The Department of Marine and Environmental Sciences’ programs are designed to help students develop an in-depth understanding of the processes that affect the earth’s surface and that have the greatest impacts on society. Graduates of such programs contribute to the solution of environmental problems such as soil or groundwater contamination, flooding, slope stability, shore erosion related to changing land use, or coping with the impact of sea-level rise or changing weather patterns related to global warming. Commonly, environmental professionals are expected to work effectively as part of a multidisciplinary team containing scientists, engineers, and professionals who can evaluate the legal, economic, political, and social ramifications of complex environmental problems. As part of their undergraduate program, Northeastern emphasizes experiential, off-campus learning in addition to classroom learning, which is designed to help our students to become well grounded in their field of study and to work effectively with others to study and address real problems.

Our Bachelor of Science in Environmental Science degree is organized for students who seek a comprehensive understanding of the scientific implications of environmental issues and the ways that environmental scientists from a range of disciplines can approach their solution. Every student has an opportunity to develop core knowledge in geology, biology, chemistry, and mathematics early in the program. Students then select one of three concentrations—marine science, conservation science, or geoscience—as a program focus for their upper-level coursework. We also provide an independent track for students whose interests do not fall into one of these four areas. Students who elect this option work with a faculty advisor to identify a group of five mid- to upper-level science courses that are aligned with the student’s career interests. (Students interested in studying environmental issues from a policy-based perspective should consider the BA in environmental studies (http://catalog.northeastern.edu/undergraduate/science/environmental/environmental-studies-ba).)

Our Bachelor of Science in Marine Biology degree is designed to provide a strong foundation in marine biology and related disciplines. This major is offered through Northeastern University’s Marine Science Center in Nahant.

A number of combined-major programs are offered; these can help focus a student’s course choices along avenues that faculty feel are particularly appropriate.

Fieldwork is a valued component of training in our programs, and many of our courses use field sites throughout New England to demonstrate environmental processes or problems in their full complexity. In addition to sponsoring local trips, we have taken students on one longer field excursion each year to Iceland, the Cascade Mountains of Washington, the island of San Salvador in the Bahamas, or the Grand Canyon. Students also have the option to complete undergraduate research experiences with a faculty member. Undergraduate research projects can involve fieldwork and/or lab work completed under the guidance of faculty.

Many of our recent graduates work for environmental or geotechnical firms or continue their studies in graduate school. Students who participate in the co-op program typically work with local engineering or environmental consulting companies or with government agencies. These jobs often involve assessing building sites, evaluating land use, and studying problems concerned with groundwater contamination and remediation.

**Three Seas Program**

The Three Seas Program allows advanced undergraduate and beginning graduate students in biology and related areas to spend a year of field study in three diverse marine environments.

The program begins in the spring semester at Northeastern University’s Marine Science Center in Nahant, 12 miles north of the main campus. Courses the following fall are conducted at the University of Washington’s Friday Harbor Laboratories on San Juan Island, which is 70 miles north of Seattle and part of an archipelago that lies between the mainland and Vancouver Island, and at the Smithsonian Tropical Research Institute in Bocas del Toro, Panama, where students engage in tropical biology research. For more information, contact Mark Patterson at 781.581.7370 (ext. 313), or visit the Three Seas Program website at www.northeastern.edu/threeseas (http://www.northeastern.edu/threeseas).

**Massachusetts Bay Marine Studies Consortium**

Northeastern University students may take classes at the Massachusetts Bay Marine Studies Consortium. The consortium’s course offerings are interdisciplinary and seek to bridge academic disciplines and current concerns in the marine world. For more information, contact the marine studies program director, Professor Rebeca Rosengaus at 617.373.7032 or at r.rosengaus@northeastern.edu.

**Sea Education Association**

SEA Semester is an interdisciplinary program focusing on the sea, in which students undertake course work ashore followed by a practical component at sea. The program combines intensive research in the areas of oceanography, maritime studies, and nautical science with hands-on experience aboard a traditional sailing ship. Piloting, celestial navigation, and practical seamanship are learned together with oceanographic sampling techniques and marine laboratory procedures during a six-week voyage on a ship sailing either on the Atlantic or Pacific oceans. Critical thinking, problem solving, team building, and leadership skills are emphasized throughout the program. Some cruises focus on specialized topics including oceans and climate, Caribbean studies, or Polynesian studies. Through our affiliation with the Sea Education Association, SEA Semester courses earn Northeastern credit. The program is appropriate for students in biology, environmental and physical sciences, environmental studies, American studies, and most other areas within the liberal arts and sciences. For more information, contact the faculty advisor for marine biology, Professor Mark Patterson.
Marine and Environmental Sciences

(Marine Science Center), at 781.581.7370, extension 313, or by email (m.patterson@northeastern.edu).

Marine Science Center Summer Program in Marine Biology
The summer program allows students to participate in intensive courses at the Marine Science Center (MSC). Students conduct independent research at the MSC laboratory throughout the year. Graduate students from other universities are encouraged to use the laboratory and field sites for thesis research.

Academic Progression Standards
Same as college standards.

Programs

Bachelor of Arts (BA)
- Environmental Studies (http://catalog.northeastern.edu/undergraduate/science/marine-environmental/environmental-studies-ba)
- Environmental Studies and History (http://catalog.northeastern.edu/undergraduate/science/marine-environmental/environmental-studies-history-ba)
- Environmental Studies and International Affairs (http://catalog.northeastern.edu/undergraduate/science/marine-environmental/environmental-studies-international-affairs-ba)
- Environmental Studies and Philosophy (http://catalog.northeastern.edu/undergraduate/science/marine-environmental/environmental-studies-philosophy-ba)
- Environmental Studies and Political Science (http://catalog.northeastern.edu/undergraduate/science/marine-environmental/environmental-studies-political-science-ba)

Bachelor of Science (BS)
- Environmental Science (http://catalog.northeastern.edu/undergraduate/science/marine-environmental/environmental-science-bs)
- Computer Science and Environmental Science (http://catalog.northeastern.edu/undergraduate/computer-information-science/computer-information-science-combined-majors/computer-environmental-science-bs)
- Environmental Geology and Chemistry (http://catalog.northeastern.edu/undergraduate/science/marine-environmental/environmental-geology-chemistry-bs)
- Environmental Studies and Economics (http://catalog.northeastern.edu/undergraduate/science/marine-environmental/environmental-studies-economics-bs)
- Information Science and Environmental Science (http://catalog.northeastern.edu/undergraduate/computer-information-science/computer-information-science-combined-majors/information-environmental-science-bs)
- Sociology and Environmental Studies (http://catalog.northeastern.edu/undergraduate/social-sciences-humanities/sociology-anthropology/sociology-environmental-studies-bs)

Minors
- Environmental Geology (http://catalog.northeastern.edu/undergraduate/science/marine-environmental/environmental-geology-minor)
- Environmental Science (http://catalog.northeastern.edu/undergraduate/science/marine-environmental/environmental-science-minor)
- Environmental Studies (http://catalog.northeastern.edu/undergraduate/science/marine-environmental/environmental-studies-minor)
- Geology (http://catalog.northeastern.edu/undergraduate/science/marine-environmental/geology-minor)
- Marine Studies (http://catalog.northeastern.edu/undergraduate/science/marine-environmental/marine-studies-minor)

Courses

Marine Studies Courses
MARS 3200. Marine Studies. 4 Hours.
Surveys the issues and methodologies involved in the interdisciplinary study of marine environments. Examines the physical, biological, social, and historical processes that interact in this complex system. Guest lectures provide an overview of the range of disciplines in the study of the world’s oceans.

MARS 3210. Marine Mammals. 4 Hours.
Designed to familiarize students with biology and conservation of marine mammals. The course content is primarily scientific, but the goal of the course is to consider how scientific knowledge is used as a tool of conservation. Topics include the evolution and taxonomy of whales, seals, and other marine mammals, adaptations to the ocean environment, feeding and social behavior, and population ecology. Issues include whaling and sealing, environmental contaminants, entanglements in fishing gear, tuna/dolphin interactions, and the decline of Stellar Sea lions.

MARS 3300. The Ocean World. 4 Hours.
Provides a comprehensive, interdisciplinary introduction to the oceans. Focuses on the sea’s complexity and the far-reaching consequences of our interactions with them. Draws on specialists in the sciences, social sciences, humanities, and arts, each with an interest in marine issues and a commitment to bridging the gaps among disciplines. The course themes are broad, but, when appropriate, focus on Boston Harbor, a first step into the ocean world for this area.

MARS 3305. Maritime History of New England. 4 Hours.
Surveys maritime transportation, trade, travel, exploration, and warfare from approximately 3500 B.C. to the end of the wooden boat era in the late nineteenth century. Prior to the widespread application of steam power on land and sea, ships were the fastest, safest, and most economical means of transporting large cargoes over long distances. Literary and art history sources are also introduced, along with several films on maritime archaeology.

MARS 3310. Water Resources Policy and Management. 4 Hours.
Explores the ways in which water has affected our bodies, our planet, our history, our culture, and the danger posed by increasing demand, waste, and pollution on our limited supply of usable fresh water. Considers water through scientific, historical, and cultural viewpoints. Surveys contemporary water problems in all their dimensions-political, economic, and technological.
MARS 3315. Wetlands: Ecology and Hydrology. 4 Hours.
Investigates the vital role of wetlands in the hydrology and ecology of global landscapes. Topics include function of inland and coastal marshes, and swamps and bogs in water and nutrient cycles, and in support of biodiversity from microbes to vertebrates. Examines biological links between wetlands and human activities, such as agriculture, coastal development, and fisheries. Also covers legal framework for the protection and restoration of endangered wetlands.

MARS 3325. Coastal Zone Management. 4 Hours.
Focuses on outstanding issues in coastal environment affairs. Discusses scientific, legal, economic, and technical aspects of coastal issues and integrates them into problem-solving exercises.

MARS 3425. Biology of Fishes. 4 Hours.
Covers the evolution, systematics, anatomy, physiology, and behavior of freshwater, marine, and anadromous fishes from temperate to tropical environments. Examines the diversity of fish interactions in aquatic communities; predator/prey relationships, host/symbiont interactions, and the various roles of fishes as herbivores. Studies inter- and intraspecific predator-prey relationships among fish populations in aquatic communities and integrates principles of ecology. Provides access to the collection of the New England Aquarium resulting in an extraordinary opportunity to understand principles of ichthyology through the study of living fish. Hosted each year by a consortium member institution, this Massachusetts Bay Marine Studies Consortium is an intermediate-level survey course.

MARS 3430. Biology of Whales. 4 Hours.
Offers a comprehensive review of the biology, ecology, and management of cetaceans. A thorough grounding in cetacean mammalogy and population biology seeks to prepare students to understand conservation problems presented as case histories. Requires students to complete an independent research paper on a topic related to cetacean biology. Hands-on activities may include the dissection of a small cetacean and a shore-based whale watch in Cape Cod Bay. Hosted each year by a consortium member institution (at Northeastern University's Boston campus), this is a Massachusetts Bay Marine Studies Consortium course.

MARS 4500. Advanced Seminar in Marine Studies. 4 Hours.
Focuses on outstanding issues in the marine environment. Using a seminar format, students from colleges and universities throughout the Boston area convene to address the complex interactions of disciplines including scientific, legal, economic, and technical aspects of issues that come into play in marine affairs. Seminars are led by experts actively involved in the issues.

Ecology, Evolution, and Marine Biology Courses

EEMB 1122. Physical Oceanography. 4 Hours.
Provides a description of the physical properties and composition of seawater, waves, tides, and ocean currents. Discusses how these properties are measured by oceanographers and how they influence the earth's environment and climate.

EEMB 1123. Biological Oceanography. 4 Hours.
Covers the productivity of plant and animal life in the various zones of the ocean and the growing economic importance of the oceans as a source of food for the expanding world population.

EEMB 1145. Beginning Scuba. 1 Hour.
Focuses on basic skin diving and scuba diving skills, with emphasis on safety. Requires lab fee. Requires ability to pass a swim test and basic comfort in the water.

EEMB 1450. Introduction to Marine Biology. 4 Hours.
Surveys the tremendous diversity of marine organisms in the context of the major marine ecosystems in which they are found. Explores interactions among organisms and how the physical and chemical environment influence marine organisms. Links changes on land to declines in organism numbers and diversity and explores the benefits humans gain from our relationship with the marine environment. Offers opportunities to investigate recent advances and understanding of marine organisms and their environments. Requires freshman or sophomore standing; open to juniors and seniors with permission of instructor; intended for students not majoring in marine biology or environmental science.

EEMB 1990. Elective. 1-4 Hours.
Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

EEMB 2290. Ecology and Evolution of Behavior. 4 Hours.
Studies fundamental biological principles at behavioral, ecological, and evolutionary levels. Covers ethology, ecology, genetics, and comparative psychology, all within the conceptual framework of evolutionary theory. Explores both scientific practice and progress through readings, discussion, and projects. Illustrates the process by which biologists study questions about the evolutionary origin of behavior through a series of in-class activities, computer modeling assignments, interpretation of graphical data, collection and statistical analyses of behavioral data, as well as the generation and presentation of research. Does not focus on the neurological basis of behavior. Offers students an opportunity to become critical thinkers, critical readers, and to attain tools to interpret the world in a unique way. Requires permission of advisor.

EEMB 2302. Ecology. 4 Hours.
Offers students an opportunity to learn about the environmental and biological processes that control the distribution and abundance of species and controlling factors that operate on individuals, populations, and communities. The lecture and laboratory introduce a set of generalizable concepts that are of fundamental importance to plant and animal life on the land and in the sea and provide hands-on experiential learning that reinforce concepts covered in lecture. Offers students an opportunity to become proficient in the following: (a) understanding research results the primary literature; (b) conducting a research experiment; (c) interpreting the results of in-class research; (d) communicating results as manuscript.

EEMB 2303. Lab for EEMB 2302. 1 Hour.
Accompanies EEMB 2302. Covers topics from the course through various experiments.

EEMB 2400. Introduction to Evolution. 4 Hours.
Introduces evolutionary thinking, including contemporary examples of evolution. To understand the evolution of Charles Darwin’s “endless forms most beautiful,” the course adopts an integrative approach that includes information from ecology, genetics, molecular biology, biogeography, and paleobiology. Considers mechanisms of evolutionary change—how does it happen? Examines adaptation, the process by which attributes of an organism change to enhance fitness and the evolutionary history of life on our planet—what was the first living thing, how does speciation occur, what have we learned about evolution of life in the distant past, and how did humans evolve. Includes student presentations and analysis of scientific literature.
EEMB 2410. Fish Biology and Ecology. 4 Hours.
Covers fish evolutionary relationships, functional morphology, global biogeography, reproductive behavior, and basic ecology. Considers how fishes interact with each other and with their environment across multiple scales. Focuses on how basic life requirements such as habitat use, behavior, foraging, and reproduction lead to variation among individuals, affect population dynamics, and impact the structure and function of community organization and ultimately how these processes influence broad-scale patterns and dynamics at the ecosystem level.

EEMB 2411. Lab for EEMB 2410. 1 Hour.
Accompanies EEMB 2410. Covers topics from the course through various experiments.

EEMB 2420. Fisheries Biology, Policy, and Conservation. 4 Hours.
Focuses on the study and management of economically valuable fish species. Studies the basic biology and ecology of fisheries species, quantifying and modeling their population biology to their interactions with each other and the environment. Requires students to read and analyze the scientific literature, to complete worksheets and writing assignments, and to develop and present research projects. Covers traditional stock assessment methods as well as how fisheries science and management has evolved more recently to integrate community- and ecosystem-level information. Reviews fisheries and how fisheries are managed, their involvement in the management process, and the future fisheries in the United States and elsewhere.

EEMB 2610. Plant Biology. 4 Hours.
Examines the biology and diversity of plants and plant-like organisms. Explores the relationships between humans and plants by looking at plants through three different perspectives: feeding a starving world; curing a sick world; and engineering a better world. Employs case studies to highlight major themes.

EEMB 2611. Lab for EEMB 2610. 1 Hour.
Accompanies EEMB 2610. Covers topics from the course through various experiments.

EEMB 2616. Invertebrate Zoology. 4 Hours.
Surveys the tremendous diversity of invertebrates, emphasizing their form and function in ecological and evolutionary contexts. Explores functional morphology, systematics, phylogenetic relationships, ecology, and economic importance of the major invertebrate phyla. Discusses comparisons among phyla to enhance understanding of evolutionary relationships.

EEMB 2617. Lab for EEMB 2616. 1 Hour.
Accompanies EEMB 2616. Covers topics from the course through various experiments.

EEMB 2618. Vertebrate Zoology. 4 Hours.
Explores functional morphology, systematics, ecology, and phylogenetic relationships of the major vertebrate phyla.

EEMB 2619. Lab for EEMB 2618. 1 Hour.
Accompanies EEMB 2618. Covers topics from the course through various experiments.

EEMB 2700. Marine Biology. 4 Hours.
Examines biological aspects of natural ocean ecosystems and the physical processes that regulate them. Covers distributions, abundances, and interactions of marine organisms; interactions between organisms and the transformation and flux of energy and matter in marine ecosystems; and aspects of physiology related to marine species distributions, abundances, and roles. Students generate, evaluate, discuss, and present data from primary research and apply their knowledge of the scientific method and biological concepts through the creation of a written grant proposal.

EEMB 2701. Lab for EEMB 2700. 1 Hour.
Accompanies EEMB 2700. Covers topics from the course through discussions and experiments.

EEMB 2990. Elective. 1-4 Hours.
Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

EEMB 3120. Physical Biology of Marine Organisms. 4 Hours.
Introduces principles from the physical sciences (fluid and solid mechanics, mass and heat transfer theory) applied to the analysis of form, function, ecology, and evolution of marine organisms. Topics covered include suspension and deposit feeding in invertebrates, allometry of metabolic processes, drag and lift in sessile organisms, locomotion of nekton (fishes, marine mammals) and plankton, diffusive limitations to metabolic transactions in marine invertebrates and algae, thermal transactions in intertidal organisms, the biology of the benthic boundary layer, and the properties of biomaterials and biological structures. Presents engineering methods and measurement techniques applicable to biomechanical investigations.

EEMB 3450. Physiological Adaptations to the Environment. 4 Hours.
Explores the evolutionary mechanisms by which organisms adapt physiologically to survive, and thrive, in diverse, often seemingly "hostile," habitats. Examines paleo- and modern examples of adaptation with the goal of predicting species success or failure as our planetary environment changes rapidly. Topics include adaptation of cellular metabolism, adaptations to variable oxygen availability and to changes in pH, the roles of water and microsolutes in regulation of the internal environment of cells, and the effects of temperature on cellular function and the biogeographic distribution of organisms. Includes student presentations and analysis of scientific literature. Requires junior or senior standing; sophomores admitted by permission of instructor; EEMB 2400 or ENVR 2400 recommended but not required.

EEMB 3455. Ecosystems Ecology. 4 Hours.
Focuses on the foundational principles of ecosystems ecology. Examines the flow of energy and materials through both the biosphere (plants, animals, and microbes) and the geosphere (soils, atmospheres, and oceans) and the role that humans are playing in altering these key fluxes. Studies elemental cycles that are critically important for human and environmental sustainability—including carbon, nitrogen, and phosphorus —and examines similarities and differences in these cycles and flows while drawing on examples from both terrestrial and marine systems. Seeks to understand how changes in ecosystem structure ultimately affect ecosystem function and how this translates into the important services ecosystems provide.

EEMB 3460. Conservation Biology. 4 Hours.
Explores conservation biology, an interdisciplinary science that focuses on conservation of biological diversity at multiple levels. Emphasizes the causes and consequences of biodiversity loss and demonstrates how ecological and evolutionary principles are applied to conservation problems. Covers sustainability; climate change; introduced species; conservation of threatened and endangered species; and pollution, disease, and habitat restoration using examples from marine, aquatic, and terrestrial systems. Offers students an opportunity to read, discuss, evaluate, and present data from primary research through written assignments and oral debates and to apply this knowledge to conservation issues. Emphasizes critical thinking, problem solving, and recognizing multiple perspectives.
EEMB 3465. Ecological and Conservation Genetics. 4 Hours.
Offers an overview of ecological and conservation genetics, an interdisciplinary science that focuses on understanding the processes that determine genetic diversity at the individual to population level. Focuses on fundamental concepts in evolutionary ecology and population and quantitative genetics, then applies those concepts to solving real-world problems in conservation science. Covers harvested populations, inbreeding, climate change, introduced species, conservation of threatened and endangered species, adaptation, and habitat restoration. Exposes students to multiple sides of these issues and the science that underpins them. Offers students an opportunity to develop the R programming skills required to analyze the complex data sets that often emerge when addressing cutting-edge questions in genetics. Includes writing and coding exercises and mathematical derivations. Emphasizes critical thinking and problem solving.

EEMB 3475. Terrestrial Wildlife Ecology. 4 Hours.
Discussess wildlife ecology and management, mainly focusing on terrestrial species. Topics include habitat use, behavior, wildlife conservation, parasites and pathogens, wildlife sampling, and wildlife management. Offers students an opportunity to participate in activities in which they look at and interpret wildlife data. Course format includes group work, analyzing the scientific literature, and in-class activities. Requires sophomore or junior standing; open to seniors with permission of instructor.

EEMB 3990. Elective. 1-4 Hours.
Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

EEMB 4001. Landscape and Restoration Ecology. 4 Hours.
Topics include ecosystem processes, spatial patterns, disturbance, species distributions, invasive species, and habitat loss. Offers students an opportunity to participate in activities in which they look at and interpret spatial data. Course format includes group work, analyzing the scientific literature, and in-class activities. Requires sophomore or junior standing; open to seniors with permission of instructor.

EEMB 4010. Mammalogy. 4 Hours.
Surveys the mammals of the world, including their evolution, morphology, physiology, behavior, and ecology. Students conduct a research project in which they investigate the morphology, evolution, ecology, and behavior of a species and present their findings to the class. Includes reading and analyzing the scientific literature and conducting in-class activities.

EEMB 4990. Elective. 1-4 Hours.
Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

EEMB 4992. Directed Study. 1-4 Hours.
Offers independent work under the direction of members of the department on a chosen topic. Course content depends on instructor. May be repeated without limit.

EEMB 5130. Ecological Dynamics. 4 Hours.
Offers a comprehensive overview of mathematical and computational concepts needed to construct (meta)population, (meta)community, and (meta)ecosystem models. Focuses on how to mathematically derive and model processes (growth, trophic and nontrophic species interactions, dispersal, and environmental variability) to understand patterns of population abundance and species diversity. Emphasizes the mathematical tools required to analyze the dynamical behavior of ecological models (stability, invasion, graphical, and numerical analyses) and validate model predictions using empirical data (via maximum likelihood and optimization methods). Sophomores admitted by permission of instructor.

EEMB 5131. Lab for EEMB 5130. 1 Hour.
Accompanies EEMB 5130. Offers supervised lab sessions designed to show how the topics covered in the lectures can be addressed in industry-standard programming environments.

EEMB 5303. Marine Biology Careers Seminar. 1 Hour.
Covers the information and tools needed to begin pursuing career opportunities in marine biology. Encourages students to explore a variety of career paths, construct résumés, contact potential employers for their internship and permanent positions. Presents invited speakers from state and federal agencies, and from private consulting firms, to talk about their work and career track.

EEMB 5504. Biology of Corals. 3 Hours.
Focuses on the biology of Scleractinian reef-building corals and associated anthozoa found in coral reef ecosystems. Topics include systematics, anatomy, physiology, and population biology of corals, with an emphasis on the latest techniques employed by coral molecular biologists and physiologists.

EEMB 5506. Biology and Ecology of Fishes. 3 Hours.
Examines processes and interactions in ocean ecosystems. Topics include habitat use, behavior, and evolution of seabirds and marine mammals. Also addresses conservation and protection of animals and essential habitat. Includes field trips to observe local species.

EEMB 5509. Lab for EEMB 5508. 1 Hour.
Accompanies EEMB 5508. Covers topics from the course through various experiments.

EEMB 5511. Adaptations of Aquatic Organisms. 3 Hours.
Explores the adaptive responses of marine organisms to variations in environmental factors. Focuses on physiological responses to a variety of natural and anthropogenic conditions. The laboratory component includes a combination of field and laboratory experiments.

EEMB 5512. Tropical Terrestrial Ecology. 1 Hour.
Studies the animals, plants, and ecosystems of the new world tropics, with the community structure and diversity of terrestrial Jamaican habitats as an example. Includes field trips to lowland forests, carbonate caves, and the Blue Mountain mist-montane forest. The issue of land use and development vs. conservation is a recurring theme.

EEMB 5514. Marine Ecology. 4 Hours.
Examines processes and interactions in ocean ecosystems. Topics include an introduction to major ocean ecosystems; the biotic and abiotic factors influencing the distributions, abundances, and interactions of marine organisms; and the transformation and flux of energy and matter in marine systems. Particularly emphasizes local coastal habitats, which are used to demonstrate quantitative field research methods.

EEMB 5515. Lab for EEMB 5514. 1 Hour.
Accompanies EEMB 5514. Covers topics from the course through various experiments.
EEMB 5516. Oceanography. 4 Hours.
Offers an integrated overview of physical, chemical, biological, and geological processes operating in the world ocean. Seemingly unrelated topics like plate tectonics, oscillating currents and waves in the atmosphere, the activities of microbes and phytoplankton, and land-use practices in the middle of the continent have global reach and interact with each other in surprising yet understandable ways. Examines how new technologies have allowed stunning insights into global weather and climate, the deep sea, biodiversity, and how the biogeochemistry of the oceans can be measured and understood. Presents data use and analysis and formal reasoning used in marine science. Views the ocean as a “system of systems” where integration of experience from disparate disciplines is key.

EEMB 5517. Lab for EEMB 5516. 1 Hour.
Accompanies EEMB 5516. Offers experiential field and laboratory exercises in oceanography. The New England rocky intertidal, subtidal, wetlands, barrier islands, and dunes provide opportunities for field exercises in marine geology, physical oceanography, and marine ecology. Investigates processes affecting changes in the global ocean, such as ocean acidification; temperature stress in organisms; hydrodynamic drag and lift; suspension feeding; and the ecophysiology of reef corals, boreal invertebrates, and macroalgae.

EEMB 5518. Ocean and Coastal Processes. 2 Hours.
Examines the coupling between physical and biological processes on coral reefs and adjacent habitats. Focuses on biophysical, oceanographic, and benthic-pelagic processes acting in coral reef and associated nearshore ecosystems. Specific topics include oceanographic forcing mechanisms, organismal biomechanics, hydrodynamics, and nutrient dynamics.

EEMB 5520. Coral Reef Ecology. 2 Hours.
Examines the ecology and paleoecology of coral reefs. This course highlights the ecological importance of coral reefs and associated nearshore communities, ecosystem function, changes in reef biotas through geologic time, and the causes and consequences of reef degradation worldwide.

EEMB 5522. Experimental Design Marine Ecology. 4 Hours.
Includes introduction to and application of observational methods in three local marine habitats, experimental design, statistical analysis, R statistical computing and graphics software, and principles of marine ecology. Combines lecture, hand-on research experience, and computer laboratory and includes reading and analyzing the scientific literature and developing research projects. At the end of the semester, students are expected to demonstrate an integrative mastery of key topics by writing a scientific manuscript about a class experiment. Seeks to prepare students for practicing ecology in new environments and to provide students with the foundational knowledge necessary for pursuing more complex concepts in experimental design, statistical analysis, and marine ecology.

EEMB 5523. Lab for EEMB 5522. 1 Hour.
Accompanies EEMB 5522. Covers topics from the course through various experiments.

EEMB 5524. Molecular Marine Biology. 3 Hours.
Uses molecular approaches (electrophoresis and DNA) to determine genetic relationships at the population and species level for the study of ecological and evolutionary questions. Techniques learned are applied to research projects.

EEMB 5526. Marine Microbial Ecology. 2 Hours.
Examines the diversity of marine microorganisms and recent advances in the area of microbial ecology. Emphasizes the structure and function of microbial food webs in marine communities.

EEMB 5527. Lab for EEMB 5526. 1 Hour.
Accompanies EEMB 5526. Covers topics from the course through various experiments.

EEMB 5528. Marine Conservation Biology. 3 Hours.
Examines several critical issues facing marine ecosystems, including invasive species, marine pollution and eutrophication, fisheries impacts, physical alteration of habitats, and global climate change. Offers students an opportunity to spend field time surveying intertidal and subtidal habitats within the San Juan Islands and Friday Harbor Marine Reserve and to conduct independent research projects.

EEMB 5530. Molecular Ecology and Evolution. 4 Hours.
Examines the diversity of marine microorganisms and recent advances in the area of microbial ecology. Emphasizes the structure and function of microbial food webs in marine communities. Views the ocean as a “system of systems” where integration of experience from disparate disciplines is key.

EEMB 5531. Lab for EEMB 5530. 1 Hour.
Accompanies EEMB 5530. Covers topics from the course through various experiments.

EEMB 5532. Physiological and Molecular Marine Ecology. 3 Hours.
Explores the physiological responses of marine organisms to variations in environmental factors. Uses complementary techniques, including molecular and physiological approaches, to determine genetic relationships at the species and population level and elucidate the mechanistic basis of organismic responses to environmental conditions at the level of genes and gene products.

EEMB 5534. Marine Invertebrate Zoology and Botany. 4 Hours.
Surveys the major groups of marine invertebrates, algae, and plants, in addition to their ecological roles and relationships. Offers students an opportunity to learn to identify these groups and understand the mechanisms they use to survive and adapt to changing oceans. Topics include ecological and evolutionary importance, ecosystem engineering, adaptive physiology, and climate change effects. Emphasizes interrelationships among major taxa. Hands-on learning includes field identification; visits to intertidal and subtidal marine environments; and specimen dissection, preparation, and cataloging. Offers students an opportunity to improve skills in reading and discussing scientific literature, experimental design, and scientific communication. Restricted to Three Seas students only; not open to students who have taken EEMB 5500 or EEMB 5502.

EEMB 5535. Lab for EEMB 5534. 1 Hour.
Accompanies EEMB 5534. Covers topics from the course through various experiments.

EEMB 5536. Ocean and Coastal Sustainability. 3 Hours.
Offers students advanced training in the expanding field of sustainability, with a combined focus on the practical aspects of systems management and the theoretical understanding of whole-systems design and resiliency. Seeks to train future leaders capable of creating innovative solutions to sustainability issues at local and global levels. Key interdisciplinary themes discussed include the social and political aspects of ocean and coastal sustainability (i.e., education and communication), sustainable development and ecosystem stability, the impacts of climate change on ocean and coastal resilience, and the economic and entrepreneurial possibilities in the field of sustainability. Restricted to Three Seas students only.
EEMB 5548. Sociobiology. 4 Hours.
Studies sociobiology, a field of biology that strives to understand the biological basis of social behavior in animals. Sociobiology is a multidisciplinary science, meshing together ethology (animal behavior), ecology, genetics, population biology, and comparative psychology, all within the conceptual framework of evolutionary theory. Why do animals live in societies? Why do animals cooperate? Why do they sometimes show extreme forms of altruism? What are the costs and benefits of group living? Reviews studies on nonhuman animals that demonstrate sociobiological principles by using a series of in-class activities, computer modeling assignments, interpretation of graphical and tabulated data, collection and statistical analyses of behavioral data, as well as the generation and presentation of research.

EEMB 5560. Entomology. 4 Hours.
Studies the biology of insects and related arthropods including their anatomy, morphology, physiology, development, taxonomy, ecology, behavior, and life histories. Includes field and laboratory study of insect biology.

EEMB 5561. Lab for EEMB 5560. 1 Hour.
Accompanies EEMB 5560. Covers topics from the course through field and laboratory study, including insect collection.

EEMB 5562. Herpetology. 4 Hours.
Offers a survey of the amphibians and reptiles of the world, with emphasis on eastern North America. Topics include morphology, physiology, systematics, paleontology, ecology, zoogeography, and behavior. Includes field trips to observe the habitats and behavior of local herpetofauna. Laboratory emphasizes systematics and ecology.

EEMB 5563. Lab for EEMB 5562. 1 Hour.
Accompanies EEMB 5562. Covers topics from the course through various experiments.

EEMB 5564. Ornithology. 4 Hours.
Offers a survey of the birds of the world including morphology, physiology, systematics, behavior, ecology, zoogeography, and paleontology. Laboratory focuses on the identification and ecology of the avifauna of the Northeast, with field trips in eastern Massachusetts.

EEMB 5565. Lab for EEMB 5564. 1 Hour.
Accompanies EEMB 5564. Covers topics from the course through various experiments.

EEMB 5568. Wildlife Biology. 4 Hours.
Presents concepts and techniques utilized in the conservation and study of wild animals including the sociological aspects of management. Topics include habitat management, nonnative species, zoonoses, endangered species, legislation, and financing. Includes extended field trips to observe various ecosystems and wildlife.

EEMB 5569. Lab for EEMB 5568. 1 Hour.
Accompanies EEMB 5568. Covers topics from the course through various experiments.

EEMB 5589. Diving Research Methods. 2 Hours.
Presents experimental design, sampling methodology, statistical analysis, techniques, and the use of underwater equipment to conduct subtidal research.

Earth and Environmental Sciences Courses

ENVR 1000. Marine and Environmental Sciences at Northeastern. 1 Hour.
Intended for first-year students in the College of Science. Introduces students to liberal arts; familiarizes them with their major; develops the academic skills necessary to succeed (analytical ability and critical thinking); provides grounding in the culture and values of the University community; and helps to develop interpersonal skills—in short, familiarizes students with all skills needed to become a successful university student.

ENVR 1101. Environmental Science. 4 Hours.
Focuses on the complex array of topics that collectively form the discipline of environmental science. Emphasizes the problems facing today’s natural, human-managed, and coupled human/natural ecosystems and the solutions to those problems. Studies the human dimensions of environmental science, including culture, politics, worldviews, ethics, and economics, particularly within the context of global climate change. Offers students an opportunity to learn to analyze data as a means of exploring relationships among societal and ecological drivers affecting economic, ecological, and socioeconomic stability; to learn how the scientific method is used to separate fact and data from opinion; and to apply these methods to explore the causes and solutions to global climate change.

ENVR 1103. Age of Dinosaurs. 4 Hours.
Utilizes evidence from the sedimentary rock record to evaluate and to interpret significant biological and physical events in Mesozoic earth history. Changes in the Earth’s landscape due to variations in climate, plate tectonics, and sea level provide the background for detailed consideration of Mesozoic life. Emphasizes the evolutionary history of dinosaurs and provides detailed data for testing hypotheses of evolutionary mechanisms, paleobiogeography, functional anatomy, ecology and community structure, and extinction and extinction models.

ENVR 1104. Natural Disasters and Catastrophes. 4 Hours.
Provides an overview of what we know about the causes, locations, and effects of some of the most important natural disasters such as earthquakes, floods, and hurricanes. Also examines how loss of life and property damage can be minimized by implementing geologic knowledge. Briefly examines less common but possibly more devastating catastrophes such as large volcanic eruptions, large meteorite impacts, and rapid climate change.

ENVR 1110. Global Climate Change. 4 Hours.
Analyzes Earth’s modern climate system and natural climate change over Earth’s 4.5-billion-year history. Examines ongoing and future climate change. Includes expected impacts of the predicted climate changes as well as mitigation and adaptation options.

ENVR 1111. Weather and Climate. 4 Hours.
Discusses the patterns and processes that combine to produce our daily weather and how weather integrates over time to define climate. Identifies natural and human-made causes of climate change.

ENVR 1112. Environmental Geology. 4 Hours.
Investigates geologic processes such as flooding, volcanic eruptions, and earthquakes, as well as strategies for safer land use incorporating geologic information. Exercises completed and discussed in class offer hands-on experience with evaluating geologic factors that impact land use and formulating hazards mitigation strategies. Offers students an opportunity to increase their understanding of problems resulting from the interaction of humans with the geologic environment and how we can more appropriately interact with it.
May be repeated without limit.

ENVR 1120. Oceans and Coasts. 4 Hours.
Explores the marine and coastal realm and the problems that arise from the human-marine relationship. Begins by studying the history of the ocean and ends with how to create a more sustainable marine world. Topics covered include ocean and estuarine circulation, climate change and ocean response, and the plant and animal life thriving in different parts of the ocean. Includes reading and analyzing the scientific literature, developing and presenting research projects, and group work.

ENVR 1121. Marine Resources. 4 Hours.
Provides a qualitative and quantitative survey of renewable and nonrenewable resources from the sea. Topics include coral reefs, shellfish, marine mammals, sharks, sport and recreational fishing, clams, lobsters, shrimp, toxic seafood, energy from the ocean, ocean pollution, shore erosion, beaches, coastal zone recreation, marine law, and law of the sea.

ENVR 1140. Physical Geography. 4 Hours.
Introduces physical geography for students in history, political science, economics, or other social sciences who intend to pursue a career in education or other social sciences.

ENVR 1145. Volcanoes. 4 Hours.
Offers students an opportunity to understand how volcanoes work, why volcanoes occur, where volcanoes occur, and what their impacts have been throughout human history and prehistoric times. Also address strategies for safer land use around active volcanoes.

ENVR 1200. Dynamic Earth. 4 Hours.
Offers a systematic study of the materials and systems comprising the earth. Emphasizes the processes that form, transport, alter, and destroy rocks, as well as the nature and development of landscape. Plate tectonics theory is introduced as a guiding paradigm in geology.

ENVR 1201. Lab for ENVR 1200. 1 Hour.
Accompanies ENVR 1200. Covers exercises pertaining to mineral and rock identification and topographic and geologic map interpretation. Required for environmental geology and geology majors.

ENVR 1202. History of Earth and Life. 4 Hours.
Traces biological and environmental development of the earth over the past 4.6 billion years using evidence preserved in the rock record. A primary goal is to understand how geoscientists interpret earth history by learning how to test hypotheses and develop explanations for events that occurred far in the geologic past. Examination of major earth systems, the biosphere, lithosphere, atmosphere and hydrosphere, reveals how they interact to control the origin of earth, the origin and evolution of life, the causes and effects of extinction, plate tectonics and mountain building, and climate change over earth history.

ENVR 1203. Interpreting Earth History. 1 Hour.
Focuses on students using sedimentary rocks, fossils, and geologic maps and stratigraphic sections to record and to interpret events in earth history.

ENVR 1445. Environment and Humankind. 4 Hours.
Offers an ecological analysis of human interaction with other organisms. Presents the necessary foundation of biological principles.

ENVR 1990. Elective. 1-4 Hours.
Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

ENVR 2310. Earth Materials. 4 Hours.
Describes the physical and chemical characteristics of common rock-forming minerals and geologic processes that form rock and soils in the igneous, sedimentary, and metamorphic environments. Focuses on commonly encountered minerals, soil, and rock types and how these are used to interpret past and present earth processes. This is a writing-intensive course with a required term paper.

ENVR 2311. Lab for ENVR 2310. 1 Hour.
Accompanies ENVR 2310. Cover topics from the course through various experiments.

ENVR 2340. Earth Landforms and Processes. 4 Hours.
Focuses on the origin and evolution of landscape features by processes operating at or near the earth’s surface. Exercises introduce interpretation of air photos, topographic maps, remotely sensed data, and digital elevation models.

ENVR 2341. Lab for ENVR 2340. 1 Hour.
Accompanies ENVR 2340. Covers topics from the course through various experiments.

ENVR 2500. Biostatistics. 4 Hours.
Offers an overview of traditional and modern statistical methods used to analyze biological data using the free and open-source R programming environment. Lectures describe core statistical approaches and discuss their suitability for understanding patterns that arise at different levels of biological organization, from cellular processes to whole ecosystems. Supervised lab sessions offer students an opportunity to develop the R programming skills required to analyze the complex datasets that often emerge when addressing cutting-edge questions in biology. Topics include basic probability and sampling theory, experimental design, null hypothesis significance testing, t-tests and ANOVA, correlation and regression, Monte Carlo simulations, likelihood, generalized linear models, model selection, and information theory.

ENVR 2501. Lab for ENVR 2500. 1 Hour.
Accompanies ENVR 2500. Offers supervised lab sessions demonstrating how topics covered in the lectures can be addressed in the R programming environment.

ENVR 2940. Oceans in the Global Carbon Cycle. 4 Hours.
Studies various topics on environmental issues. May be repeated without limit.

ENVR 2941. Ocean Science and Public Policy. 4 Hours.
Explores the marine and coastal realm and the problems that arise from the human-marine relationship. Begins by studying the history of the ocean and ends with how to create a more sustainable marine world. Topics covered include ocean and estuarine circulation, climate change and ocean response, and the plant and animal life thriving in different parts of the ocean. Includes reading and analyzing the scientific literature, developing and presenting research projects, and group work.

ENVR 2941. Lab for ENVR 2940. 1 Hour.
Accompanies ENVR 2940. Covers topics from the course through various experiments.

ENVR 2990. Special Topics in Environmental Studies. 4 Hours.
Studies various topics on environmental issues. May be repeated without limit.

ENVR 2994. Oceans in the Global Carbon Cycle. 4 Hours.
Studies various topics on environmental issues. May be repeated without limit.

ENVR 2994. Lab for ENVR 2994. 1 Hour.
Accompanies ENVR 2994. Offers supervised lab sessions demonstrating how topics covered in the lectures can be addressed in the R programming environment.

ENVR 2995. Ocean Science and Public Policy. 4 Hours.
Explores the marine and coastal realm and the problems that arise from the human-marine relationship. Begins by studying the history of the ocean and ends with how to create a more sustainable marine world. Topics covered include ocean and estuarine circulation, climate change and ocean response, and the plant and animal life thriving in different parts of the ocean. Includes reading and analyzing the scientific literature, developing and presenting research projects, and group work.

ENVR 2995. Lab for ENVR 2994. 1 Hour.
Accompanies ENVR 2994. Offers supervised lab sessions demonstrating how topics covered in the lectures can be addressed in the R programming environment.

ENVR 2996. Special Topics in Environmental Studies. 4 Hours.
Studies various topics on environmental issues. May be repeated without limit.

ENVR 2996. Lab for ENVR 2994. 1 Hour.
Accompanies ENVR 2994. Offers supervised lab sessions demonstrating how topics covered in the lectures can be addressed in the R programming environment.

ENVR 3120. Marine Resources. 4 Hours.
Provides a qualitative and quantitative survey of renewable and nonrenewable resources from the sea. Topics include coral reefs, shellfish, marine mammals, sharks, sport and recreational fishing, clams, lobsters, shrimp, toxic seafood, energy from the ocean, ocean pollution, shore erosion, beaches, coastal zone recreation, marine law, and law of the sea.

ENVR 3140. Physical Geography. 4 Hours.
Introduces physical geography for students in history, political science, economics, or other social sciences who intend to pursue a career in education or other social sciences.

ENVR 3145. Volcanoes. 4 Hours.
Offers students an opportunity to understand how volcanoes work, why volcanoes occur, where volcanoes occur, and what their impacts have been throughout human history and prehistoric times. Also address strategies for safer land use around active volcanoes.

ENVR 3200. Dynamic Earth. 4 Hours.
Offers a systematic study of the materials and systems comprising the earth. Emphasizes the processes that form, transport, alter, and destroy rocks, as well as the nature and development of landscape. Plate tectonics theory is introduced as a guiding paradigm in geology.

ENVR 3201. Lab for ENVR 3200. 1 Hour.
Accompanies ENVR 3200. Covers exercises pertaining to mineral and rock identification and topographic and geologic map interpretation. Required for environmental geology and geology majors.

ENVR 3202. History of Earth and Life. 4 Hours.
Traces biological and environmental development of the earth over the past 4.6 billion years using evidence preserved in the rock record. A primary goal is to understand how geoscientists interpret earth history by learning how to test hypotheses and develop explanations for events that occurred far in the geologic past. Examination of major earth systems, the biosphere, lithosphere, atmosphere and hydrosphere, reveals how they interact to control the origin of earth, the origin and evolution of life, the causes and effects of extinction, plate tectonics and mountain building, and climate change over earth history.

ENVR 3203. Interpreting Earth History. 1 Hour.
Focuses on students using sedimentary rocks, fossils, and geologic maps and stratigraphic sections to record and to interpret events in earth history.

ENVR 3445. Environment and Humankind. 4 Hours.
Offers an ecological analysis of human interaction with other organisms. Presents the necessary foundation of biological principles.

ENVR 3990. Elective. 1-4 Hours.
Offers elective credit for courses taken at other academic institutions. May be repeated without limit.
EEVR 2492. Maritime History and Culture: The Caribbean. 4 Hours.
Explores political, cultural, and social changes in the Caribbean since before Europeans arrived at the end of the fifteenth century. Starting from the maritime landscapes of winds, currents, islands, and harbors, we see how the physical nature of the region has influenced patterns of settlement and development from the time of the Arawaks and Caribs to the commodification of the Caribbean as a modern tourist destination. Other topics include the impact of European expansion on peoples throughout the Atlantic world, especially at the transportation of some 5 million enslaved Africans into the Caribbean region; at the technology that underpinned European expansion; and at the cultural expressions that document the extraordinary demographic changes that transformed the islands. Requires acceptance into the SEA Semester Program.

EEVR 2493. Marine Environmental History: The Caribbean. 4 Hours.
Explores the interaction of ecological factors in ocean, coastal, and island environments; the impact of human actions on those environments; and the need for local, regional, and international responses and strategies to mitigate and manage that impact. The enormous environmental changes that have taken place in the Caribbean Islands over the last five centuries provide us with a regional example of global issues. Looks at issues of resource exploitation, potentiation, development, and the introduction of non-native species and attempts to understand the process by which we come to an intelligent understanding of these issues. Requires acceptance into the SEA Semester Program.

EEVR 2990. Elective. 1-4 Hours.
Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

EEVR 3000. Igneous Petrology and Volcanology. 4 Hours.
Examines the origin and nature of igneous rocks in general and volcanoes in particular. Surveys the characteristics and classification of igneous rocks, with a special emphasis on studying volcanic eruptive products and the nature of volcanic eruptions. Also covers the environmental impact and monitoring of volcanic activity.

EEVR 3001. Lab for EEVR 3000. 1 Hour.
Accompanies EEVR 3000. Exercises emphasize the identification and classification of igneous rocks as seen in hand specimen and with the aid of a petrographic microscope.

EEVR 3100. Oceanography. 3 Hours.
Introduces students to the scientific study of the ocean. Teaches basic understanding of global ocean processes and a more in-depth understanding of the waters through which students sail during their subsequent Sea Component. Covers the four interrelated disciplines of oceanography—physics, chemistry, biology, and geology. The development of proposals for independent student research projects to be carried out at sea is a key component of this shore-based course. Opportunities are provided to discuss current research with scientists working at the cutting edge of marine science. Includes lectures, labs, and field trips. Labs may include study of a coastal pond or salt marsh as an introduction to data collection, processing, chemical analyses, and microscopy that are used onboard ship. Part of the SEA Semester Program. Requires acceptance into the SEA Semester Program and prior completion of one lab science course.

EEVR 3101. Nautical Science. 3 Hours.
Provides the theoretical background necessary for operating vessels at sea through lectures, lab sessions, field trips, and student projects. Covers the principles of navigating a vessel within sight of land; discussions include the earth's coordinate system of latitude and longitude, nautical charts, and the magnetic compass. Students are also introduced to electronic navigation, including radar and GPS (Global Positioning System), and celestial navigation to fix the navigator's position at sea. Topics include Archimedes' principle, Newton's laws, the Bernouilli effect, Boyle's law, and mechanical advantage as applied to the study of vessels and their operation; vessel handling under sail; center of effort; operations under power; and vessel design. Classroom lectures, discussions, and student projects focus on learning about global, regional, and local weather. Part of the SEA Semester Program. Requires acceptance into the SEA Semester Program.

EEVR 3102. Maritime Studies. 3 Hours.
Focuses on a multidisciplinary study of the sea and sea voyage in the Western tradition and the role of the sea in the historical development of the modern world system of labor, trade, and scientific resource management. Tales of the sea from literature are supplemented with classic films, paintings, and songs. Together, students explore the expectations that they, as products of American popular and high culture, bring to their impending sea voyage. Through further readings, lectures, and field studies, students explore the uses we have made of the sea—from fishing and whaling to scientific exploration and warfare—with an eye toward understanding the roots of contemporary maritime affairs. Part of the SEA Semester Program. Requires acceptance into the SEA Semester Program.

EEVR 3103. Oceanographic Field Methods. 4 Hours.
Continues EEVR 3103. Focuses on the completion of student research projects and increasing responsibility for routine lab work, the sampling program, and operation of the vessel. The goal is for students to oversee the lab watch, direct their peers, plan and carry out station work with minimal staff supervision, finish analyzing and interpreting their data, complete written research papers, and present their research in a formal seminar format. May culminate with one or more ship's missions, which usually involves study of a particular area, either for SEA's data collections or at the request of another scientific agency, and allows students to integrate their nautical and science knowledge and to direct the vessel and its operation. Part of the SEA Semester Program. Requires acceptance into the SEA Semester Program.
ENVR 3105. Practical Oceanographic Research. 3 Hours.
Guides students at sea from an introductory learning phase to increasing responsibility in station planning, equipment deployment, and data interpretation. Each day, students participate in lectures, discussions, or hands-on study of specific topics in oceanography, nautical science, or maritime studies. Students also receive individual and small-group instruction by the scientific and nautical staff during regular watches in the lab and on deck. Focuses on analyzing and interpreting data, completing a written research paper, and presenting the research to the ship's company in a formal seminar format. The end of the cruise may also culminate in one or more missions, allowing students to integrate their nautical and science knowledge and to direct the vessel and its operation. Part of the SEA Semester Program. Requires acceptance into the SEA Summer Session Program.

ENVR 3125. Global Oceanic Change. 4 Hours.
Explores major changes in physical, biological, and chemical properties of the ocean over geological and human timescales. Includes origin and early evolution of the oceans; sea-level change; global warming; ocean acidification; the role of plate tectonics in driving long-term oceanic change; the role of atmospheric carbon dioxide in driving short-term oceanic change; tipping points in the oceans; snowball earth theory; marine pollution; oil exploration; and social, economic, and political implications of global oceanic change. Themes include differentiating drivers of change across multiple temporal and spatial scales; evaluating change from different and sometimes conflicting perspectives (social, economic, political, environmental); differentiating local and global change; and establishing linkages between physical, chemical, and biological processes in the ocean. Requires prior completion of one laboratory science course or permission of instructor.

ENVR 3200. Water Resources. 4 Hours.
Offers students who wish to work in the area of water resources an opportunity to understand the issues related to water's availability and behavior at the Earth's surface. Topics covered include (1) the hydrologic cycle, including global and regional patterns of water movement; (2) characteristics of surface and groundwater systems, including the linkage between streams, rivers, lakes, wetlands, groundwater, and the sea; (3) water management issues and regulations that have been enacted to control the use of water as a resource; (4) water quality measures for surface water and groundwater; and (5) examples of water use conflicts and emerging water issues. Case studies include examples from California, New England, New York, the southwestern United States, China, Africa, and the Middle East.

ENVR 3300. Geographic Information Systems. 4 Hours.
Studies how to use a geographic information system (GIS). Explores the practical application of GIS to support scientific and social inquiry, analysis, and decision making. Topics include spatial data collection; data accuracy and uncertainty; cartographic principles and data visualization; geographic analysis; and legal, economic, and ethical issues associated with using GIS. Investigates case studies from geology, environmental science, urban planning, architecture, social studies, and engineering. Provides extensive hands-on experience with a leading commercial GIS software package. Offers students an opportunity to conceive their own research problem that can be addressed using GIS and reach conclusions that are summarized in a professional report. Students who do not meet course prerequisites may seek permission of instructor.

ENVR 3301. Lab for ENVR 3300. 1 Hour.
Accompanies ENVR 3300. Covers topics from the course through various experiments.

ENVR 3302. Introduction to Remote Sensing. 4 Hours.
Explores the fundamental concepts of remote sensing of the environment. Topics include digital imagery from spacecraft, conventional and high-altitude aerial photography, orthophotography production, and surface modeling systems. Offers hands-on experience with basic functions of industry standard image processing software. Students who do not meet course prerequisites may seek permission of instructor.

ENVR 3303. Lab for ENVR 3302. 1 Hour.
Accompanies ENVR 3302. Covers topics from the course through various applied activities.

ENVR 3410. Environmental Geochemistry. 4 Hours.
Provides a context for understanding environmental problems through studies in atmospheric, terrestrial, freshwater, and marine geochemistry. Topics include aqueous geochemistry, environmental chemical analysis, nature and source of hazardous wastes (environmental chemistry, reduction, treatment and disposal), acid rain, ozone hole, nuclear winter, green engineering, and alcohol production.

ENVR 3418. Geophysics. 4 Hours.
Studies the basic techniques of reflection and refraction seismology and earthquake analysis; gravity and magnetic surveying methods; radioactive decay principles and Earth's heat flow; and how information from these methods are used to interpret the nature and age of the Earth's surface and interior. Emphasizes near-surface exploration, data collection methods, data analysis, and using data to constrain mathematical models of the subsurface distribution of geologic units.

ENVR 3990. Elective. 1-4 Hours.
Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

ENVR 4106. Coastal Processes. 4 Hours.
Examines the effect of coastal marine processes and the resultant coastal responses. Topics include the dynamics of waves and currents and the associated erosion, transportation, and deposition of sediment-forming beaches, barrier islands, and cliffed shorelines.

ENVR 4107. Lab for ENVR 4106. 1 Hour.
Accompanies ENVR 4106. Covers topics from the course through various experiments.

ENVR 4500. Applied Hydrogeology. 4 Hours.
Covers the origin, distribution, and flow of groundwater in permeable sediments and bedrock; hydrological and geological characteristics of aquifers; regional flow systems emphasizing rock structure, stratigraphy, and other aspects of the geological environment; principles of hydrogeologic mapping and analysis; and introduces well testing and well hydraulics. Uses methods of collecting data about the physical distribution and properties of water and its interaction with geologic materials in the subsurface, including its chemical composition, and mathematical models to interpret the direction and velocity of groundwater flow. Considers remediation strategies for dealing with contaminated water in the subsurface.

ENVR 4501. Lab for ENVR 4500. 1 Hour.
Accompanies ENVR 4500. Covers topics from the course through various experiments.
ENVR 4504. Environmental Pollution. 4 Hours.
Surveys pollution in our atmosphere, on land, and in our oceans. Offers students an opportunity to develop the skills to understand the sources, processes, and fate of environmental contaminants in surface and groundwater, soils, sediment, and biota, with special focus on organic contaminants. Links environmental chemistry with ecotoxicology through an understanding of bioaccumulation, food web models, and risk assessment. Uses case studies and real-world scenarios to illustrate important concepts. Emphasizes innovative solutions for pollution remediation. Discusses current pollution issues and how to clearly communicate these issues to a broad audience. Students who do not meet course prerequisites may seek permission of instructor.

ENVR 4505. Wetlands. 4 Hours.
Presents an interdisciplinary overview of the physical, biological, and cultural aspects of wetlands. Topics covered include definitions, classification systems, origins, human use, and natural processes of wetland environments. Offers students an opportunity to learn about wetland hydrology, soils, and vegetation and their relationship to ecosystem processes, societal values, and management. Includes reading and analyzing the scientific literature and conducting in-class activities.

ENVR 4515. Sustainable Development. 4 Hours.
Focuses on the development of communities in an environmentally sustainable way and on the division of natural resources within these communities and the global system. Defines and discusses “sustainable development” and its global role today. Exposes students to a history of developmental methods while learning about the interconnectedness of development and the environment. Encourages students to draw conclusions about the environmental impacts of these methods and to consider more equitable uses of natural resources.

ENVR 4563. Advanced Spatial Analysis. 4 Hours.
Provides an in-depth evaluation of theoretical, mathematical, and computational foundations of geographic information systems (GIS). Topics include spatial information theory, database theory, mathematical models of spatial objects, and GIS-based representation. Examines advanced concepts and techniques in raster-based GIS and high-level GIS modeling techniques. May be repeated without limit.

ENVR 4900. Earth and Environmental Science Capstone. 1 Hour.
Designed for students enrolled in concert with an approved 500–600-level environmental studies course (check with department office for up-to-date listings). Faculty help students to identify topics for individual research tailored to students’ interests and the course content. Provides an opportunity for reflection about what the student has learned in the major, in their NU Core course work, and experiential learning. Required components include writing with revision and an oral presentation at a departmentwide capstone seminar late in the semester.

ENVR 4965. Undergraduate Teaching Experience 1. 4 Hours.
Offers an opportunity for qualified undergraduate students to continue to serve as undergraduate teaching assistants. Requires various assignments closely directed by the assigned course instructor. These may include holding office hours, light grading, maintaining the records for the course, proctoring—but not solely administering—exams and quizzes, holding recitation/tutorial sessions, and (very) limited lecturing or leading class discussions. Requires minimum overall GPA of 3.33 and grade of A– or better in course assignment; permission to enroll is further subject to the availability of an appropriate course assignment and instructor.

ENVR 4966. Undergraduate Teaching Experience 2. 1 Hour.
Offers an opportunity for qualified undergraduate students to continue to serve as undergraduate teaching assistants. Requires various assignments closely directed by the assigned course instructor. These may include holding office hours, light grading, maintaining the records for the course, proctoring—but not solely administering—exams and quizzes, holding recitation/tutorial sessions, and (very) limited lecturing or leading class discussions. May incur a one-credit overload charge. Requires minimum overall GPA of 3.33 and grade of A– or better in course assignment; permission to enroll is further subject to the availability of an appropriate course assignment and instructor.

ENVR 4970. Junior/Senior Honors Project 1. 4 Hours.
Focuses on in-depth project in which a student conducts research or produces a product related to the student’s major field. Combined with Junior/Senior Project 2 or college-defined equivalent for 8-credit honors project. May be repeated without limit.

ENVR 4971. Junior/Senior Honors Project 2. 4 Hours.
Focuses on second semester of in-depth project in which a student conducts research or produces a product related to the student’s major field. May be repeated without limit.

ENVR 4990. Elective. 1-4 Hours.
Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

ENVR 4992. Directed Study. 1-4 Hours.
Offers independent work under the direction of members of the department on a chosen topic. Course content depends on instructor. May be repeated without limit.

ENVR 4993. Independent Study. 1-4 Hours.
Offers independent work under the direction of members of the department on a chosen topic. Course content depends on instructor. May be repeated without limit.

ENVR 4994. Internship. 4 Hours.
Offers students an opportunity for internship work. May be repeated without limit.

ENVR 4996. Experiential Education Directed Study. 4 Hours.
Draws upon the student’s approved experiential activity and integrates it with study in the academic major. Restricted to those students who are using the course to fulfill their experiential education requirement. May be repeated without limit.

ENVR 4997. Senior Thesis. 4 Hours.
Offers students an opportunity to prepare an undergraduate thesis under faculty supervision.

ENVR 5105. Geophysics. 4 Hours.
Examines the physical processes of sediment erosion, transportation, and deposition and the origin of sediment. Emphasis is on the effect of coastal marine processes and resultant responses of the coast. Topics include the dynamics of waves and currents and such coastal landforms as beaches, barriers, salt marshes, and bluffed and rocky coasts. (a) ENVR 1112, ENVR 1200, or graduate standing and (b) MATH 1241, MATH 1251, MATH 1341, or graduate standing and (c) junior, senior, or graduate standing.

ENVR 5110. Coastal Sedimentation. 4 Hours.
Examines a current environmental issue or topic through an understanding of the scientific principles controlling the process, review of alternative actions, and inquiry into societal implications of the issue. Topics include groundwater supply, groundwater contamination, coastal erosion and flooding, or impacts of land development.
ENVR 5115. Advanced Topics in Environmental Geology. 4 Hours.
Examines selected topics in geology through an understanding of the basic processes, materials, and evolution. Topics include basin analysis, landform evolution, volcanology, or regional geology. May be repeated without limit.

ENVR 5120. Advanced Topics in Geology. 4 Hours.
Introduces spatial data analysis through geographical information system (GIS) systems. Topics include basics of cartography, cartographic transformations on the computer, data input, data sorting and presentation, and statistical analysis. Emphasis is on practical applications of GIS methods. May be repeated without limit.

ENVR 5190. Soil Science. 4 Hours.
Provides a description and evaluation of the physical, chemical, and biological properties of soils. Includes soil formation, soil types, and processes that occur in soil including the importance of these processes for the soil productivity and management of soil. Also covers sources, reactions, transports, and fates of chemical species in soils and associated water and air environments, as well as the chemical behavior of elements and compounds and the phenomena affecting natural and anthropogenic materials in soils.

ENVR 5200. Geology Seminar. 4 Hours.
Offers an analysis of selected topics in geology for advanced study. Topics are selected from current areas of active research in the field. May be repeated without limit.

ENVR 5201. Geologic Field Seminar. 4 Hours.
Studies aspects of geology/environmental science associated with a particular field setting, in the classroom, followed by an intensive field investigation. Examples include carbonate petrology and reef ecology, then field studies in the Bahamas; glacial geology and volcanology, followed by field studies in Iceland; or stratigraphy of the U.S. Southwest, with field studies in the Grand Canyon. Focuses on using field observations and field data to interpret modern and ancient geologic processes. May be repeated without limit.

ENVR 5202. Environmental Science Field Seminar Abroad. 4 Hours.
Offers an intensive environmental science field study experience associated with a particular off-campus geographic setting, such as Iceland, Newfoundland, Bahamas, etc. Offers students an opportunity to learn the principles of field study, to learn to recognize and record significant data, and to reach conclusions about a range of field-based problems being studied. May be repeated without limit.

ENVR 5210. Environmental Planning. 4 Hours.
Examines aspects of surface runoff from geomorphic and hydrologic perspectives. Develops methods for description and calculation of major river and drainage basin processes and applies the results to the planning process. Examines human modification of these systems—including urbanization, dams, and channelization—and applies this information to an understanding of regulatory processes. This is a writing-intensive course.

ENVR 5230. Structural Geology. 4 Hours.
Focuses on the description and origin of rock structures, with emphasis on interpretation of the mechanics of deformation. Lab analyses of structural features and problems utilize geologic maps, structural models, stereograms, petrographic microscope, rock specimens, and field exercises.

ENVR 5231. Lab for ENVR 5230. 1 Hour.
Accompanies ENVR 5230. Covers topics from the course through various experiments.

ENVR 5240. Sedimentary Basin Analysis. 4 Hours.
Presents the analysis of sedimentary basins based on detailed study of sedimentary petrology, sedimentary structures, and stratigraphic sequences and fossils.

ENVR 5241. Lab for ENVR 5240. 1 Hour.
Accompanies ENVR 5240. Lab work uses geologic sections, suites of sedimentary rocks and thin sections, and drill cores and bore hole logs to interpret and analyze the geologic history and environmental and economic potential of sedimentary basins.

ENVR 5242. Ancient Marine Life. 4 Hours.
 Begins with a survey of major events, processes, and important invertebrate phyla preserved in the fossil record. This knowledge of paleontology is then utilized to evaluate evolutionary principles and the nature of function and adaptation in the history of life. Organization of populations into paleocommunities and their relationships to changes in environments through time permit the assessment and evaluation of paleoecology in Earth history.

ENVR 5243. Lab for ENVR 5242. 1 Hour.
Accompanies ENVR 5242. Introduces invertebrate fossil morphology by study of fossil specimens of all major groups. Principles of paleoecology and evolutionary theory are illustrated by analysis of suites of fossil specimens.

ENVR 5244. Sedimentation. 4 Hours.
Describes the physical processes of sedimentation and their role in the interpretation of sedimentary environments.

ENVR 5245. Lab for ENVR 5244. 1 Hour.
Accompanies ENVR 5244. Concentrates on the interpretation and description of the physical properties of sediments and sedimentary environments.

ENVR 5248. Marine Geology. 4 Hours.
Compares the balance between major sedimentary and tectonic forces in ocean basins and margins to the resulting ocean form. Topics include origin of continental margins, shelf sedimentation and transport, deep-sea processes, and sediments. Evaluates resource development of OCS oil, sand and gravel, and manganese nodules.

ENVR 5250. Geology and Land-Use Planning. 4 Hours.
Studies the causes and solutions of geologic environmental problems related to land use. Emphasizes geologic-based land-use planning solutions to problems related to landslides, ground subsidence, coastal erosion, stream erosion, flooding, soil erosion, and groundwater pollution. Assignments are based on actual examples requiring application of concepts covered in the course.

ENVR 5260. Geographical Information Systems. 4 Hours.
Examines geographical information systems (GIS), a way to input, store, analyze, and display spatial data (data with a geographic location). Introduces the major components and applications of this exciting new tool. Consists of two lectures and one laboratory period a week. Laboratory exercises introduce methods of data analysis as well as practical issues of how to manipulate various GIS software packages.

ENVR 5262. GIS Workshop. 2 Hours.
Studies the basic techniques of reflection and refraction seismology, gravity, aeromagnetic and heat-flow processes, and the information they provide on the structure, composition, and dynamics of the earth's interior.
ENVR 5270. Glacial and Quaternary History. 4 Hours.
Examines the environmental conditions conducive to forming glaciers, the processes of ice movement, glacial erosion, modes of deposition, and the resulting landforms created under and around glaciers. Introduces the natural climate change of the ice age cycles and the major events of the Quaternary period.

ENVR 5271. Lab for ENVR 5270. 1 Hour.
Accompanies ENVR 5270. Covers topics from the course through various experiments.

ENVR 5290. Engineering Geology. 4 Hours.
Explores engineering geology, the interdisciplinary study of how geology is applied to engineering projects. Covers the application of geologic thought and geophysical methods to the site selection and planning of human-constructed features, such as foundations, landfills, highways, dams, tunnels, power plants, and mines. An individual research project augments class activities.

ENVR 5300. Graduate Research. 4 Hours.
Offers an individual research project under the direction of a faculty member. May be repeated without limit.

ENVR 5400. Marine Science Policy and Ethics. 3 Hours.
Offers ethics training for a critical review of marine policies in the following topical areas: marine environmental ethics (conservation and preservation), conflicts of interest/research integrity, human subjects/mammal protections, ethical challenges in marine science modeling, ethics of fishing governance (marine conservation and regulations), sustainability models for marine sciences, data management, and new models of comanagement and community engagement with marine research. Reviews critical environmental policies affecting marine resources (NEPA, CERCLA, RCRA, Endangered Species, Marine Mammal Protection, and Oil Pollution acts, Magnuson-Stevens Act, etc.). Critically evaluates case studies and ethical review of coastal management for sustainability and pollution control, marine fisheries, and energy development.

ENVR 5976. Directed Study. 1-4 Hours.
Offers independent study of a specific topic not normally contained in the regular course offerings but within the area of competence of a faculty member. May be repeated without limit.

ENVR 5978. Independent Study. 1-4 Hours.
Offers independent work under the direction of members of the department on a chosen topic. Course content depends on instructor. May be repeated without limit.

ENVS 1990. Elective. 1-4 Hours.
Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

ENVS 2990. Elective. 1-4 Hours.
Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

ENVS 3990. Elective. 1-4 Hours.
Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

ENVS 4970. Junior/Senior Honors Project 1. 4 Hours.
Focuses on in-depth project in which a student conducts research or produces a product related to the student’s major field. Combined with Junior/Senior Project 2 or college-defined equivalent for 8-credit honors project. May be repeated without limit.

ENVS 4971. Junior/Senior Honors Project 2. 4 Hours.
Focuses on second semester of in-depth project in which a student conducts research or produces a product related to the student’s major field. May be repeated without limit.

ENVS 4990. Elective. 1-4 Hours.
Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

ENVS 4991. Research. 4 Hours.
Offers an opportunity to conduct research under faculty supervision.

ENVS 4992. Directed Study. 1-4 Hours.
Offers students an opportunity for special readings and research in environmental studies. May be repeated without limit.

ENVS 4993. Independent Study. 1-4 Hours.
Offers independent work under the direction of members of the department on a chosen topic. Course content depends on instructor.

ENVS 4996. Experiential Education Directed Study. 4 Hours.
Draws upon the student’s approved experiential activity and integrates it with study in the academic major. Restricted to those students who are using it to fulfill their experiential education requirement. May be repeated without limit.

ENVS 4997. Senior Thesis. 4 Hours.
Offers students an opportunity to prepare an undergraduate thesis under faculty supervision.