

July 2008

## **ECOTOXICOLOGY AND ENVIRONMENTAL HEALTH** (Master of Environmental Management)

The **Ecotoxicology and Environmental Health Program (EEH)** emphasizes interactions among human/environmental health and ecological processes. The **EEH** is concerned with the fates, effects, and risks of pollutants to natural ecosystems and human users of those systems both within the U.S. and internationally. A multidisciplinary program, **EEH** incorporates the concepts, information bases, and methodologies of toxicology, environmental chemistry, risk assessment and ecology. This program stresses risk assessment attendant to actions/processes that affect human/environmental health and provides a scientific approach to environmental management. By instilling in the student a science-based approach combining integrated assessment for humans, biota, and natural resources, **EEH** seeks to produce scientists and environmental managers with a solid foundation in the principles underlying pollutant fates and impacts on ecology and environmental health, as well as a firm grasp of state-of-the-art approaches for evaluating specific instances of environmental contamination and for making management decisions based upon quantitative analysis.

The Nicholas School shares research and programmatic overlap with the Duke University Medical Center especially the Duke Global Health Institute. In addition, Occupational/environmental health and safety represents an interdisciplinary program between the Nicholas School of the Environment and the Division of Occupational and Environmental Medicine, Duke University Medical Center. Additionally, the entire **EEH** program is enhanced by resources of sister universities in the Research Triangle area (particularly the University of North Carolina at Chapel Hill and North Carolina State University) and institutions within the Research Triangle Park, such as the Environmental Protection Agency, the National Institutes of Environmental Health Sciences, Research Triangle Institute, and the Hamner Institutes for Health Sciences (formerly Chemical Industries Institute of Toxicology).

Important areas of strength are: environmental chemistry; toxic chemicals and other environmental stressors, including mechanisms of toxicity, fate and transport in the environment, and effects on ecosystems and human health; occupational and environmental health; and risk assessment. Methodologies addressed include chemical analysis, molecular and cellular approaches, geospatial analysis, field studies, and environmental epidemiology.

Graduates of the program have the skills to become analysts or consultants for private industry and public agencies that deal with health effects and environmental issues including: international aid organizations, public health departments, federal agencies managing disaster relief, departments of agriculture, nuclear regulatory councils, and state and federal environmental protection agencies. Graduates have a very strong record of obtaining jobs.

During the first year of study, students enrolled in the **EEH** will work with a faculty member on course selection and in determining an area of study for the Master's Project. By the end of the first year, the student will choose an advisor who will work with the student on developing a project, as well as advising on courses to be taken during the second year. The summer between the first and second years is often spent in an internship or research laboratory position; this work is frequently the basis for the Master's Project. In the second year, the student will complete the course requirements and devote time to the completion of the Master's Project. A paper and presentation will be made at the end of the second semester of the second year.

This program relies largely on faculty and courses taught at the Durham campus, but it is possible for a student to take appropriate classes for one semester at the Duke University Marine Laboratory. This approach would be desirable if the student is interested in developing a project dealing with coastal environmental change.

### **Research Track**

The research track provides specialized and concentrated in-depth training in one of the research areas of participating faculty. Moreover, this specialization provides a research-oriented approach without the commitment to a Ph.D. degree program. Students admitted to this track will perform a research project under the direction of a faculty mentor. This is a highly competitive track with limited openings. It is anticipated that a given faculty member will typically admit no more than one MEM student into this track each year. Students wishing to enter the research track must commit to working on their research project in the faculty member's research laboratory during the summer between their first and second year, and frequently need to devote some time to laboratory work during their second year as well.

### **PREREQUISITES**

School-wide prerequisites: one semester of college calculus; an introductory applied statistics course covering descriptive statistics, probability distributions, hypothesis testing, confidence intervals, correlation, simple linear regression, and simple ANOVAs; one semester of college biology (including animal or human physiology); one semester of college chemistry; and, one semester of organic chemistry.

## CURRICULUM

The curriculum consists of 4 core courses, 3 courses within a chosen specialization, 4 courses of approaches to include: 1 statistics class, 1 law, economics or policy class, and 2 courses in a focal area (see page 5); 1 required course in ecology (see list below); the Master's Project and associated seminar, plus elective courses to total 48 credits..

### CORE COURSES \* (each of the 4 courses below at least 12 credits)

- |                   |   |
|-------------------|---|
| 1) ENVIRON 240    | Chemical Fate of Organic Compounds or ENVIRON 242 (Aquatic Chemistry) |
| 2) ENVIRON 212    | Environmental Toxicology  |
| 3) ENVIRON 239    | Human Health and Environmental Risk Assessment                        |
| 4) ENVIRON 298.02 | Environmental Epidemiology  |

**The required graduate level course in ecology** may be selected from one of the examples below; or, select another with approval of advisor).

EOS 251S	Global Environmental Change
ENVIRON 203	Conservation Biology Theory/Practice
ENVIRON 213	Forest Ecosystems
ENVIRON 214	Landscape Ecology
ENVIRON 312	Wetlands Ecology
EOS 272	Biogeochemistry
BIOLOGY 217	Ecology/Global Change
BIOLOGY 267L	Biodiversity Science and Applications

All students are encouraged to develop a specialization in one of the three areas listed below. A minimum of 9 credits within a specialty is required. (Note: This is in addition to the required core course requirements.) For students wishing to emphasize environmental health, a number of required specialization courses are identified. Alternatively, students may select a combination of courses from the specialties; in this case, a combined minimum of 15 credits is required. The courses listed below are appropriate examples; students are encouraged to identify other appropriate courses at Duke and neighboring universities.

## **SPECIALIZATIONS (3 courses, at least 9 credits)**

### **1. Environmental Toxicology**

*At least one additional course in toxicology is required. Remaining courses may include any combination of graduate-level toxicology, physiology, biochemistry, and molecular biology.*

ENVIRON 228L. Physiology of Marine Animals (4-6 units, Beaufort)

ENVIRON 298.60 Pathobiology for Toxicologists (3 units)

ENVIRON 319. Mechanisms in Environmental Toxicology (3 units)

BCH 227. Introductory Biochemistry I (3 units)

PHARM 233. Essentials of Pharmacology and Toxicology (4 units)

### **2. Environmental Chemistry**

ENVIRON 242. Environmental Aquatic Chemistry (3 units)

ENVIRON 279. Atmospheric Chemistry: Principles and Processes (3 units)

*In addition one additional course from those listed below is to be taken:*

*Other appropriate courses include:*

ENVIRON 298.81 Instrumental Methods for Pollutant Analysis (Lab component)

EOS 251 Global Environmental Change (3 units)

EOS 272/ Biogeochemistry (3 units)

EOS 273S. Analytic Techniques (3 units)

CE 208 Environmental Transport (3 units)

CE 239L Environmental Molecular Biotechnology (Lab component)

CE 249 Hazardous/Toxic Waste (3 units)

### **3. Environmental Health**

*Students in this specialization are required to take these two courses:*

ENVIRON 246. Survey of Occupational Health and Safety (3 units, fall)

ENVIRON 247. Survey of Environmental Health and Safety (3 units, fall)

*In addition one additional course from those listed below is to be taken:*

ENVIRON 230. Environmental Health Issues (3 units, fall)

ENVIRON 430. Health Effects of Environmental Agents (3 units, fall)

*The following courses can be used with approval as electives:*

ENVIRON 235 Air Quality Management (3 units)

BCH 227 Introductory General Biochemistry (4 units)

CEE 249 Control of Hazardous and Toxic Waste Engineering (3 units)

## **APPROACHES (4 courses, at least 12 credits)**

**One statistics course (either introductory level or, if qualified, second level course) is required.**

BAA 250 Biometry(

ENVIRON 210 Applied Data Analysis for Environmental Science

ENVIRON 255 Applied Regression Analysis

PHARMA 333 Statistics for Basic Biomedical Scientists

**FOCAL AREA (2 courses in a focal area are required, at least 6 credits)**

Examples of Focal Areas are provided below.

Focal Area in Statistical/Mathematical Modeling

ENVIRON 210	Applied Data Analysis
ENVIRON 255	Applied Regression Analysis
ENVIRON 236	Water Quality Modeling

Focal Area in Risk Analysis

ENVIRON 239	Human Health and Environmental Risk Assessment
ENVIRON 385	Environmental Decision Analysis
BA 510	Bayesian Inference and Decision

Focal Area in Geospatial analysis

ENVIRON 259	Fundamental of GIS and Geospatial Analysis
ENVIRON 359	Advanced Geospatial Analysis

Focal Area in Field studies

BIO 222	Entomology
ENVIRON 298.17	Wetlands Field Skills
ENVIRON 201	Forest Resources Field Skills

**A single course in law, policy, economics or other social science relevant to the chosen specialization, is required.**

- LAW 235. Environmental Law (3 units) moved to here]
- LAW 488 Regulating Hazardous Waste (2 units)
- PPS 219 American Grand Strategy (3 units)
- PPS 255S Health Policy Analysis
- PPS 263S Public Health Issues: Prevention and Management
- SOCIOL 227BS ProSeminar Medical Sociology

**Master's Project (5-7 credits)**

- ENVIRON 398.07S MP Seminar (1 credit)
- ENVIRON 399.xx: Master's Project (4-6 credits)

**Electives (8-10 credits)**

**Participating Faculty**

Faculty members who are participating in this program and will serve as advisors are listed below with contact information. Additional information can be found at individual web sites at [www.env.duke.edu](http://www.env.duke.edu).

Richard DiGiulio	<a href="mailto:richd@duke.edu">richd@duke.edu</a>	Program Chair
Celia Bonaventura	<a href="mailto:bona@duke.edu">bona@duke.edu</a>	
David E. Hinton	<a href="mailto:dhinton@duke.edu">dhinton@duke.edu</a>	
Prasad Kasibhatla	<a href="mailto:psk9@duke.edu">psk9@duke.edu</a>	

Randall Kramer	<a href="mailto:kramer@duke.edu">kramer@duke.edu</a>
Joel Meyer	<a href="mailto:joel.meyer@duke.edu">joel.meyer@duke.edu</a>
Marie Lynn Miranda	<a href="mailto:mmiranda@duke.edu">mmiranda@duke.edu</a>
Dan Rittschof	<a href="mailto:ritt@duke.edu">ritt@duke.edu</a>
Heather Stapleton	<a href="mailto:heather.stapleton@duke.edu">heather.stapleton@duke.edu</a>
Wayne Thomann	<a href="mailto:thoma010@mc.duke.edu">thoma010@mc.duke.edu</a>
Avner Vengosh	<a href="mailto:vengosh@duke.edu">vengosh@duke.edu</a>