

# ENVIRONMENT, ECOLOGY, AND ENERGY PROGRAM (GRAD)

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The Environment, Ecology, and Energy Program (E3P) is a multidisciplinary, degree-granting program that seeks to foster an understanding and appreciation of ecological systems and to demonstrate the value of ecological approaches to the solution of current and future environmental problems. With the participation of faculty and students from many disciplines and departments, emphasis is placed on interdisciplinary activities that explicitly consider the complexity of the environment and integrated approaches to problem identification and solution. In particular, it seeks to foster an understanding and appreciation of ecological systems, human and nonhuman, and to demonstrate the value of ecological approaches to the solution of current and future environmental problems.

Current faculty come from the departments of anthropology, biology, biostatistics, city and regional planning, communication, economics, environmental sciences and engineering, geography, earth, marine and environmental sciences, public policy, and sociology. Whereas degree programs with a strong ecology component may be arranged in other departments, by combining many approaches and methods and by linking the social and natural sciences the curriculum explicitly considers the complexity of the environment and the need for integrated approaches to problem identification and solution. Using the resources of many departments, E3P provides both broad and specialized training in ecology, human ecology, and the study of environmental systems. Graduate degrees available in the program are the master of science, the master of arts, and the doctor of philosophy. Applications will be accepted from persons with varied backgrounds and goals, with the specific program of study and research tailored to the needs of the individual.

## Requirements for Admission

For admission to E3P, an undergraduate degree is required in a natural science such as physics, chemistry, biology, bacteriology, botany, zoology, or geology; a social science such as anthropology, sociology, or economics; a mathematical area such as statistics, mathematics, or systems analysis; an engineering area; or environmental science. To guarantee full consideration for admission and campus fellowships, students must submit all program and Graduate School admission materials by mid-December. Late applications will cause students to miss out on some opportunities. The specific deadline in a given year can be found by checking the E3P website (<https://e3p.unc.edu/academics/graduate-program/graduate-admissions/>) and The Graduate School's admissions website (<http://gradschool.unc.edu/admissions/>).

Every student must gain an understanding of the breadth and depth of ecology and environmental sciences as they are treated among various traditional disciplines. This is accomplished in two ways: first, through the ENEC 567 and ENEC 569 course sequence; and second, through the composition of the student's advisory committee. Students are required to do their best to establish state residency in their first year and must apply for state residency after their first year in order to be considered for tuition remission in subsequent years.

## Doctor of Philosophy

Each ecology Ph.D. student, in addition to taking ENEC 567 and ENEC 569, must register for ENEC 994 at least once for three hours credit. There are no other course requirements for the Ph.D. except for those designated by the student's graduate advisory committee and as long as the student meets the credit hour requirements of The UNC Graduate School.

Owing to the diversity of research methods and approaches within the field of ecology and environmental sciences, the curriculum has no explicit research skill course requirements for graduate degrees. The student's graduate advisory committee is responsible for seeing that the student has gained the proficiencies expected of a degree candidate in the student's selected area of expertise.

## Master's Degrees

Two master's degrees are offered by the program: the master of science degree requiring independent research and a thesis, and the master of arts degree requiring a thesis question and literature research review. All master's degrees are terminal degrees at UNC-Chapel Hill. Master's students must request readmission for Ph.D. work following completion of all requirements for the master's degree.

### Master of Science

The master of science course requirements are determined by the student's advisory committee. They must include a minimum of 30 hours of graduate credit (of which no less than 24 hours must be earned in courses, and at least three hours in research), and completion of the thesis. One semester of registration is required in ENEC 567 and ENEC 569, and M.S. students must register for three hours of ENEC 993.

### Master of Arts

Requirements for the master of arts are the same as those for the master of science, except a master of arts paper is prepared (ENEC 992) in place of a master's thesis (ENEC 993).

## Adjunct Professors

**Carol Arnosti**, Carbon Cycling in the Ocean, Organic Marine Geochemistry  
**Larry K. Benninger**, Low-Temperature Geochemistry  
**Richard E. Bilsborrow**, Economic Demography, Population, Development and the Environment  
**John F. Bruno**, Ecology and Conservation of Marine Communities  
**Jaye Cable**, Marine Sciences, Chemical Oceanography  
**Michael Emch**, Medical Geography, Epidemiology  
**Barbara Entwisle**, Social Demography, Population and Environment  
**Patricia Gensel**, Paleobotany, Patterns of Evolutionary Change  
**Joel G. Kingsolver**, Environmental Physiology, Functional Morphology, Population Ecology and Evolution  
**Paul W. Leslie**, Human Ecology, Population Biology  
**Christopher S. Martens**, Biogeochemistry  
**Charles Mitchell**, Disease Ecology, Global Change, Biological Invasions  
**Rachel Noble**, Environmental Microbiology, Marine Microbial Ecology  
**Hans Paerl**, Microbial Ecology, Estuarine and Coastal Ecology, Water Quality Dynamics  
**Robert K. Peet**, Plant Community and Population Ecology, Biogeography, Ecoinformatics  
**Charles H. Peterson**, Marine Ecology, Population and Community Processes  
**David W. Pfennig**, Evolutionary Ecology

**Karin S. Pfennig**, Behavioral Ecology and Evolution, Speciation, Host-Parasite Interactions

**Michael F. Piehler**, Coastal Ecosystems and Human Health, Tracking Pathogens in Water

**Maria Servedio**, Evolutionary Ecology, Behavioral Ecology

**Donna Surge**, Paleoclimatology, Paleoecology, Low-Temperature Geochemistry

**Gonghe Song**, Remote Sensing of Vegetation, Ecological Modeling, Geographic Information Systems

**Jill Stewart**, Linkages between Ecosystems and Human Health, Tracking Pathogens in Water

**Andreas P. Teske**, Microbial Ecology, Evolution and Systematics

**Stephen J. Walsh**, Land Use and Land Cover Dynamics, Spatial Modeling and Analysis

**Jason West**, Climate and Air Quality Modeling

**Peter S. White**, Plant Population and Community Ecology, Conservation Biology

**Andrew J. Yates**, Resource Economics, Environmental Markets

## Adjunct Associate Professors

**Marc Alperin**, Carbon Cycling in Coastal Sediments, Global Carbon Budgets

**Todd Bendor**, Computer Modeling in Human Ecological Impacts, Land Use and Environmental Planning

**Karl Castillo**, Ecophysiology of Coral Reefs, Climate Change and Ocean Acidification Effects

**Xiaodong Chen**, Coupled Human-Natural Systems, Remote Sensing and GIS

**Joel Fodrie**, Coastal Biological Oceanography

**Clark Gray**, Population Mobility and Environmental Change

**Allen Hurlbert**, Community Ecology, Biogeography, Avian Ecology

**Nihkil Kaza**, Urban Development, Energy Planning and Landscape

**Charles E. Konrad**, Synoptic Climatology and Climate Change

**Adrian Marchetti**, Ecophysiology and Molecular Biology of Marine Phytoplankton

**Aaron Moody**, Remote Sensing, Landscape Ecology, Biogeography, Geographical Information Systems

**Laura Moore**, Large-Scale Geologic and Modern Evolution of Coastal Environments

**Tamlin Pavelsky**, World Hydrology, Remote Sensing

**Johanna Rosman**, Coastal and Estuarine Physical Oceanography

**Alan Weakley**, Plant Systematics, Floristics, Biogeography, Conservation Biology, Bioinformatics

**Colin West**, Human Ecology of Global Change, Ecological Anthropology

**Erika Wise**, Climatology and Endochronology, Climate Variability

## Adjunct Assistant Professors

**Elizabeth Dickinson**, Environmental Communication

**Lindsay Dubbs**, Ecological and Environmental Impacts on Energy Generation, Biogeochemistry

**Diego Riveros-Iregui**, Watershed and Ecohydrology, Biogeochemistry

**Alecia Septer**, Microbial Ecology, Microbiology

**James Umbanhowar**, Theoretical Ecology, Dynamics of Species Interactions Webs, Host-Parasitoid Interactions

## Faculty Emeriti

**Richard N. Andrews**, Environmental and Energy Policy, Policy Instruments and Incentives

**Joe Carter**, Invertebrate Paleontology

**John W. Florin**, Population Geography, Medical Geography

**R. Haven Wiley**, Behavioral Ecology of Vertebrates, Avian Social Behavior

## ENEC

### Advanced Undergraduate and Graduate-level Courses

#### ENEC 403. Environmental Chemistry Processes. 3 Credits.

Required preparation, a background in chemistry and mathematics, including ordinary differential equations. Chemical processes occurring in natural and engineered systems: chemical cycles; transport and transformation processes of chemicals in air, water, and multimedia environments; chemical dynamics; thermodynamics; structure/activity relationships.

#### Rules & Requirements

**Requisites:** Pre- or corequisite, CHEM 261.

**Grading Status:** Letter grade.

**Same as:** ENVR 403, CHEM 403.

#### ENEC 405. Mountain Preservation. 4 Credits.

Introduces students to approaches used to preserve the natural and cultural heritage of the Southern Appalachians. Taught at off-campus field station.

#### Rules & Requirements

**Grading Status:** Letter grade.

#### ENEC 406. Atmospheric Processes II. 4 Credits.

Principles of analysis of the atmosphere are applied to the analysis of environmental phenomena. The link between the atmosphere and other environmental compartments is explored through environmental case studies.

#### Rules & Requirements

**Grading Status:** Letter grade.

**Same as:** GEOG 406.

#### ENEC 407. Principles of Energy Conversion. 3 Credits.

Recommended preparation, ENEC 201, and MATH 152 or 231. This course will get students familiar with the principles governing the conversion of a variety of non-renewable and renewable resources to energy services. Physical, chemical, and biological principles involved in the design and analysis of these systems will be reviewed. The basics of project economics applied to the design of energy conversion systems will also be introduced.

#### Rules & Requirements

**Grading Status:** Letter grade.

#### ENEC 410. Earth Processes in Environmental Systems. 4 Credits.

Principles of geological and related Earth systems sciences are applied to analyses of environmental phenomena. The link between the lithosphere and other environmental compartments is explored through case studies of environmental issues. Three lecture hours and one laboratory hour a week.

#### Rules & Requirements

**Requisites:** Prerequisites, CHEM 102, GEOL 200, and MATH 231; and PHYS 115 or 119; permission of the instructor for students lacking the prerequisites.

**Grading Status:** Letter grade.

**Same as:** EMES 410.

**ENEC 411. Oceanic Processes in Environmental Systems. 4 Credits.**

Principles of analysis of the ocean, coast, and estuarine environments and the processes that control these environments are applied to the analysis of environmental phenomena. Case studies of environmental issues. Three lecture hours and one laboratory hour a week.

**Rules & Requirements**

**Requisites:** Prerequisite, BIOL 101, CHEM 102, ENEC 222, MATH 231, PHYS 115 or PHYS 119; permission of the instructor for students lacking the prerequisites.

**Grading Status:** Letter grade.

**Same as:** EMES 411.

**ENEC 412. Principles and Methods of Teaching Earth Science. 4 Credits.**

Required preparation, any introductory geology course. This course develops the knowledge and skills teachers need to implement inquiry-based earth science instruction: conceptual knowledge of earth sciences and mastery of inquiry instructional methods. Students study inquiry in cognitive science and learning theory. This course is a requirement for the UNC-BEST program in geological sciences. Course previously offered as GEOL 412.

**Rules & Requirements**

**IDEAs in Action Gen Ed:** HI-SERVICE.

**Making Connections Gen Ed:** EE- Service Learning.

**Grading Status:** Letter grade.

**Same as:** EMES 412.

**ENEC 415. Environmental Systems Modeling. 3 Credits.**

This course explores principles and strategies for studying environmental phenomena, and presents methods for developing explanatory and predictive models of environmental systems, e.g., predator-prey, estuaries, greenhouse gases, and ecosystem material cycles.

**Rules & Requirements**

**Requisites:** Prerequisite, MATH 383; pre- or corequisite, PHYS 115 or 118, and COMP 116.

**Grading Status:** Letter grade.

**Same as:** EMES 415.

**ENEC 416. Environmental Meteorology. 3 Credits.**

This course explores atmospheric processes most important to environmental problems such as the transport and transformation of air pollutants and weather systems involved in intercontinental transport of gases and particles.

**Rules & Requirements**

**Grading Status:** Letter grade.

**ENEC 417. Surface Processes and Landscape Evolution. 4 Credits.**

The interplay among the fluxes of water, energy, and sediment through geologic time sculpt landscapes and drive environmental change. In both lectures and laboratory exercises, students will learn how simple physical principles applied to rivers and hillslopes allow us to understand the evolution of topography and mountain belts, predict hazards arising from floods, landslides and debris flows, and lead to sustainable management of natural resources such as soil. Previously offered as GEOL 417.

**Rules & Requirements**

**Requisites:** Pre- or corequisites, EMES 200 and EMES 201; permission of the instructor for students lacking the pre- or corequisites.

**Grading Status:** Letter grade.

**Same as:** EMES 417.

**ENEC 420. Community Design and Green Architecture. 3 Credits.**

The impact of building on the environment and health will be examined by looking at the major areas of: land use planning, water resource use, energy, materials and indoor environment.

**Rules & Requirements**

**Grading Status:** Letter grade.

**Same as:** PLAN 420.

**ENEC 421. Textiles: Environmental Impacts, Issues, and Innovations. 3 Credits.**

Textiles are pervasive in our lives, from clothing to upholstery, yet have major impacts on our environment and health, from the products' cradle to grave. This course examines the environmental and social costs of producing our clothing, carpet, and other textiles in daily life. We will also consider possible solutions currently offered by industry and entrepreneurs.

**Rules & Requirements**

**Requisites:** Pre- or co-requisite, ENEC 201 or 202; permission of the instructor for students lacking the prerequisite.

**Grading Status:** Letter grade.

**ENEC 431. Sustainable Cities: Exploring Ways of Making Cities More Sustainable. 3 Credits.**

Recommended preparation, ENEC 330. For the first time in history, a majority of the world's people live in cities with huge implications for sustainability. Students will examine the factors driving the trend toward urbanization worldwide, the challenges posed by this trend, and the efforts by cities to become more sustainable.

**Rules & Requirements**

**Grading Status:** Letter grade.

**ENEC 432. Environmental Life Cycle Assessment. 3 Credits.**

Recommended preparation, ENEC 201, and MATH 110 or 130. This class will introduce students to environmental life cycle assessment (LCA). The methodology to calculate the environmental impacts associated with a product, a service, or a system will be reviewed through case studies in the field of energy systems, waste management, and eco-design. Students will also get a chance to learn how to perform a full LCA through a hands-on project using LCA software and databases.

**Rules & Requirements**

**Grading Status:** Letter grade.

**ENEC 433. Wetland Hydrology. 3 Credits.**

Study of wetland ecosystems with particular emphasis on hydrological functioning, the transition from terrestrial to aquatic systems, wetlands as filtration systems, and exchange between wetlands and other environments. Course previously offered as MASC 433.

**Rules & Requirements**

**Grading Status:** Letter grade.

**Same as:** EMES 433.

**ENEC 435. Principles of Environmental Consulting: Mechanics of Groundwater Flow. 3 Credits.**

Water is an essential resource for all life, and the availability of clean water will become one of the most important socio-political and economic discussions over the coming decades. This course covers fundamentals of groundwater storage, subsurface flow, and contaminant transport, emphasizing the role of groundwater in the hydrologic cycle, the relation of groundwater flow to geologic structure, and the management of contaminated groundwater and drinking water resources. Course previously offered as GEOL 435.

**Rules & Requirements**

**Making Connections Gen Ed:** QI.

**Requisites:** Prerequisite, EMES 324; MATH 232; PHYS 114 or 118; permission of the instructor for students lacking the prerequisites.

**Grading Status:** Letter grade.

**Same as:** EMES 435.

 **ENEC 437. Social Vulnerability to Climate Change. 3 Credits.**

How does climate change affect vulnerable human populations? We will attempt to answer a shared research question on this topic by reading the peer-reviewed literature and by conducting a semester-long data analysis project incorporating social and climate data from around the world. This is a course-based undergraduate research experience (CURE).

**Rules & Requirements**

 **IDEAs in Action Gen Ed:** FC-GLOBAL, RESEARCH.

**Making Connections Gen Ed:** EE- Mentored Research, GL.

**Grading Status:** Letter grade.

**Same as:** GEOG 437.

**ENEC 441. Marine Physiological Ecology. 3 Credits.**

This course introduces students to the physiological, morphological, and behavioral factors employed by marine organisms to cope with their physical environment. Emphasis will be placed on the response of marine organisms to environmental factors such as seawater temperature, light, water salinity, ocean acidification, etc. Course previously offered as MASC 441.

**Rules & Requirements**

**Grading Status:** Letter grade.

**Same as:** EMES 441.

**ENEC 444. Marine Phytoplankton. 3 Credits.**

For junior and senior science majors or graduate students. Biology of marine photosynthetic protists and cyanobacteria. Phytoplankton evolution, biodiversity, structure, function, biogeochemical cycles and genomics. Harmful algal blooms, commercial products, and climate change. Three lecture/practical session hours per week. Course previously offered as MASC 444. Permission of the instructor.

**Rules & Requirements**

**Grading Status:** Letter grade.

**Same as:** EMES 444, BIOL 456.

**ENEC 448. Coastal and Estuarine Ecology. 4 Credits.**

A field-intensive study of the ecology of marine organisms and their interactions with their environment, including commercially important organisms. Laboratory/recitation/field work is included and contributes two credit hours to the course. Course previously offered as MASC 448.

**Rules & Requirements**

**Requisites:** Prerequisites, CHEM 102 and MATH 231.

**Grading Status:** Letter grade.

**Same as:** EMES 448.

**ENEC 450. Biogeochemical Processes. 4 Credits.**

Principles of chemistry, biology, and geology are applied to analysis of the fate and transport of materials in environmental systems, with an emphasis on those materials that form the most significant cycles. Three lecture hours and one laboratory hour a week. Previously offered as GEOL 450/MASC 450.

**Rules & Requirements**

**Making Connections Gen Ed:** PL.

**Requisites:** Prerequisites, CHEM 101 or permission of instructor.

**Grading Status:** Letter grade.

**Same as:** EMES 450.

 **ENEC 451. Population, Development, and the Environment. 3 Credits.**

Introduction to contemporary and historical changes in human population, international development, and the global environment and how these processes interact, drawing on population geography as an organizing framework. Previously offered as GEOG 450.

**Rules & Requirements**

 **IDEAs in Action Gen Ed:** FC-GLOBAL.

**Making Connections Gen Ed:** GL.

**Grading Status:** Letter grade.

**Same as:** GEOG 451.

**ENEC 459. Ecological Anthropology. 3 Credits.**

Examines how human-environmental adaptations shape the economic, social, and cultural lives of hunter-gatherers, pastoralists and agriculturalists. Approaches include optimal foraging theory, political ecology and subsistence risk.

**Rules & Requirements**

**Making Connections Gen Ed:** SS.

**Grading Status:** Letter grade.

**Same as:** ANTH 459.

**ENEC 460. Historical Ecology. 3 Credits.**

Historical ecology is a framework for integrating physical, biological, and social science data with insights from the humanities to understand the reciprocal relationship between human activity and the Earth system.

**Rules & Requirements**

**Making Connections Gen Ed:** HS, GL.

**Grading Status:** Letter grade.

**Same as:** ANTH 460.

**ENEC 461. Fundamentals of Ecology. 4 Credits.**

Students will develop a comprehensive understanding of the field of ecology, including modern and emerging trends in ecology. They will develop literacy in the fundamental theories and models that capture ecological processes; emphasis will also be placed on the relevance of ecology and ecological research for human society.

**Rules & Requirements**

**Requisites:** Prerequisites, BIOL 201; or BIOL 103, BIOL 104, and BIOL 260.

**Grading Status:** Letter grade.

**Same as:** BIOL 461.

**ENEC 462. Ecosystem Management. 3 Credits.**

Explores the ecological concepts underlying ecosystem management (e.g., genetic and species diversity, stability, resilience, landscape ecology, etc.), the tools used in the approach, and case studies of how communities are implementing ecosystem management.

**Rules & Requirements**

**Requisites:** Prerequisite, BIOL 101.

**Grading Status:** Letter grade.

 **ENEC 463. Corporate Environmental Stewardship. 3 Credits.**

This course explores the intersection of business/economic growth and the major sustainability issues affecting the environment and societal well-being and raises questions about business ethics and the moral responsibility of business leaders, consumers, and citizens. Previously offered as ENEC 306.

**Rules & Requirements**

 **IDEAs in Action Gen Ed:** FC-GLOBAL or FC-VALUES.

**Making Connections Gen Ed:** PH, CI, GL.

**Requisites:** Prerequisite, ENEC 201.

**Grading Status:** Letter grade.

**Same as:** BUSI 463.

 **ENEC 465. Global Biodiversity and Macroecology. 3 Credits.**

We will explore global patterns of diversity of plants, animals, fungi, and microbes, and the insights gained by taking a statistical approach to describing these and other broad-scale ecological patterns.

**Rules & Requirements**

 **IDEAs in Action Gen Ed:** FC-NATSCI or FC-QUANT, RESEARCH.

**Requisites:** Prerequisites, BIOL 201; or BIOL 103, BIOL 104, and BIOL 260; or permission of the instructor for students lacking the prerequisites.

**Grading Status:** Letter grade.

**Same as:** BIOL 465.

**ENEC 468. Temporal GIS and Space/Time Geostatistics for the Environment and Public Health. 3 Credits.**

Reviews geographical information systems (GIS). Covers geostatistics theory for the interpolation of environmental and health monitoring data across space and time. Uses publicly available water and air quality monitoring data to create maps used for environmental assessment, regulatory compliance analysis, exposure science, and risk analysis.

**Rules & Requirements**

**Requisites:** Prerequisite, MATH 232; permission of the instructor for students lacking the prerequisite.

**Grading Status:** Letter grade.

**Same as:** ENVR 468.

**ENEC 470. Environmental Risk Assessment. 3 Credits.**

Required preparation, one course in probability and statistics. Use of mathematical models and computer simulation tools to estimate the human health impacts of exposure to environmental pollutants. Three lecture hours per week.

**Rules & Requirements**

**Grading Status:** Letter grade.

**Same as:** ENVR 470.

**ENEC 471. Human Impacts on Estuarine Ecosystems. 4 Credits.**

A cohesive examination of the human impacts on biological processes in estuarine ecosystems. Laboratory/recitation/field work is included and contributes two credit hours to the course. Taught at off-campus field station.

**Rules & Requirements**

**Making Connections Gen Ed:** EE- Field Work.

**Requisites:** Prerequisites, CHEM 102 and MATH 231.

**Grading Status:** Letter grade.

**Same as:** EMES 471.

 **ENEC 473. Business and Finance Fundamentals for Change Makers. 3 Credits.**

This course is designed to develop basic finance skills along with familiarity with core business concepts. The goal of the course is to empower non-business majors with the skills and vocabulary required to advance the goals of pro-environment businesses and social entrepreneurs.

**Rules & Requirements**

 **IDEAs in Action Gen Ed:** FC-QUANT.

**Making Connections Gen Ed:** QI.

**Grading Status:** Letter grade.

**ENEC 474. Sustainable Coastal Management. 3 Credits.**

This course explores the environmental history of the Albemarle estuary and its larger watershed and explores ways in which humans can utilize this region in a more sustainable manner. Taught at off-campus field station.

**Rules & Requirements**

**Grading Status:** Letter grade.

**ENEC 475. The Political Economy of Food. 3 Credits.**

This course examines the political and economic dimensions of the food we eat, how it is produced, who eats what, and related social and environmental issues, both domestic and international, affecting the production, pricing, trade, distribution, and consumption of food. Honors version available.

**Rules & Requirements**

**Making Connections Gen Ed:** SS, GL.

**Grading Status:** Letter grade.

**Same as:** PLCY 475.

**ENEC 479. Landscape Analysis. 3 Credits.**

This course utilizes GIS, GPS, and remote sensing technologies to gather data on geology, watersheds, soils, integrated moisture indices. The class also develops habitat maps and derives species diversity indices. Taught at off-campus field station.

**Rules & Requirements**

**Making Connections Gen Ed:** EE- Field Work.

**Grading Status:** Letter grade.

**ENEC 481. Energy Economics. 3 Credits.**

This course develops a core set of principles to understand and evaluate energy markets, policies, and regulations. Topics include oil markets, electric vehicles and CAFÉ standards, pollution permit markets and CO<sub>2</sub> regulations, and electricity markets.

**Rules & Requirements**

**Making Connections Gen Ed:** SS.

**Requisites:** Prerequisite, ECON 101.

**Grading Status:** Letter grade.

**ENEC 482. Energy and the Environment: A Coastal Perspective. 3 Credits.**

Explores coastal and offshore energy issues, including energy demand, present-day and innovative sources of energy to meet that demand, economics, policy, and environmental and human health outcomes of different energy sources. Summer session only; online and field trip hybrid course, with a mandatory 8-day field site component on the Outer Banks. Housing and field activities arranged by the instructor, which will carry a fee. Taught at off-campus field station.

**Rules & Requirements**

**Making Connections Gen Ed:** EE- Field Work.

**Grading Status:** Letter grade.

**ENEC 485. Coastal Resource Economics and Policy. 3-4 Credits.**

This course develops and applies core principles essential to understanding and evaluating coastal environmental policy and renewable resource use. The principles include the economics of pollution, public choice, information and cost-benefit analysis, property rights, incentive-based regulation, and the economics of renewable resources. Includes insights from politics and ethics. Taught at off-campus field station.

**Rules & Requirements**

**Requisites:** Prerequisite, ECON 101.

**Grading Status:** Letter grade.

**ENEC 489. Ecological Processes in Environmental Systems. 4 Credits.**

Principles of analysis of the structure and function of ecosystems are applied to environmental phenomena. The link between the biosphere and other environmental compartments is explored through case studies of environmental issues. Three lecture hours and one laboratory hour a week. Taught at off-campus field station.

**Rules & Requirements**

**Grading Status:** Letter grade.

**ENEC 490. Special Topics in Environmental Science and Studies. 1-12 Credits.**

Advanced topics from diverse areas of environmental science and/or environmental studies are explored. Honors version available.

**Rules & Requirements**

**Repeat Rules:** May be repeated for credit; may be repeated in the same term for different topics; 12 total credits. 4 total completions.

**Grading Status:** Letter grade.

**ENEC 491. Effective Environmental Communication. 3 Credits.**

Combines theory and application to explore effective communication in various environmental contexts and professions. Offers students from diverse disciplines tools to effectively and credibly communicate about environmental topics using a spectrum of strategies, and offers methods for effective thinking, writing, and speaking.

**Rules & Requirements**

**Making Connections Gen Ed:** CI.

**Grading Status:** Letter grade.

**ENEC 492. Social Science Research Methods. 3 Credits.**

Students learn quantitative, qualitative, and mixed methods research skills and their application to public policies and management of natural resources.

**Rules & Requirements**

**Making Connections Gen Ed:** SS, EE- Mentored Research.

**Grading Status:** Letter grade.

 **ENEC 493. Environmental Internship. 1-4 Credits.**

Permission of the instructor. This course provides an internship with an organization related to environmental sciences or studies. Pass/Fail only.

**Rules & Requirements**

 **IDEAs in Action Gen Ed:** HI-INTERN.

**Making Connections Gen Ed:** EE- Academic Internship.

**Repeat Rules:** May be repeated for credit. 6 total credits. 6 total completions.

**Grading Status:** Pass/Fail.

**ENEC 510. Policy Analysis of Global Climate Change. 3 Credits.**

Provides a real-world and relevant case study in which to apply material from multiple disciplines including public policy, economics, environmental science, and international studies. Teaches techniques for building policy models not covered elsewhere.

**Rules & Requirements**

**Making Connections Gen Ed:** SS, GL.

**Grading Status:** Letter grade.

**ENEC 511. Stable Isotopes in the Environment. 3 Credits.**

Introduction to the theory, methods, and applications of stable isotopes to environmental problems. Primary focus will be on the origin, natural abundance, and fractionation of carbon, hydrogen, oxygen, and nitrogen isotopes. Course previously offered as GEOL 511.

**Rules & Requirements**

**Requisites:** Prerequisite, CHEM 102.

**Grading Status:** Letter grade.

**Same as:** EMES 511.

**ENEC 512. Advanced Coastal Environmental Change. 3 Credits.**

This 3-credit seminar-style class for graduate students and advanced undergraduate students focuses on developing a deeper understanding of coastal environmental change as illuminated by the scientific literature, including topics such as climate change impacts; coupled human-natural coastal dynamics; feedbacks between biological and physical processes; carbon storage and flux; adaptive coastal management; and the role of science, policy and communication in coastal resilience. Course previously offered as ENEC 710/GEOL 710/MASC 730.

**Rules & Requirements**

**Requisites:** Prerequisite, EMES 303, 310, 410, 417, or 503; permission of the instructor for students lacking the prerequisite.

**Repeat Rules:** May be repeated for credit. 12 total credits. 4 total completions.

**Grading Status:** Letter grade.

**Same as:** EMES 512.

**ENEC 514. Flood Hydrology: Models and Data Analysis. 3 Credits.**

River floods are critically important in the global hydrologic cycle. While seasonal floods can be environmentally restorative, they can also have devastating socio-economic and public health consequences. Beginning with the hydrologic cycle, this course will cover concepts related to rainfall runoff and hydrologic response, flood frequency analysis, the mechanics of open channel flow, and overland and channel routing. Students will also gain experience working with real-world data and engineering software. Previously offered as GEOL 514.

**Rules & Requirements**

**Requisites:** Prerequisites, EMES 201, EMES 324, MATH 232, and PHYS 114 or 118; or permission of instructor for students missing prerequisites or graduate students.

**Grading Status:** Letter grade.

**Same as:** EMES 414.

**ENEC 522. Environmental Change and Human Health. 3 Credits.**

The course will provide students with a multidisciplinary perspective of environmental changes to encompass both human health and ecological health.

**Rules & Requirements**

**Requisites:** Prerequisite, ENEC 201 or 202.

**Grading Status:** Letter grade.

**Same as:** ENVR 522.

**ENEC 530. Principles of Climate Modeling. 3 Credits.**

Recommended preparation, MATH 383. Develops explanatory and predictive models of the earth's climate. The level is introductory and the emphasis is on modeling past climate with the hope of understanding its future.

**Rules & Requirements**

**Requisites:** Prerequisites, MATH 231, 232, and 233; PHYS 118 and 119.

**Grading Status:** Letter grade.

**ENEC 547. Energy, Transportation, and Land Use. 3 Credits.**

This course explores the reciprocal connections between energy (production/conversion, distribution, and use), land use, environment, and transportation. Evaluation of federal, state, and local policies on energy conservation and alternative energy sources are emphasized. Students gain skills to analyze impacts, interdependencies, and uncertainties of various energy conservation measures and production technologies.

**Rules & Requirements**

**Grading Status:** Letter grade.

**Same as:** PLAN 547.

**ENEC 548. Sustainable Energy Systems. 3 Credits.**

This course will provide an introduction to urgent topics related to energy, sustainability, and the environment. The course material will focus on new technologies, policies, and plans in cities and different governing bodies in the energy system with a focus on developing tools to analyze energy for its sustainability, impact on people, the environment, and the economy.

**Rules & Requirements**

**Grading Status:** Letter grade.

**Same as:** PLAN 548, ENVR 548.

**ENEC 562. Statistics for Environmental Scientists. 4 Credits.**

Introduction to the application of quantitative and statistical methods in environmental science, including environmental monitoring, assessment, threshold exceedance, risk assessment, and environmental decision making.

**Rules & Requirements**

**Requisites:** Prerequisites, BIOL 103 and BIOL 104, and either STOR 120 or STOR 155; or permission of the instructor for students lacking the prerequisites.

**Grading Status:** Letter grade.

**Same as:** BIOL 562.

**ENEC 563. Statistical Analysis in Ecology and Evolution. 4 Credits.**

Application of modern statistical analysis and data modeling in ecological and evolutionary research. Emphasis is on computer-intensive methods and model-based approaches. Familiarity with standard parametric statistics is assumed.

**Rules & Requirements**

**Requisites:** Prerequisites, BIOL 103, BIOL 104, MATH 231, and either STOR 120 or STOR 155; or permission of the instructor for students lacking the prerequisites.

**Grading Status:** Letter grade.

**Same as:** BIOL 563.

**ENEC 565. Environmental Storytelling. 3 Credits.**

An interdisciplinary course for students interested in environmental issues or journalism to produce stories about environmental issues that matter to North Carolinians. Students learn to identify credible sources, manage substantial amounts of information, and find story focus as they report on technical and often controversial subjects in a variety of media.

**Rules & Requirements**

**Grading Status:** Letter grade.

**Same as:** MEJO 565.

**ENEC 567. Ecological Analyses and Application. 3 Credits.**

This course provides an overview of natural and social science approaches to addressing biodiversity conservation and resource management. Concepts and methods from population biology, evolutionary ecology, community ecology, and conservation biology will be complemented with approaches from common property theory, indigenous resource management, and human evolutionary ecology.

**Rules & Requirements**

**Grading Status:** Letter grade.

**ENEC 569. Current Issues in Ecology. 3 Credits.**

Required preparation, previous course work in ecology. Permission of the instructor. Topics vary but focus on interdisciplinary problems facing humans and/or the environment. May be repeated for credit.

**Rules & Requirements**

**Repeat Rules:** May be repeated for credit. 6 total credits. 2 total completions.

**Grading Status:** Letter grade.

**ENEC 570. Uncertainty, Decisions, and the Environment. 3 Credits.**

Required preparation, one course in probability and statistics. Use of quantitative tools for balancing conflicting priorities (such as costs versus human health protection) and evaluating uncertainties when making environmental decisions.

**Rules & Requirements**

**Grading Status:** Letter grade.

**Same as:** ENVR 570.

**ENEC 580. Environmental Markets: Science and Economics. 3 Credits.**

Examines the interplay of science and economics in the design of environmental markets. The first part introduces the principles of environmental economics. The second part considers several case studies that illustrate the critical role that scientific models of natural systems play in the design of environmental markets.

**Rules & Requirements**

**Grading Status:** Letter grade.

**ENEC 581. Water Resource Planning and Policy Analysis. 3 Credits.**

Water resources demand-supply relationships, United States water resource and related water quality policy, legal structure for water allocation, planning, project and program evaluation, and pricing. Strategies for coping with floods, droughts, and climate change will be explored. Extensive use of case studies.

**Rules & Requirements**

**Grading Status:** Letter grade.

**ENEC 586. Water Quality Policies and Planning. 3 Credits.**

Introduction to the management of water quality at the local and basinwide scales. Topics include theory and management frameworks; state and federal statutes and programs; water contaminants, their fate and transport; alternatives for improving and protecting water quality; and the technologies and management practices of selected basinwide comprehensive strategies.

**Rules & Requirements**

**Requisites:** Prerequisites, BIOL 101 and MATH 231.

**Grading Status:** Letter grade.

 **ENEC 593. Environmental Practicum. 1-3 Credits.**

Permission of the instructor required. Students receive service-learning credit through active participation in a community, campus, or other approved group project.

**Rules & Requirements**

 **IDEAs in Action Gen Ed:** HI-INTERN.

**Making Connections Gen Ed:** EE- Academic Internship.

**Repeat Rules:** May be repeated for credit. 6 total credits. 6 total completions.

**Grading Status:** Letter grade.

**ENEC 602. Professional Development Skills for Ecologists and Biologists. 3 Credits.**

The goal of this course is to help students who intend to become professional ecologists or biologists acquire critical skills and strategies needed for achieving their career goals.

**Rules & Requirements**

**Grading Status:** Letter grade.

**Same as:** BIOL 602.

**ENEC 608. Continuum Mechanics in the Earth Sciences. 3 Credits.**

Applications of continuum mechanics in the earth sciences, including stress, strain, elasticity, and viscous flow. Numerical solutions to problems in heterogeneous finite strain including finite element analysis. Course previously offered as GEOL 608.

**Rules & Requirements**

**Requisites:** Prerequisites, EMES 302, and PHYS 114 or 118.

**Grading Status:** Letter grade.

**Same as:** EMES 608.

**ENEC 635. Energy Modeling for Environment and Public Health. 3 Credits.**

Recommended preparation, MATH 231. This course will equip students with an overview of contemporary issues in energy modeling and energy systems analysis, with a focus on environmental and public health impacts of energy systems. Students will gain exposure to a variety of research methodologies, analytical tools, and applications of energy modeling applied to environmental and public health related problems such as climate change, air pollution, and water footprints of energy systems.

**Rules & Requirements**

**Grading Status:** Letter grade.

**Same as:** ENVR 635, PLAN 635.

**ENEC 641. Watershed Planning. 3 Credits.**

This course explores the functions of ecosystems, land development activities that impact such functions, and the land use management tools to create strategies for mitigating and restoring environmental damage. Course goals include understanding the ecological context of planning and how ecological principles may inform planning decisions. Prepares planners to engage effectively with biologists, natural resource managers, park managers, and other professionals from the natural sciences.

**Rules & Requirements**

**Grading Status:** Letter grade.

**Same as:** PLAN 641.

**ENEC 669. Seminar in Ecology. 1-3 Credits.**

May be repeated for credit.

**Rules & Requirements**

**Requisites:** Prerequisite, BIOL 201 or BIOL 260; or permission of the instructor for students lacking the prerequisite.

**Repeat Rules:** May be repeated for credit; may be repeated in the same term for different topics; 12 total credits. 12 total completions.

**Grading Status:** Letter grade.

**Same as:** BIOL 669.

**ENEC 675. Environmental Communication and the Public Sphere. 3 Credits.**

Examines communication practices that accompany citizen participation in environmental decisions, including public education campaigns of nonprofit organizations, "risk communication," media representations, and mediation in environmental disputes.

**Rules & Requirements**

**Grading Status:** Letter grade.

**ENEC 685. Environmental and Resource Economics. 3 Credits.**

Theory and methods of environmental economics. Topics covered include cost-benefit analysis and environmental policy analysis, economic concept of sustainability, optimal use of natural resources, nonmarket valuation, and economic instruments.

**Rules & Requirements**

**Requisites:** Prerequisite, ECON 310.

**Grading Status:** Letter grade.

 **ENEC 693H. Honors Research in Environmental Sciences and Studies. 3 Credits.**

Permission of the director of undergraduate studies. First of two course sequence leading to the honors designation.

**Rules & Requirements**

 **IDEAs in Action Gen Ed:** RESEARCH.

**Making Connections Gen Ed:** EE- Mentored Research.

**Grading Status:** Letter grade.

 **ENEC 694H. Honors Project in Environmental Sciences and Studies. 3 Credits.**

Permission of the director of undergraduate studies. Independent project leading to the honors designation. Includes weekly research seminar.

**Rules & Requirements**

 **IDEAs in Action Gen Ed:** RESEARCH.

**Making Connections Gen Ed:** EE- Mentored Research.

**Grading Status:** Letter grade.

**ENEC 698. Capstone: Analysis and Solution of Environmental Problems. 3 Credits.**

Interdisciplinary, team-based analyses of environmental phenomena are performed and applied to problems of the selection of effective environmental strategies. Students may select from a wide range of examples and venues.

**Rules & Requirements**

**Making Connections Gen Ed:** EE- Mentored Research.

**Grading Status:** Letter grade.

## Graduate-level Courses

**ENEC 765. Field Experience in Ecology. 2 Credits.**

Graduate standing in ecology required. Organized field work in remote environments with a faculty instructor as approved by student's supervisory committee. May be repeated for credit.

**Rules & Requirements**

**Repeat Rules:** May be repeated for credit.

**Grading Status:** Letter grade.

**ENEC 891. Special Topics in Ecology. 2-4 Credits.**

Permission of the instructor. May be repeated for credit.

**Rules & Requirements**

**Repeat Rules:** May be repeated for credit.

**Grading Status:** Letter grade.

**ENEC 961. Research in Ecology. 1-15 Credits.**

Acquaints early career graduate students with research techniques and assesses their propensity for research. Arranged by mutual agreement of the student and faculty member.

**Rules & Requirements**

**Grading Status:** Letter grade.

**ENEC 992. Master's (Non-Thesis). 3 Credits.****Rules & Requirements**

**Repeat Rules:** May be repeated for credit.

**ENEC 993. Master's Research and Thesis. 3 Credits.****Rules & Requirements**

**Repeat Rules:** May be repeated for credit.

**ENEC 994. Doctoral Research and Dissertation. 3 Credits.****Rules & Requirements**

**Repeat Rules:** May be repeated for credit.

## Contact Information

**Curriculum for the Environment and Ecology**

Visit Program Website (<http://www.cee.unc.edu>)

**Chair**

Paul W. Leslie

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Andrew J. Yates