semester hour course).

Students who will not be attending a summer term or course for which tuition and fees have been paid are eligible for refunds following these policies:

1. There is a financial obligation of full tuition and fees if the student drops a course(s) or withdraws from the term after the third day. After the first week of the term, the room and board fees less the cost of each week of room and board (a week of room and board is considered Sunday-Saturday) is refunded.
2. There is a financial obligation of $225 (for a 6 semester hour course), $150 (for a 3-4 semester hour course), or $75 (for a 2 semester hour course) if the student officially drops a course(s) or withdraws from the term during the first three days. The health fee is not refunded. The room and board fee less the cost of one week of room and board will also be refunded. (There is no charge for drop/adds that result in no change in course load in the same term.)
3. Full tuition and fees are refunded if the student officially drops a course(s) or withdraws from the term before the first day.

**Check Cashing**

The banks in the Beaufort-Morehead City area have indicated that they will not cash personal checks for students unless the checks are guaranteed. Therefore, it is recommended that students who come to the laboratory bring with them sufficient travelers’ checks, money orders, certified checks (which the banks will cash), or cash to cover personal expenses. The Marine Laboratory will accept personal checks to pay course fees and other accounts, but cannot convert personal checks for cash purposes. Additionally, the Marine Laboratory cannot accept credit cards for payment of accounts.

**Financial Assistance**

**UNDERGRADUATE FINANCIAL AID**

Financial aid is generally available to Duke University undergraduate students for each summer term. Interested students can obtain specific details on available funding and an application through the Duke University Financial Aid Office (919/ 684-6225; Durham campus) in March of each year.

**SUMMER TUITION SCHOLARSHIPS**

All Duke Marine Laboratory summer school students are eligible to apply for summer tuition scholarships, awarded on a competitive basis by the Marine Laboratory faculty. Normally a student may receive only one tuition scholarship per summer. Each award provides tuition for one course taken during the summer. Awards require that undergraduates live on campus, i.e., take room and board at the Marine Laboratory.
The criteria used in review of scholarship applicants are academic excellence, scope of preparation, professional goals, and need.

Preconditions for review of a scholarship application are admission to a specific summer course and submission of the $150 course deposit. Admission to courses does not automatically imply award of a scholarship; separate reviews are conducted.

There is no separate scholarship application form. Intent to apply for a scholarship should be made known on the reverse of the summer course application found at the back of this publication or online at http://www.env.duke.edu/marinelab/mlforms.html. In addition to the summer application for courses and current college or professional school transcript, each scholarship applicant is required to submit a letter of recommendation from academic faculty and a brief statement of purpose, i.e., the reason for taking the particular course, and demonstrate a need for the scholarship. Financial statements are not required to demonstrate need for a scholarship. All scholarship credentials must be received no later than 1 April by the admissions office of the Marine Laboratory. All scholarship applicants will be notified of their award status shortly after the deadline date.

**Lawrence E. Blanchard Endowment Fund.** The fund income is used to support undergraduate students in academic courses at the Duke University Marine Laboratory.

**Bookhout Scholarship.** The Bookhout Scholarship provides financial assistance to juniors, seniors, or beginning graduate students with a professional interest in the natural sciences.

**August A. Busch, Jr., Memorial Scholarship Fund.** The income provides unrestricted scholarship support for undergraduates studying at the Duke University Marine Laboratory.

**Laura J. Grierson Memorial Fund.** The fund income is used to support undergraduate students in academic independent study courses at the Duke University Marine Laboratory.

**Lawrence I’Anson Scholarship Endowment Fund.** The income provides unrestricted scholarship support for undergraduates studying at the Duke University Marine Laboratory.

**Melanie Elizabeth Lynn Memorial Scholarship.** The income provides financial assistance to female graduate students for summer academic course work.

**Marine Biomedical Center.** This scholarship provides support for undergraduate students studying at the Marine Laboratory.

**Mary Derrickson McCurdy Scholarship.** The fund provides financial assistance to graduate students for academic course work.

**Richard C. and Linda G. Seale Scholarship Endowment Fund.** The fund income is intended to provide support to qualified students from Denison University for participation in summer courses at the Duke Marine Laboratory. Denison University students interested in applying for this scholarship are directed to the Chairman, Department of Biology, at Denison University with respect to required supporting credentials and deadlines for application and award notification. Should there be no applicants from Denison, the scholarship may be used to provide financial assistance to any qualified student.

**Harvey W. Smith Undergraduate Fellowship in Biological Sciences.** The income from this fund is used to support undergraduate participation in academic courses.

**Deborah Susan Steer Memorial Scholarship in Marine-Life Sciences.** The income from the fund is used to provide financial assistance to promising Duke undergraduates who wish to study marine life-sciences at the Duke University Marine Laboratory.
The Wade Family Fund. The income from this fund is used to support undergraduate and graduate student participation in academic courses.

GLOBAL FELLOWS IN MARINE CONSERVATION

Funding is provided for international students to participate in the Nicholas School of the Environment and Earth Science’s new program in global marine conservation during the Marine Laboratory’s Summer Term II. If funding is available, fellowships for international students fully cover travel expenses, room and board, and tuition for BIO 109/ENV 209 Conservation Biology and Policy, plus one complementary course.

This fellowship is available to any international applicant who meets the following precondition for review of a fellowship application: admission to BIO 109/ENV 209 Conservation Biology and Policy. Admission to the course does not automatically imply award of a fellowship; separate reviews are conducted. Awards are based on merit and need. There is no separate fellowship application form. Intent to apply for a fellowship should be made known on the reverse of the summer course application found at the back of the Marine Lab Bulletin or online at http://www.env.duke.edu/marinelab/mlforms.html.

In addition to the summer application for courses and current college or professional school transcript, each fellowship applicant is required to submit a letter of recommendation from academic faculty, a brief statement of purpose, i.e., the reason for taking the particular course, and a brief essay (one page or less) outlining the applicant’s background, position, education and what they hope the course opportunity at Duke will prepare them to do when they return home.

All international fellowship credentials must be received no later than 1 April by the admissions office of the Marine Laboratory. All fellowship applicants will be notified concerning their award status shortly after the deadline date.

GRADUATE SUPPORT

Graduate support (nine months) in the form of Duke University Marine Laboratory instructional assistantships and endowed fellowships is available to Ph.D. students registered in a graduate program at Duke University. Recipients usually reside in Beaufort after their course work is completed on the Durham campus and base their research at the Beaufort campus. Support is considered on a case-by-case basis and is generally guaranteed to students resident at the Duke Marine Laboratory making satisfactory progress and whose advisors are also resident at the Laboratory. Awards are made annually and students are eligible for five years.

Applicants making satisfactory progress must submit a letter of request for support in response to the announcement of funding that is made to students and faculty in January or February of each year. Faculty advisors must submit a letter indicating students are making satisfactory progress. Further documentation may be requested of students whose progress is uncertain. For further information, write the Director of Graduate Studies, Duke University Marine Laboratory, 135 Duke Marine Lab Road, Beaufort, North Carolina 28516-9721.

Kathryn M. Deane and Walter L. Deane Endowment Fund. This fund income is used to support minority students studying at the Duke University Marine Laboratory during the summer sessions.

Rachel Carson Fund. This fund income is used to support students pursuing the Ph.D. in any science or public science who uses, as a major component in their research objective, the Rachel Carson Sanctuary site, Beaufort, North Carolina.

Robert W. Safrit, Jr. Fellowship Endowment Fund. This fund income is used to provide graduate fellowships to students at the Duke University Marine Laboratory.

Harvey W. Smith Graduate Fellowship Endowment Fund. This fund income is used to support graduate students at Duke University who are doctoral candidates in
one of the biological sciences and have directed their dissertation research specifically in
the area of marine science.

The Mary Derrickson McCurdy Endowment Fund. This fund income provides fi-
nancial assistance for graduate students at the Duke Marine Laboratory in Beaufort,
North Carolina. The recipients shall be known as Mary McCurdy Scholars.

POSTDOCTORAL SUPPORT

Mary Derrickson McCurdy Visiting Fellow. To enhance the mission of the Nicho-
las School of the Environment and Earth Sciences, Duke University seeks scholars-in-
residence to enrich the emerging curriculum at the Marine Laboratory in ocean science
aspects of issues related to the environment and living resources. Ideally, the scholar
will teach an innovative seminar in the fall and spring semesters and perform collabora-
tive research with students. The curriculum is designed for advanced undergraduate,
professional and graduate students.

The funds available are ideal for a postdoctoral year or a sabbatical leave, and can
be used for salary and research. Applicants should send a course prospectus, a research
prospectus, a curriculum vitae, and a list of references to the director of the Marine
Laboratory by 1 January for the following academic year.
Additional Information for Visiting Scholars and Researchers
The figures quoted in this chapter are applicable in academic year 2001-2002 and are projections in some cases; they may be subject to change without prior notice.

**Visiting Scholar Information**

**Research Space.** Research space, including seawater tables, is available on a limited basis for Duke University Marine Laboratory visitors. The typical size of a laboratory-office area is 100 square feet.

**Teaching Space.** Classrooms of various sizes are available throughout the year; however, first priority must be given to Marine Laboratory classes when they are in session. Compound or dissecting microscopes are available for a small additional fee.

**Room and Board** is available for a reasonable cost. Allowances will be made only for meals missed at the beginning and end of the stay.

**Boat Rentals.** Please visit the following web site for current fees and information about the Duke Marine Laboratory’s Marine Operations: http://www.env.duke.edu/marinelab/marops.html.

The boats may be scheduled through the Marine Operations Office, however, first priority must be given to classes when they are in session. The rates are intended to partially defray the cost of operations and maintenance.

Charges apply to all research and teaching activities. Use of Duke University Marine Laboratory vessels for any sponsored research will be subject to charges.

Requests for the use of boats should be scheduled through Karen Ashley (252) 504-7583 or karen.ashley@duke.edu.

**Off-Campus Housing.** The Bradley International House, a complex of seven apartment units, is operated by the Marine Laboratory to accommodate visiting researchers and instructors. It is located within walking distance of the Marine Laboratory and in the historic district of the town of Beaufort. The complex was designed to promote collegiality among academics and to enhance the historic district. The Bradley International House was dedicated in 1992, and was constructed with funds provided by the Lynde and Harry Bradley Foundation of Milwaukee, Wisconsin.
The units are fully furnished, including linens and utensils. The preferred occupancy is one month or more.

**Support Available.** The exchange of knowledge is kept lively by several programs which bring distinguished scientists/educators to the Marine Laboratory. The Visiting Scholar Program brings lecturers for a period of several days on a monthly basis year-round. The Mary Derrickson McCurdy Visiting Fellow is in residence one year or more. The scholars, while in residence, lecture to the community at large as well as enrich specific research groups. For information on financial support for visiting scholars, see the section entitled Postdoctoral Support in the chapter, Financial Information.

**Information and Reservations.** All requests for use of facilities or equipment at the Marine Laboratory, including the Bradley International House, should be addressed to Auxiliaries and Administrative Services, Duke University Marine Laboratory, 135 Duke Marine Lab Road, Beaufort, North Carolina 28516-9721; telephone (252) 504-7525 or drg@duke.edu.

Please visit our home page for additional information: http://www.env.duke.edu/marinelab/.
Courses Taught at the Marine Laboratory

Course offerings are subject to change. The student should consult the current university course schedule for listings of courses to be offered each semester or summer term.

Biology (BIOLOGY)

10L. Marine Biology. EI, NS, STS Physical and chemical aspects of estuarine and marine ecosystems and environments. Functional adaptations of marine organisms and the role of man and society on the ecosystems. Includes field trips to local environments with an emphasis on impacted environments and their relation to societal activity and policy. For students not majoring in natural sciences. (Given at Beaufort.) Instructor: Staff. C-L: Marine Sciences. One course.

109. Conservation Biology and Policy. EI, NS, STS Introduction to the key concepts of ecology and policy relevant to conservation issues at the population to ecosystem level. Focus on the origin and maintenance of biodiversity and conservation applications from both the biology and policy perspectives (for example, endangered species, captive breeding, reserve design, habitat fragmentation, ecosystem restoration/rehabilitation). (Given at Beaufort.) Prerequisites: introductory biology; suggested: a policy and/or introductory ecology course. Instructors: Crowder (Beaufort) and staff. C-L: Marine Sciences. One course.

114L. Biological Oceanography. NS, QID, R Physical, chemical, and biological processes of the oceans, emphasizing factors controlling distribution and abundances of organisms. The theory, methods, and limitations of biological oceanographic research. The laboratory teaches quantitative methods, experimental design, data acquisition, data processing, and data analysis and culminates in a research cruise where the students organize into a scientific party. One course (spring); one and one-half courses (summer). (Given at Beaufort and Bermuda.) Prerequisite: Biology 25L. Instructors: Ramus or staff (Beaufort); Lipschultz and Schnetzer (Bermuda). C-L: Marine Sciences. Variable credit.

123. Analysis of Ocean Ecosystems. NS The history, utility, and heuristic value of the ecosystem; ocean systems in the context of Odum’s ecosystem concept; structure and function of the earth’s major ecosystems. (Given at Beaufort.) Prerequisite: one year of biology, one year of chemistry, or consent of instructor. Instructor: Barber. C-L: Marine Sciences. One course.

125L. Biology and Conservation of Sea Turtles. NS, STS Biology including the anatomy, physiology, behavior, life histories, and population dynamics of sea turtles linked to conservation issues and management. Focus on threatened and endangered sea turtle species, with special attention to science and policy issues in United States waters. Includes field experience with the animals and with their habitat requirements. Sea turtle assessment and recovery efforts, fishery-turtle interactions, population modeling and state/national/international management efforts. Students are encouraged to enroll for Biology 109 Conservation Biology and Policy concurrently. (Given at Beaufort.) Prerequisite: introductory biology. Instructor: Crowder, Wynken (visiting summer faculty), and staff. C-L: Marine Sciences. One course.

126. Marine Mammals. NS, QID, STS The biology of cetaceans, pinnipeds, sirenians, and sea otters. Topics covered include the diversity, evolution, ecology, and behavior of marine mammals and their interactions with humans. Detailed consideration
given to the adaptations that allow these mammals to live in the sea. Evaluation of the scientific, ethical, and aesthetic factors influencing societal attitudes toward these animals and of their conservation management in light of domestic legislation and international treaties. (Given at Beaufort.) Prerequisite: introductory biology. Instructor: Read or staff. C-L: Marine Sciences. One course.

126L. Marine Mammals. NS, QID, R, STS Laboratory version of Biology 126. Laboratory and field exercises consider social organization, behavior, ecology, communication, and anatomy of local bottlenose dolphins. (Given at Beaufort.) Prerequisite: introductory biology. Instructor: Read or staff. C-L: Marine Sciences. One course.

127L. Marine Microbial Ecology. NS, QID, R Microbial physiology and ecology within the context of biogeochemical processes. Quantitative modeling of microbial control of biogeochemical processes. Lectures, field trips, and laboratory exercises illustrating and employing the research techniques of microbial ecology to investigate microbial processes controlling nutrient cycling in the open ocean and coral reefs of Bermuda. (Given at Bermuda.) Prerequisite: introductory biology and chemistry. Instructor: Staff (Bermuda). C-L: Marine Sciences. One course.

129L. Marine Ecology. NS Factors that influence the distribution, abundance, and diversity of marine organisms. Course structure integrates lectures and field excursions. Topics include characteristics of marine habitats, adaptation to environment, species interactions, biogeography, larval recruitment, and communities found in rocky shores, tidal flats, beaches, mangrove, coral reefs, and subtidal areas. Not open to students who have taken Zoology 203L. (Given at Beaufort fall and summer and at Bermuda, spring.) Prerequisite: introductory biology. Instructors: Crowder or Kirby-Smith (Beaufort); Lipschultz and Smith (Bermuda). C-L: Marine Sciences. One course.

132S. Marine Biodiversity. NS, QID Marine biodiversity in the context of theoretical ecology and environmental physiology. Topics include methods for quantifying and evaluating diversity and biological diversity in major marine habitats. Primary literature examples focus on quantifying human impacts and developing conservation measures. (Given at Bermuda.) Prerequisite: introductory biology. Instructor: Coates (Bermuda). C-L: Marine Sciences. Half course.

133S. Molecular Approaches to Questions of Physiology, Ecology, and Evolution in the Marine Environment. NS Techniques of molecular biology as they relate to physiological, ecological, and evolutionary questions. Examples from the subcellular to global scale taken from classic and contemporary readings from the primary scientific literature. Each participant in the course presents a critical analysis of the literature on a chosen subject. (Given at Bermuda.) Prerequisite: introductory biology. Instructor: Trapido-Rosenthal. C-L: Environment 133S, C-L: Marine Sciences. Half course.

150L. Physiology of Marine Animals. NS, QID, R, W Comparative physiology of estuarine and marine animals. Physics and chemistry of estuarine and marine environments and physiological adaptations of animal residents. Focus on theory, behavioral, and physiological responses of animals to the major environmental drivers of temperature, salinity, oxygen, and light. Lectures and laboratories illustrating the approaches and methodology, analysis techniques, and written reporting of classical environmental physiology research. One course (fall); one and one-half courses (summer). (Given at Beaufort.) Prerequisites: Biology 25L and Chemistry 12L or 22L. Instructor: Forward. C-L: Marine Sciences. Variable credit.

155L. Biochemistry of Marine Animals. NS, QID, R The molecular basis of behavioral and physiological responses of organisms. Evolution of molecular endocrinology and signal transduction pathways. Focus on the theory and research methodology used to study the evolution of molecular signaling and control systems. Research projects using local invertebrates to study behavioral and physiological responses to environmen-
tal signals. Field trips include night walks in local environments and marine fossil expeditions to local strip mines involved with production of fertilizer, food additives, cement, and gravel. One course (fall); one and one-half courses (summer). (Given at Beaufort.) Prerequisites: Biology 25L; and Chemistry 11L and 12L, or 21L and 22L. Instructor: Rittschof. C-L: Marine Sciences. Variable credit.

156L. Sensory Physiology and Behavior of Marine Animals. NS Sensory physiological principles with emphasis on visual and chemical cues. Laboratories will use behavior to measure physiological processes. (Given at Beaufort.) Prerequisites: Biology 25L and Chemistry 12L. Instructors: Forward and Rittschof. C-L: Marine Sciences. One course.

176L. Marine Invertebrate Zoology. NS Structure, function, and development of invertebrates collected from estuarine and marine habitats. Not open to students who have taken Zoology 274L. One course (fall, spring, and Summer Term II); one and one-half courses (Summer Term I). (Given at Beaufort fall, spring, and summer or at Bermuda, spring.) Prerequisite: Biology 25L. Instructors: Dimock (Beaufort) or Kirby-Smith (Beaufort); Barnes and Coates (Bermuda). C-L: Marine Sciences. Variable credit.

190. Research Independent Study. R Individual research and reading in a field of special interest, under the supervision of a faculty member, resulting in a substantive paper or written report containing significant analysis and interpretation of a previously approved topic. Open to all qualified students with consent of supervising instructor and director of undergraduate studies. A maximum of three courses of 190, 191, 192, 193T, and 197T may count toward the biology major. Instructor: Staff. Half course.

191. Research Independent Study. R Individual research in a field of special interest, under the supervision of a faculty member, the major product of which is a substantive paper or written report containing significant analysis and interpretation of a previously approved topic. Open to all qualified students with consent of supervising instructor and director of undergraduate studies. A maximum of three courses of 190, 191, 192, 193T, 297, and 298 may count toward the biology major. Instructor: Staff. One course.

192. Research Independent Study. R Continuation of Biology 191. Open to all qualified students with consent of supervising instructor and director of undergraduate studies. A maximum of three courses of 190, 191, 192, 193T, 297, and 298 may count toward the biology major. Instructor: Staff. One course.

193T. Tutorial. For junior and senior majors with consent of director of undergraduate studies and supervising instructor. Three courses of 191, 192, and 193T, maximum. Instructor: Staff. One course.

197T. Tutorial. For junior and senior majors with consent of director of undergraduate studies and supervising instructor. A maximum of three courses of 190, 191, 192, 193T, and 197T may count toward the major. Instructor: Staff. Half course.

203L. Marine Ecology. Factors that influence the distribution, abundance, and diversity of marine organisms. Course structure integrates lectures and field excursions. Topics include characteristics of marine habitats, adaptation to environment, species interactions, biogeography, larval recruitment, and communities found in rocky shores, tidal flats, beaches, mangrove, coral reefs, and subtidal areas. Not open to students who have taken Biology 203L. Open to undergraduates only under Biology 129L. (Given at Beaufort fall and summer and at Bermuda, spring.) Prerequisite: introductory biology. Instructors: Crowder or Kirby-Smith (Beaufort); Lipschultz and Smith (Bermuda). C-L: Environment 219L, C-L: Marine Sciences. 4 units.

218L. Barrier Island Ecology. NS, QID, R An integration of barrier island plant and animal ecology within the context of geomorphological change and human disturbance.
Experimental evidence supporting the theory of barrier island formation and migration; plant and animal adaptations and their evolution, succession ecology, and conservation and restoration ecology. Strong emphasis in labs on independent use of quantitative field observation and research techniques. (Given at Beaufort.) Prerequisite: Biology 25L or equivalent; suggested: course in botany or ecology. Instructors: Peterson and Wells (visiting summer faculty). C-L: Environment 218L, C-L: Marine Sciences. One course or 4 units.

219L. Coastal Ecosystem Processes. NS, QID Physical, chemical, and biological processes in the coastal zone of the Carolinas. A unifying theme will be the coupling of watersheds, river basins, estuaries, and the coastal ocean through the movement of ground and surface waters. Topics include hydrology, nutrient cycles, sediment-water column interactions, primary and secondary production, and food web dynamics. Sustaining coastal ecosystems in the face of land use change. (Given at Beaufort.) Instructors: Ramus and staff. C-L: Environment 224L, C-L: Marine Sciences. 4 units.

253L. Physiology of Marine Animals. Environmental factors, biological rhythms, and behavioral adaptations in the comparative physiology of marine animals. Open to undergraduates only under Biology 150L. Four units (fall); six units (summer). (Given at Beaufort.) Prerequisites: Introductory biology and chemistry. Instructor: Forward. C-L: Environment 228L, C-L: Marine Sciences. Variable credit.

255L. Biochemistry of Marine Animals. Functional, structural, and evolutionary relationships of biochemical processes of importance to marine organisms. Open to undergraduates only under Biology 155L. Four units (fall and spring); six units (summer). (Given at Beaufort.) Prerequisites: Biology 25L; and Chemistry 11L, 12L. Instructor: Rittschof (summer). C-L: Environment 229L, C-L: Marine Sciences. Variable credit.

264S. Advanced Topics in Marine Ecology. NS Theoretical concepts from population, community, and evolutionary ecology will be linked to observations and experiments to enhance understanding of the structure and function of marine systems. Current topics in marine ecology (for example, marine food web dynamics, species interactions, life history strategies, fisheries ecology, conservation biology). Discussions based on readings from the primary literature with emphasis on developing critical and synthetic skills. Each student will prepare a research proposal in NSF format. May be repeated. (Given at Beaufort.) Instructor: Crowder. C-L: Environment 269S, C-L: Marine Sciences. 2 units.

274L. Marine Invertebrate Zoology. Structure, function, and development of invertebrates collected from estuarine and marine habitats. Not open to students who have taken Biology 176L, Biology 274L, or Zoology 274L. Open to undergraduates only under Biology 176L. Four units (fall, spring, and Summer Term II); six units (Summer Term I). (Given at Beaufort fall, spring, and summer or at Bermuda, spring.) Prerequisite: Biology 25L. Instructors: Dimock (Beaufort) or Kirby-Smith (Beaufort); Barnes and Coates (Bermuda). C-L: Environment 295L, C-L: Marine Sciences. Variable credit.

295S. Seminar. NS Instructor: Staff. One course.

297. Research Independent Study. R Individual research and reading of the primary literature in a field of special interest, under the supervision of a faculty member, the major product of which is a substantive paper or written report containing significant analysis and interpretation of a previously approved topic. Open to juniors and seniors only with consent of supervising instructor and director of undergraduate studies. A maximum of three courses of 190, 191, 192, 193T, 297, and 298 may count toward the biology major. Continued in Biology 298. Instructor: Staff. One course.

298. Research Independent Study. R Continuation of Biology 297. Open to juniors and seniors only with consent of supervising instructor and director of undergraduate
studies. A maximum of three courses of 190, 191, 192, 193T, 297, and 298 may count toward the biology major. Instructor: Staff. One course.

351. Tutorial. An approved academic exercise, such as writing an essay or learning a research skill, carried out under the direction of the appropriate staff members. Consent of instructor required. Hours and credit to be arranged. Instructor: Staff. Variable credit.

352. Tutorial. An approved academic exercise, such as writing an essay or learning a research skill, carried out under the direction of the appropriate staff members. Consent of instructor required. Hours and credit to be arranged. Instructor: Staff. Variable credit.

353. Research. To be carried on under the direction of the appropriate staff members. Consent of instructor required. Hours and credit to be arranged. Instructor: Staff. C-L: Marine Sciences. Variable credit.

354. Research. To be carried on under the direction of the appropriate staff members. Consent of instructor required. Hours and credit to be arranged. Instructor: Staff. C-L: Marine Sciences. Variable credit.

COURSES CURRENTLY UNSCHEDULED

113L. Behavioral Ecology
128L. Estuarine Ecology
213L. Behavioral Ecology

Cell Biology (CELLBIO)

210. Independent Study. Research resulting in a substantive paper or written report containing significant analysis and interpretation of a previously approved topic. Descriptions of specific areas may be obtained from the director of graduate studies. Consent of director of graduate studies required. 3 to 9 units. Instructor: Staff. Variable credit.


244L. Molecular and Cellular Processes in Marine Organisms. Joint research projects on the adverse effects of environmental pollutants on marine organisms at the cellular and molecular level. Research methodologies include: spectroscopy (UV/VIS, fluorescence, and atomic absorption); subcellular fractionation; protein purification and characterization using chromatography and electrophoresis; analysis of pollutant-induced damage to proteins, membranes, and DNA; measurement of activity of enzymatic defense systems. Lectures cover molecular mechanisms of damage and damage control, and concepts that underlie the methods to be used. (Given at Beaufort.) Prerequisite: organic chemistry. Instructors: C. Bonaventura and Mcclellan-Green. C-L: Environment 244L, C-L: Marine Sciences. One course or 4 units.

Earth and Ocean Sciences (EOS)

191. Research Independent Study. Individual research in a field of special interest under the supervision of a faculty member, the central goal of which is a substantive paper or written report containing significant analysis and interpretation of a previously approved topic. Open only to qualified juniors and seniors by consent of director of undergraduate studies and supervising instructor. Instructor: Staff. One course.
192. Research Independent Study. See Earth and Ocean Sciences 191. Open only to qualified juniors and seniors by consent of director of undergraduate studies and supervising instructor. Instructor: Staff. One course.

193. Independent Study. Directed reading or individual projects. Open only to qualified juniors and seniors by consent of director of undergraduate studies and supervising instructor. Instructor: Staff. One course.

194. Independent Study. See Earth and Ocean Sciences 193. Open only to qualified juniors and seniors by consent of director of undergraduate studies and supervising instructor. Instructor: Staff. One course.

195. Independent Study for Nonmajors. Individual research and reading in a field of special interest, under the supervision of a faculty member, resulting in a substantive paper or written report containing significant analysis and interpretation of a previously approved topic. Open to qualified juniors and seniors upon approval of the departmental faculty. Instructor: Staff. One course.

201L. Physical Processes in Coastal Environments. NS The physical processes of beaches, the inner continental shelf, and estuaries, in the context of their implications for the biological and geological environments. Topics drawn from the origin of waves, currents, tides, turbulence, and mixing transport of sand and larvae. Applications to biomechanics and coastal erosion, and to marine ecology, coastal zone management, and water quality. (Given at Beaufort.) Prerequisites: Mathematics 31 and 32. Instructor: Staff. C-L: Environment 222L, C-L: Marine Sciences. One course or 4 units.

202. Beach and Island Geological Processes. NS Field seminar in the evolution of beaches and barrier islands with emphasis on the interaction of nearshore processes with the trappings of man. Consent of instructor required. (Given at coast on two weekends.) Instructor: Staff. C-L: Marine Sciences. Half course or 2 units.

205. Geological Oceanography. NS The geology of ocean basins, including origin, bottom physiography, sediment distribution, and sedimentary processes. Not open to students who have taken Earth and Ocean Sciences 206S. (Given at Beaufort.) Instructor: Staff C-L: Environment 291, C-L: Marine Sciences. One course or 3 units.

371. Advanced Topics in Geology. To meet the individual needs of graduate students for independent study. Instructor: Staff Variable credit.

372. Advanced Topics in Geology. To meet the individual needs of graduate students for independent study. Instructor: Staff Variable credit.

Environment (ENVIRON)

121. Climate Change: A Global Perspective. NS, R Introduction to the scientific basis for prediction of global environmental change with emphasis on change in surface temperature, sea level, precipitation, and tropical cyclone activity. As an analytical exercise, students input temperature data sets from the Bermuda weather service and do basic analysis of Bermuda temperature anomalies over time. (Given at Bermuda.) Prerequisite: one year of chemistry. Instructor: Staff (Bermuda). C-L: Marine Sciences. One course.

122S. Climate-Related Hazards and Humanity. NS, QID The roles of science, politics, and business in quantifying and managing risks associated with climate-related hazards such as hurricanes. (Given at Bermuda.) Instructor: Staff (Bermuda). C-L: Marine Sciences. Half course.

assessments and monitoring. Individual project required, the output of which is a grant proposal to do future monitoring work on a specific topic; project includes a review and reporting of the relevant literature, analysis of existing data sets on the topic, and the experimental plan for the project. (Given at Bermuda.) Instructor: Nelson. C-L: Marine Sciences. One course.

1325. Current Topics in Oceanography and Marine Biology. NS, QID Topics including the Iron Hypothesis, toxic algal blooms, and UV light considered through readings in the primary literature and student presentations. Emphasis on critical analysis of methodology, data analysis, and conclusions in primary peer-reviewed literature. (Given at Bermuda.) Prerequisite: introductory biology. Instructor: Staff (Bermuda). C-L: Marine Sciences. Half course.

1335. Molecular Approaches to Questions of Physiology, Ecology, and Evolution in the Marine Environment. NS Techniques of molecular biology as they relate to physiological, ecological, and evolutionary questions. Examples from the subcellular to global scale taken from classic and contemporary readings from the primary scientific literature. Each participant in the course presents a critical analysis of the literature on a chosen subject. (Given at Bermuda.) Prerequisite: introductory biology. Instructor: Trapido-Rosenthal. C-L: Biology 133S, C-L: Marine Sciences. Half course.

140. A Scientist's Perspective on Environmental Principles, Policy, and Legislation. NS, QID, SS, STS Bermuda's ecological, economic, sociopolitical systems, and environmental legislation as both a case study and as a comparative microcosm. Topics include: ecosystem conservation, natural resource management, pollution and waste management, and energy conservation and management. (Given at Bermuda.) Instructor: Bates (Bermuda). C-L: Marine Sciences. One course.

191. Independent Study. Open to qualified juniors and seniors with consent of instructor and director of undergraduate studies. Instructor: Staff. One course.

191A. Independent Study. See Environment 191. Open to qualified juniors and seniors with consent of instructor and director of undergraduate studies. Instructor: Staff. Half course.

192. Independent Study. See Environment 191. Open to qualified juniors and seniors with consent of instructor and director of undergraduate studies. Instructor: Staff. One course.

192A. Independent Study. See Environment 191A. Open to qualified juniors and seniors with consent of instructor and director of undergraduate studies. Instructor: Staff. Half course.

208. Estuarine Ecosystem Processes. A study of the physical, chemical, geological, and biological processes that control the structure of estuarine communities. Includes readings, oral presentations, and discussion of current literature from the journal *Estuaries*. Discussions focus on the management and policy implications of the science. Restricted to graduate students. (Given at Beaufort.) Prerequisite: ecology, systematics, or field biology course or consent of instructor. Instructor: Kirby-Smith. C-L: Marine Sciences. 3 units.

209. Conservation Biology and Policy. Introduction to the key concepts of ecology and policy relevant to conservation issues at the population to ecosystems level. Focus on the origin and maintenance of biodiversity and conservation applications from both the biology and policy perspectives (for example, endangered species, captive breeding, reserve design, habitat fragmentation, ecosystem restoration/ rehabilitation). Open to
undergraduates only under Biology 109. (Given at Beaufort.) Prerequisite: introductory biology; suggested: a policy and/or introductory ecology course. Instructors: Crowder (Beaufort) and staff. C-L: Marine Sciences. 3 units.

218L. Barrier Island Ecology. N S, Q ID, R An integration of barrier island plant and animal ecology within the context of geomorphological change and human disturbance. Experimental evidence supporting the theory of barrier island formation and migration; plant and animal adaptations and their evolution, succession ecology, and conservation and restoration ecology. Strong emphasis in labs on independent use of quantitative field observation and research techniques. (Given at Beaufort.) Prerequisite: Biology 25L or equivalent; suggested: course in botany or ecology. Instructors: Peterson and Wells (visiting summer faculty). C-L: Biology 218L, C-L: Marine Sciences. One course or 4 units.

219L. Marine Ecology. Factors that influence the distribution, abundance, and diversity of marine organisms. Course structure integrates lectures and field excursions. Topics include characteristics of marine habitats, adaptation to environment, species interactions, biogeography, larval recruitment, and communities found in rocky shores, tidal flats, beaches, mangrove, coral reefs, and subtidal areas. Not open to students who have taken Biology 203L. Open to undergraduates only under Biology 129L. (Given at Beaufort fall and summer and at Bermuda, spring.) Prerequisite: introductory biology. Instructors: Crowder or Kirby-Smith (Beaufort); Lipschultz and Smith (Bermuda) C-L: Biology 203L. C-L: Marine Sciences. 4 units.

222L. Physical Processes in Coastal Environments. N S The physical processes of beaches, the inner continental shelf, and estuaries, in the context of their implications for the biological and geological environments. Topics drawn from the origin of waves, currents, tides, turbulence, and mixing transport of sand and larvae. Applications to biomechanics and coastal erosion, and to marine ecology, coastal zone management, and water quality. (Given at Beaufort.) Prerequisites: Mathematics 31 and 32. Instructor: Staff. C-L: Earth and Ocean Sciences 201L, C-L: Marine Sciences. One course or 4 units.

224L. Coastal Ecosystem Processes. N S, Q ID Physical, chemical, and biological processes in the coastal zone of the Carolinas. A unifying theme will be the coupling of watersheds, river basins, estuaries, and the coastal ocean through the movement of ground and surface waters. Topics include hydrology, nutrient cycles, sediment-water column interactions, primary and secondary production, and food web dynamics. Sustaining coastal ecosystems in the face of land use change. (Given at Beaufort). Instructors: Ramus and staff. C-L: Biology 219L. C-L: Marine Sciences. One course or 4 units.

225L. Coastal Ecotoxicology and Pollution. Principles of transport, fates, food-web dynamics and biological effects of pollutants in the marine environment. Laboratory to stress standard techniques for assessing pollutant levels and effects. (Given at Beaufort.) Prerequisites: introductory chemistry and biology. Instructor: Staff. C-L: Marine Sciences. One course or 4 units.

226. Marine Mammals. Ecology, social organization, behavior, acoustic communication, and management issues. Focused on marine mammals in the southeastern United States (for example, bottlenose dolphin, right whale, West Indian manatee). Only open to undergraduates under Biology 126. (Given at Beaufort.) Prerequisite: introductory biology. Instructor: Read or staff. C-L: Marine Sciences. 3 units.

226L. Marine Mammals. Laboratory version of Environment 226. Laboratory exercises consider social organization and acoustic communication in the local bottlenose dolphin population. (Given at Beaufort.) Prerequisite: introductory biology. Instructor: Read or staff. C-L: Marine Sciences. 4 units.
227L. Biology and Conservation of Sea Turtles. Biology including the anatomy, physiology, behavior, life histories, and population dynamics of sea turtles linked to conservation issues and management. Focus on threatened and endangered sea turtle species, with special attention to science and policy issues in United States waters. Includes field experience with the animals and with their habitat requirements. Sea turtle assessment and recovery efforts, fishery-turtle interactions, population modeling and state/ national/ international management efforts. Only open to undergraduates under Biology 125L. (Given at Beaufort.) Prerequisite: introductory biology. Instructor: Crowder, Wyneken (visiting summer faculty), and staff. C-L: Marine Sciences. 4 units.

228L. Physiology of Marine Animals. Environmental factors, biological rhythms, and behavioral adaptations in the comparative physiology of marine animals. Open to undergraduates only under Biology 150L. Four units (fall); six units (summer). (Given at Beaufort.) Prerequisites: introductory biology and chemistry. Instructor: Forward. C-L: Biology 253L. C-L: Marine Sciences. Variable credit.

229L. Biochemistry of Marine Animals. Functional, structural, and evolutionary relationships of biochemical processes of importance to marine organisms. Open to undergraduates only under Biology 155L. Four units (fall and spring); six units (summer). (Given at Beaufort.) Prerequisites: Biology 25L; and Chemistry 11L, 12L. Instructor: Rittschof (summer). C-L: Biology 255L. C-L: Marine Sciences. Variable credit.


244L. Molecular and Cellular Processes in Marine Organisms. Joint research projects on the adverse effects of environmental pollutants on marine organisms at the cellular and molecular level. Research methodologies include: spectroscopy (UV/VIS, fluorescence, and atomic absorption); subcellular fractionation; protein purification and characterization using chromatography and electrophoresis; analysis of pollutant-induced damage to proteins, membranes, and DNA; measurement of activity of enzymatic defense systems. Lectures cover molecular mechanisms of damage and damage control, and concepts that underlie the methods to be used. (Given at Beaufort.) Prerequisite: organic chemistry. Instructors: C. Bonaventura and McClellan-Green. C-L: Cell Biology 244L. C-L: Marine Sciences. One course or 4 units.

253L. Sensory Physiology and Behavior of Marine Animals. Sensory physiological principles with emphasis on visual and chemical cues. Laboratories will use behavior to measure physiological processes. Only open to undergraduates under Biology 156L. (Given at Beaufort.) Prerequisites: introductory biology and chemistry. Instructors: Forward and Rittschof. C-L: Marine Sciences. 4 units.

254. Research Design in Marine Studies. Fundamentals of research design with emphasis on linkage between theory, empirical statements, study objectives, study design, data collection, statistical analysis, and integration. Consideration of coastal and marine examples from both natural and social sciences. Enrollment limited to graduate students. (Given at Beaufort.) Instructor: Johnson. C-L: Marine Sciences. 4 units.

255S. Seminar in Ocean Sciences. Biological, chemical, physical, and geological aspects of the ocean and their relation to environmental issues. Consent of instructor required. (Given at Beaufort.) Instructor: Staff. C-L: Marine Sciences. Half course or 2 units.

267S. Conservation Biology of Marine Mammals. Examination of issues affecting the conservation of marine mammal populations, including: habitat loss and degrada-
tion, interactions with commercial fisheries, and direct harvests. Consent of instructor required. (Given at Beaufort.) Instructor: Read. C-L: Marine Sciences. Half course or 2 units.

269S. Advanced Topics in Marine Ecology. NS Theoretical concepts from population, community, and evolutionary ecology will be linked to observations and experiments to enhance understanding of the structure and function of marine systems. Current topics in marine ecology (for example, marine food web dynamics, species interactions, life history strategies, fisheries ecology, conservation biology). Discussions based on readings from the primary literature with emphasis on developing critical and synthetic skills. Each student will prepare a research proposal in NSF format. May be repeated. (Given at Beaufort.) Instructor: Crowder C-L: Biology 264S, C-L: Marine Sciences. Half course or 2 units.

273. Marine Fisheries Policy. Principles, structure, and process of public policy-making for marine fisheries. Topics include local, regional, national, and international approaches to the management of marine fisheries. A social systems approach is used to analyze the biological, ecological, social, and economic aspects of the policy and management process. (Given at Beaufort.) Instructor: Orbach. C-L: Marine Sciences. One course or 3 units.

276. Marine Policy. SS Formal study of policy and policy-making concerning the coastal marine environment. History of specific marine-related organizations, legislation, and issues and their effects on local, regional, national, and international arenas. Topics explored through use of theoretical and methodological perspectives, including political science, sociology, and economics. Consent of instructor required. (Given at Beaufort.) Instructor: Orbach C-L: Public Policy Studies 197, C-L: Marine Sciences. One course or 3 units.

291. Geological Oceanography. NS The geology of ocean basins, including origin, bottom physiography, sediment distribution, and sedimentary processes. Not open to students who have taken Earth and Ocean Sciences 206S. (Given at Beaufort.) Instructor: Staff. C-L: Earth and Ocean Sciences 205, C-L: Marine Sciences. One course or 3 units.

292L. Biological Oceanography. Physical, chemical, and biological processes of the oceans, emphasizing special adaptations for life in the sea and factors controlling distribution and abundance of organisms. Only open to undergraduates under Biology 114L. Four units (spring); six units (summer). (Given at Beaufort and Bermuda.) Prerequisite: introductory biology. Instructors: Ramus or staff (Beaufort); Lipschultz and Schnetzer (Bermuda). C-L: Marine Sciences. Variable credit.

293. Analysis of Ocean Ecosystems. The history, utility, and heuristic value of the ecosystem; ocean systems in the context of Odum's ecosystem concept; structure and function of the earth's major ecosystems. Open to undergraduates only under Biology 123. (Given at Beaufort.) Prerequisite: one year of biology, one year of chemistry, or consent of instructor. Instructor: Barber. C-L: Marine Sciences. 3 units.

295L. Marine Invertebrate Zoology. Structure, function, and development of invertebrates collected from estuarine and marine habitats. Not open to students who have taken Biology 176L, Biology 274L, or Zoology 274L. Open to undergraduates only under Biology 176L. Four units (fall, spring, and Summer Term II); six units (Summer Term I). (Given at Beaufort fall, spring, and summer or at Bermuda, spring.) Prerequisite: Biology 25L. Instructors: Dimock (Beaufort) or Kirby-Smith (Beaufort); Barnes and Coates (Bermuda). C-L: Biology 274L, C-L: Marine Sciences. Variable credit.

298. Special Topics. Content to be determined each semester. May be repeated. Instructor: Staff. Variable credit.
299. Independent Studies and Projects. Directed readings or research at the graduate level to meet the needs of individual students. Consent of instructor required. Units to be arranged. Instructor: Staff. Variable credit.

398. Program Area Symposium. Required symposium in each program area. Students present master's project research. Pass/ fail grading only. Instructor: Staff

399. Master's Project. An applied study of a forestry or environmental management problem or a theoretical research effort. A seminar presentation of the objectives, methodology, and preliminary findings is required. A written (or other medium) report at the conclusion of the project is also required. Undertaken with the guidance of the student's adviser. Consent of instructor required. Pass/ fail grading only. Instructor: Staff. Variable credit.

COURSES CURRENTLY UNSCHEDULED

134L. Biological Cycles in the Ocean
223L. Behavioral Ecology
252L. Statistics and Data Analysis in Earth and Ocean Science
268. Advanced Topics in Nearshore Processes

Public Policy Studies (PUBPOL)

197. Marine Policy. SS Formal study of policy and policy-making concerning the coastal marine environment. History of specific marine-related organizations, legislation, and issues and their effects on local, regional, national, and international arenas. Topics explored through use of theoretical and methodological perspectives, including political science, sociology, and economics. Consent of instructor required. (Given at Beaufort.) Instructor: Orbach. C-L: Environment 276, C-L: Marine Sciences. One course or 3 units.