The Department of Marine and Environmental Sciences graduate program offerings include core capacities in marine biology, ecology, and evolution. Students benefit from top-notch research facilities at both the Marine Science Center and the main campus in Boston. The MS program in marine biology seeks to prepare students for entry- and mid-level careers in marine research. The PhD program in ecology, evolution, and marine biology is designed to prepare graduates for careers in academia, government agencies, and the private sector.

**Programs**

**Doctor of Philosophy (PhD)**

**Master of Science (MS)**
- Marine Biology—Three Seas Program (http://catalog.northeastern.edu/graduate/science/marine-environmental-sciences/marine-biology-three-seas-ms)

**Courses**

**Earth and Environmental Sciences Courses**

**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 barriers, salt marshes, and bluff 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 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 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.
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 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.

ENVR 5984. Research. 1-4 Hours.
Offers an individual research project under the direction of a faculty member. May be repeated without limit.

ENVR 5983. 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 6220. Applied Hydrology. 4 Hours.
Covers the origin, distribution, and flow of groundwater in permeable sediments and bedrock; hydrological and geological characteristics of aquifers; regional flow systems that emphasize rock structure, stratigraphy, and other aspects of the geological environment; principles of hydrogeologic mapping and analysis; and an introduction to well testing and well hydraulics. An individual research project augments class activities.

ENVR 6221. Lab for ENVR 6220. 1 Hour.
Accompanies ENVR 6220. Covers topics from the course through various experiments.
ENVR 6255. 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.

ENVR 6962. Elective. 1-4 Hours.
Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

ENVR 6964. Co-op Work Experience. 0 Hours.
Provides eligible students with an opportunity for work experience. May be repeated without limit.

ENVR 6966. Practicum. 1-4 Hours.
Provides eligible students with an opportunity for practical experience. May be repeated without limit.

ENVR 6976. 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.

Ecology, Evolution, and Marine Biology Courses

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 nontrrophic 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 anthozoans 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.
Presents an examination of the systematics, functional morphology, and behavioral, larval, and community ecology of reef fishes through lectures. Field and laboratory experiments focus on morphology, behavior, and community ecology of reef fishes.

EEMB 5508. Marine Birds and Mammals. 2 Hours.
Studies principles of classification, anatomy, physiology, 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, benthic 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 course 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.

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 5562. Herpetology. 4 Hours.
Studies the biology of 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 5566. 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.

Presents key concepts and important recent advances in evolution and ecology, including interdisciplinary approaches to understanding the distributions, abundances, and diversity of species, organisms, and molecules. Topics include natural selection, adaptation, speciation, molecular evolution, global change, and perspectives on communities and ecosystems. Discusses and critiques current literature and methods.

EEMB 7100. Colloquium. 1 Hour.
Offers a seminar-style course that includes weekly lectures and presentations of selected topics. May be repeated up to four times.

EEMB 8507. Marine Biology Graduate Co-op Tutorial. 1 Hour.
Designed to complement learning during co-op. Offers students an opportunity to participate in activities to integrate academic learning and experiential learning including written reflections. Helps students share their experiences in the workplace through class discussions moderated by the instructor. May be repeated without limit.

EEMB 8674. Marine Biology Research Project. 1 Hour.
Offers an opportunity to design and implement a scientifically rigorous independent research project that builds upon current knowledge from the primary literature, under the supervision of a faculty advisor from the program. Students conduct research at any of the program's locations and are then required to analyze data using rigorous statistical methods, write a journal-style research paper, and present their results in a research seminar.

EEMB 8960. Exam Preparation—Doctoral. 0 Hours.
Offers students an opportunity to prepare for the PhD qualifying exam under faculty supervision. May be repeated once.

EEMB 8982. Readings. 1-4 Hours.
Assigns students independent readings on selected topics in ecology, evolution, and marine biology. May be repeated without limit.

EEMB 8984. Research. 1-4 Hours.
Offers students an opportunity to conduct research. May be repeated without limit.

EEMB 8986. Research. 0 Hours.
Offers students an opportunity to conduct full-time research under faculty supervision. May be repeated without limit.