

Earth and Environmental Sciences (ENVR)

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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.

Attribute(s): NUpath Analyzing/Using Data, NUpath Natural/Designed World

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.

Attribute(s): NUpath Natural/Designed World

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.

Attribute(s): NUpath Analyzing/Using Data, NUpath Natural/Designed World

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.

Attribute(s): NUpath Natural/Designed World

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.

Attribute(s): NUpath Natural/Designed World

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.

Prerequisite(s): ENVR 1200 (may be taken concurrently) with a minimum grade of D-

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.

Attribute(s): NUpath Natural/Designed World

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 1400. Foundations in Environmental and Sustainability Sciences. (4 Hours)

Presents a series of lectures and case studies focused on the problems facing today's natural, human-managed, and coupled human/natural ecosystems. Integrates the underlying science with the human dimensions of environmental challenges. These include an understanding of the basic chemistry, physics, and ecology of environmental change and how this science is informed and altered by culture, politics, worldviews, ethics, and economics. Examines quantitative techniques to analyze data as a means of exploring relationships among societal and ecological drivers affecting economic, ecological, and socioeconomic stability. Studies how the scientific method is used to separate facts and data from opinion and applies these methods to explore the causes and solutions to global climate change and other environmental challenges.

Corequisite(s): ENVR 1401

Attribute(s): NUpath Natural/Designed World

ENVR 1401. Lab for ENVR 1400. (1 Hour)

Accompanies ENVR 1400. Offers supervised lab/discussion sessions for students to develop the tools needed to tackle environmental problem solving at the interface of human and natural systems.

Corequisite(s): ENVR 1400

ENVR 1500. Introduction to Environmental, Social, and Biological Data. (4 Hours)

Introduces the fundamental concepts in the fields of environmental, social, and biological science. Studies the expertise needed in each discipline to organize and manage data in sustainability science. The first half of the course covers data collection relevant to pressing issues in sustainability, database organization, coding, and finding errors in data sets. The second half of the course covers basic principles in the statistical analysis of data sets used in conservation and sustainability, including simulating data, machine learning, and errors in analysis. Offers hands-on experience through students' own data collection projects. Appropriate for students interested in biology, marine biology, environmental science, and ecology and evolutionary biology. Designed to prepare students for co-ops and upper-level classes in these fields.

Corequisite(s): ENVR 1501

ENVR 1501. Lab for ENVR 1500. (1 Hour)

Accompanies ENVR 1500. Offers supervised lab sessions demonstrating how topics covered in the lectures can be addressed using a variety of platforms, including Excel, R, and Python.

Corequisite(s): ENVR 1500

Attribute(s): NUpath Analyzing/Using Data

ENVR 1990. Elective. (1-4 Hours)

Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

ENVR 2200. Earth's Changing Cycles. (4 Hours)

Introduces the biological, chemical, and physical interactions that shape our environment and how industrial emission of gases and black carbon, the use of fertilizers and plastics, and the expansion of cities are altering Earth's systems at rates unprecedented in the recent geological record. Offers students an opportunity to build a fundamental understanding of major issues in environmental science, including climate change, eutrophication, loss of biodiversity, and urbanization. Considers how we might build a more sustainable future.

Attribute(s): NUpath Natural/Designed World

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.

Prerequisite(s): (ENVR 1101 with a minimum grade of D- or ENVR 1200 with a minimum grade of D- or ENVR 1400 with a minimum grade of D-); (ENGL 1111 with a minimum grade of C or ENGL 1102 with a minimum grade of C or ENGW 1111 with a minimum grade of C or ENGW 1102 with a minimum grade of C)

Attribute(s): NUpath Writing Intensive

ENVR 2311. Lab for ENVR 2310. (1 Hour)

Accompanies ENVR 2310. Cover topics from the course through various experiments.

ENVR 2330. Field Methods in Global Change. (4 Hours)

Endeavors to teach basic field methods in global change science through a suite of hands-on field projects based in the Emerald Necklace park system adjacent to Northeastern's Boston campus. Offers students an opportunity to learn basic skills in generating primary scientific data (i.e., abstracting data directly from nature), thereby functioning as a pillar for higher-level course work and research within the MES majors. Exposes students to fundamental content (e.g., fluvial geomorphology, biogeochemistry of natural waters, environmental pollution, sedimentology/stratigraphy) and skills (e.g., hypothesis generation and testing, topographic survey, map making, sedimentary coring, sampling and analysis of natural waters, producing scientific illustrations/graphs/videos, scientific writing) in global change science.

Prerequisite(s): ENVR 1101 with a minimum grade of D- or ENVR 1110 with a minimum grade of D- or ENVR 1120 with a minimum grade of D- or ENVR 1200 with a minimum grade of D- or ENVR 1202 with a minimum grade of D-

Attribute(s): NUpath Integration Experience, NUpath Natural/Designed World

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.

Prerequisite(s): ENVR 1200 with a minimum grade of D-

Corequisite(s): ENVR 2341

ENVR 2341. Lab for ENVR 2340. (1 Hour)

Accompanies ENVR 2340. Covers topics from the course through various experiments.

Corequisite(s): ENVR 2340

ENVR 2401. Food Justice and Community Development. (4 Hours)

Uncovers and examines the key dilemmas of the food system in the United States today using readings, media, discussion, service-learning, and field trips. Working from the foundations of environmental justice and community development, covers production, access, distribution, and key stakeholders from producers to retailers, workers, and consumers. Considers what justice-related issues face stakeholders within the food system in the United States; what policies have most impacted the workforce in the American food system; and what the opportunities and leverage points are for change in improving justice outcomes in this system.

Attribute(s): NUpath Integration Experience

ENVR 2420. Fisheries Biology, Policy, and Conservation. (4 Hours)

Considers how we study and manage economically valuable fish species. Reviews how we study the basic biology and ecology of fisheries species, ranging from their population biology to their interactions with each other and the environment (i.e., their role in community ecology and ecosystem function). Covers traditional stock assessment models and more recent fisheries models that integrate community- and ecosystem-level information. Reviews how human activities have affected their biology and economics and past and ongoing efforts to manage and conserve fisheries, ranging from traditional single-species approaches to more recent fisheries approaches to ecosystem-based management.

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, likelihood, model selection, and information theory.

Corequisite(s): ENVR 2501

Attribute(s): NUpath Analyzing/Using Data, NUpath Formal/Quant Reasoning

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.

Corequisite(s): ENVR 2500

ENVR 2515. Sustainable Development. (4 Hours)

Focuses on the principles and practice of sustainable development, both as a way of looking at the interconnected world and an overarching framework for promoting economic development, social inclusion, and environmental stewardship. Students will study decades of local and global efforts aimed at developing economies, eradicating hunger and disease, and restoring and sustaining ecosystems for a large, and growing, population living on an increasingly altered planet and facing a changing climate. Along with lectures and discussions on core concepts, students will critically dissect the toughest questions and challenges of sustainable development through an online class blog and semester-long group projects.

Prerequisite(s): ENVR 1101 (may be taken concurrently) with a minimum grade of D- or ENVR 1400 (may be taken concurrently) with a minimum grade of D-

Attribute(s): NUpath Societies/Institutions, NUpath Writing Intensive

ENVR 2900. Special Topics in Environmental Studies. (4 Hours)

Studies various topics on environmental issues. May be repeated without limit.

ENVR 2990. Elective. (1-4 Hours)

Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

ENVR 2991. Research in Marine and Environmental Sciences. (1-4 Hours)

Offers an opportunity to conduct introductory-level research or creative endeavors under faculty supervision.

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.

Attribute(s): NUpath Natural/Designed World

ENVR 3150. Food Security and Sustainability. (4 Hours)

Discusses the science of sustainable agriculture, fisheries, and aquaculture. Examines the issues related to nutrition and hunger, food safety, and food production in the face of a changing climate with a scientific lens. Using the FAO Global Food Security and Strategy document and other peer-reviewed literature, compares the food issues in the United States with those in the developing world, including sub-Saharan Africa and Southeast Asia. Explores the many issues related to food production and environmental sustainability—including fertilizer use, GMOs, and pollution—and local examples of sustainable food production. Discusses the ways in which we can potentially remedy many of the issues involved in providing food for more than 7 billion people worldwide.

Prerequisite(s): EEMB 1101 with a minimum grade of D- or ENVR 1101 with a minimum grade of D- or ENVR 1110 with a minimum grade of D- or ENVR 1120 with a minimum grade of D- or ENVR 1200 with a minimum grade of D- or ENVR 1400 with a minimum grade of D- or SOCL 1246 with a minimum grade of D-

Attribute(s): NUpath Natural/Designed World, NUpath Writing Intensive

ENVR 3151. Food Sustainability in the Mediterranean - Abroad. (4 Hours)

Focuses on the Mediterranean diet, which serves as the framework for this course. Discusses the scientific evidence supporting/refuting this diet, then observes the food systems that comprise the diet. Uses museum evidence to deduce the composition of ancient diets and compares this to dietary changes over time using interviews with village locals. Explores production of olive oil, vegetables, and grains and discusses how industrial farming affects traditional agriculture and human health. Also focuses on fish and shellfish production with visits to aquaculture and marine research facilities to discuss how best to include seafood in the human diet while preserving a diverse marine environment. Through comprehensive writing and discussion, offers students an opportunity to more clearly understand the history of food in this region.

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 3201. Coastal Sustainability: Ecology and Coupled Human-Natural Systems in Southeast Asia. (4 Hours)

Accompanies ENVR 3202. The majority of the Earth's population now lives in coastal cities, where people not only depend on ocean resources but are also experiencing ever-increasing threats from the ocean environment, especially global climate change. Explores the mechanisms by which coastal communities in Southeast Asia (Hong Kong and Malaysia) are facing these expanding challenges, including their impacts on coastal ecosystems. Using a comparative approach, explores the diverse challenges facing coastal societies. Offers students an opportunity to gain an in-depth understanding of coupled human-natural systems in Southeast Asia. Prior completion of an introductory course in ecology or environmental sciences is recommended.

Corequisite(s): ENVR 3202

ENVR 3202. Coastal Sustainability: The Blue Economy of the Gulf of Maine. (4 Hours)

Accompanies ENVR 3201. Examines the status of the the Gulf of Maine (GOM) and its future trajectory from a scientific and societal perspective. The GOM is the heart of the Blue Economy in New England and the Canadian Maritime provinces. Historically, cod drove the economies of GOM communities. Now lobster, coastal development, international shipping, wild scallops, aquacultured salmon and mussels, and coastal technology are transforming the region. But the GOM is under threat from global warming, sea-level rise, eutrophication, and invasive species, as coastal cities like Boston, Portland, and Halifax seek resilient sustainable solutions to these challenges. Prior completion of an introductory course in ecology or environmental sciences is recommended.

Corequisite(s): ENVR 3201

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.

Prerequisite(s): EEMB 1101 with a minimum grade of D- or ENVR 1101 with a minimum grade of D- or ENVR 1200 with a minimum grade of D- or ENVR 1400 with a minimum grade of D-

Corequisite(s): ENVR 3301

Attribute(s): NUPATH Analyzing/Using Data, NUPATH Creative Express/Innov

ENVR 3301. Lab for ENVR 3300. (1 Hour)

Accompanies ENVR 3300. Covers topics from the course through various experiments.

Corequisite(s): ENVR 3300

ENVR 3410. Environmental Geochemistry. (4 Hours)

Offers students who wish to work in the geosciences or environmental science and engineering fields, including on the land, in freshwater, or the oceans, an opportunity to understand the geochemical principles that shape the natural and managed environment. Seeks to provide a context for understanding the natural elemental cycles and environmental problems through studies in atmospheric, terrestrial, freshwater, and marine geochemistry. Topics include fundamental geochemical principles; environmental mineralogy; organic and isotope geochemistry; the global carbon, nitrogen, and phosphorous cycles; atmospheric pollution; environmental photochemistry; and human-natural climate change feedbacks. ENVR 3410 and CHEM 3410 are cross-listed.

Prerequisite(s): CHEM 1151 with a minimum grade of D- or CHEM 1161 with a minimum grade of D- or CHEM 1214 with a minimum grade of D- or CHEM 1220 with a minimum grade of D-

Attribute(s): NUPATH Analyzing/Using Data, NUPATH Natural/Designed World

ENVR 3415. Environmental Pollution: Fate and Transport. (4 Hours)

Offers a systematic approach to analyzing the fate and transport of pollutants within natural systems. Uses equilibrium modeling and reactive transport modeling to assess the predominant processes that control the movement and persistence of pollutants in water, soil, and air. Topics include mass transfer across multiple phases; physical, chemical, and biological transformations of substances; transport processes (diffusion, dispersion, advection, interphase mass transport); eutrophication of lakes; conventional pollutants in rivers and estuaries; groundwater contamination; and atmospheric deposition.

Prerequisite(s): CHEM 1151 with a minimum grade of D- or CHEM 1161 with a minimum grade of D- or CHEM 1214 with a minimum grade of D-

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.

Prerequisite(s): (ENVR 1200 with a minimum grade of D- or ENVR 1400 with a minimum grade of D-); (MATH 1241 with a minimum grade of D- or MATH 1251 with a minimum grade of D- or MATH 1341 with a minimum grade of D-)

Attribute(s): NUpath Analyzing/Using Data

ENVR 3600. Oceanography. (4 Hours)

Presents an integrated overview of biological, chemical, physical, and geological processes operating in the world's oceans. Emphasizes understanding the fragility and resilience of marine systems in the face of human-driven perturbations such as habitat fragmentation, elevated sea surface temperature and acidification, non-native species, unsustainable fishing and aquaculture, and coastal land use. Offers students an opportunity to prepare for further course work in both marine biology and in earth, oceans, and environmental change.

ENVR 3701. Energy in the Desert Ecosystem. (4 Hours)

Incorporates lectures, seminars, and visits throughout several institutions/organizations within the Arava Desert (Israel) to identify the various ways in which energy sustains life in this arid and harsh region of the world. Covers both the biological needs for energy acquisition and conservation of desert organisms, as well as technological advances in the utilization and storage of energy such as wind, solar, biomass, fuel cells, and hybrid systems, all within the context of living and exploiting the desert environment. Touches upon the environmental consequences of energy conversion and how renewable energy can reduce air pollution and global climate change.

ENVR 3990. Elective. (1-4 Hours)

Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

ENVR 4000. Science Communication and Professional Development. (4 Hours)

Covers professional skills such as writing cover letters, crafting resumés, interviewing, creating a biographical sketch, and developing overall confidence by connecting to audiences. Science communication focuses on connecting with nonscientific audiences to convey complex scientific concepts and engaging diverse stakeholders to solve pressing societal problems using scientific approaches. Covers general principles of messaging, based on an understanding of how people learn and make decisions, using techniques such as narrative storytelling, visualizations, and theatrical improvisation and other art forms. Offers students an opportunity to develop tools to highlight their strengths, market their skills, explore potential jobs and career paths, and understand how to best prepare for those positions. Designed to integrate with ENVR 4050.

Corequisite(s): ENVR 4050

ENVR 4050. Solving Emerging Environmental Challenges through Capstone. (4 Hours)

Gathers students from across the various environmental and sustainability sciences concentrations to solve environmental problems that are of concern to various stakeholders. Students perform service-learning with a number of not-for-profit and government agencies to identify specific environmental challenges to tackle. Students work in teams that unite social scientists, sustainability experts, conservation biologists and ecologists, and physical scientists to bring the specific expertise gained during their concentration studies together to tackle pressing environmental challenges. Offers students an opportunity to provide solutions to the problems proposed by our stakeholders, as well as to learn leadership and communication skills needed to head up a large project and to thrive in a transdisciplinary environment.

Corequisite(s): ENVR 4000

Attribute(s): NUpath Capstone Experience

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.

Prerequisite(s): (ENVR 1200 with a minimum grade of D- or ENVR 1400 with a minimum grade of D-); (MATH 1241 with a minimum grade of D- or MATH 1251 with a minimum grade of D- or MATH 1341 with a minimum grade of D-)

Corequisite(s): ENVR 4501

Attribute(s): NUpath Analyzing/Using Data

ENVR 4501. Lab for ENVR 4500. (1 Hour)

Accompanies ENVR 4500. Covers topics from the course through various experiments.

Corequisite(s): ENVR 4500

ENVR 4504. Environmental Pollution. (4 Hours)

Describes models and methods for predicting fate and transport of organic contaminants within and between environmental media, including molecular diffusion, transport across boundaries, and box models. Uses chemical structure and thermodynamic properties to predict physical processes that control the distribution of contaminants between the atmosphere, fresh and marine surface waters, groundwater, soils, sediments, and biota. Introduces concepts linking environmental chemistry with ecotoxicology, including bioaccumulation, food web models, and risk assessment. Uses case studies and real-world scenarios to illustrate important concepts. Offers students an opportunity to develop the tools and skills necessary to determine the fate of organic chemicals released to the environment.

Prerequisite(s): (CHEM 1161 with a minimum grade of D or CHEM 1214 with a minimum grade of D); (EEMB 1101 with a minimum grade of D- or ENVR 1101 with a minimum grade of D- or ENVR 1200 with a minimum grade of D- or ENVR 1400 with a minimum grade of D-)

Attribute(s): NUpath Analyzing/Using Data, NUpath Natural/Designed World

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.

Prerequisite(s): EEMB 1101 with a minimum grade of D- or ENVR 1101 with a minimum grade of D- or ENVR 1200 with a minimum grade of D- or ENVR 1400 with a minimum grade of D-

Attribute(s): NUpath Analyzing/Using Data

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.

Attribute(s): NUpath Capstone Experience, NUpath Writing Intensive

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.

Attribute(s): NUpath Capstone Experience

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.

Prerequisite(s): ENVR 4970 with a minimum grade of D-

Attribute(s): NUpath Capstone Experience

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 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.

Attribute(s): NUpath Integration Experience

ENVR 4997. Senior Thesis. (4 Hours)

Offers students an opportunity to prepare an undergraduate thesis under faculty supervision.

Attribute(s): NUpath Capstone Experience, NUpath Writing Intensive

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 5150. Climate and Atmospheric Change. (4 Hours)

Offers an in-depth view of the processes that drive change in Earth's climate system. Examines the modern climate system and how and why climate changes through time. Introduces the tools used to explore past climates and changes, and explores the long-term and short-term controls on the climate system. Also introduces the application of climate models to develop future climate projections. Offers students an opportunity to obtain hands-on experience analyzing and interpreting climate data and model output.

Prerequisite(s): (ENVR 1200 with a minimum grade of D- or ENVR 2200 with a minimum grade of D-) or graduate program admission

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.

Prerequisite(s): ENVR 1101 with a minimum grade of D- or ENVR 1200 with a minimum grade of D- or ENVR 1400 with a minimum grade of D- or ENVR 2310 with a minimum grade of D- or graduate program admission

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.

Attribute(s): NUpath Analyzing/Using Data, NUpath Integration Experience, NUpath Natural/Designed World

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.

Attribute(s): NUpath Integration Experience, NUpath Natural/Designed World

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.

Prerequisite(s): ENGW 1111 with a minimum grade of C or ENGW 1102 with a minimum grade of C or ENGL 1111 with a minimum grade of C or ENGL 1102 with a minimum grade of C or graduate program admission

Attribute(s): NUpath Writing Intensive

ENVR 5220. Ecosystem-Based Management. (4 Hours)

Introduces the principles and practice of ecosystem-based management. Covers how ecosystem-based management draws from social, economic, and ecological principles, as well as how these principles are fundamentally coupled. Begins by covering the evolution of resource management, from single-species to ecosystem-based approaches, including the strengths and challenges of each approach. Focuses on how ecosystem-based management has been applied to terrestrial, freshwater aquatic, and marine ecosystems, including challenges and successes of adopting this approach. Draws from a wide range of examples, including marine protected areas, terrestrial and marine spatial planning, and habitat restoration. Designed for upper-intermediate or advanced undergraduates and graduate students in environmental science and related fields.

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.

Corequisite(s): ENVR 5241

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.

Corequisite(s): ENVR 5240

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.

Corequisite(s): ENVR 5243

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.

Corequisite(s): ENVR 5242

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 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.

Prerequisite(s): ENVR 1200 with a minimum grade of D- or ENVR 1400 with a minimum grade of D- or graduate program admission

Corequisite(s): ENVR 5271

Attribute(s): NUpath Analyzing/Using Data, NUpath Natural/Designed World

ENVR 5271. Lab for ENVR 5270. (1 Hour)

Accompanies ENVR 5270. Covers topics from the course through various experiments.

Corequisite(s): ENVR 5270

ENVR 5350. Sustainable Energy and Climate Solutions. (4 Hours)

Examines the role of sustainable energy on emissions from energy production and the resulting impacts on climate changes. Introduces current observations, predictions of future climate change, and the resulting impacts on ecological and human systems. Assesses past and current sources of U.S. energy-related and non-energy-related sources of greenhouse gases. Reviews sustainable energy alternatives and emission reduction strategies with a focus on comparing moderate and deep decarbonization strategies and the overall goal of reaching zero net emissions.

ENVR 5450. Applied Social-Ecological Systems Modeling. (4 Hours)

Covers the key frameworks, theories, and approaches for conducting social-ecological systems (SES) research. Involves topic and paper discussions focused on developing detailed knowledge and agility at describing the theoretical and applied foundations of interdisciplinary SES research. Includes semester-long projects to develop hands-on skills for conducting robust, methodologically sound studies of social-ecological systems. Particularly emphasizes participatory modeling as a tool for both scientific inquiry and stakeholder engagement. Students complete a participatory modeling project, including all steps of the scientific process, and have an opportunity to gain experience with research design, data collection, analysis, interpretation, and communication.

ENVR 5500. Advanced Biostatistics. (4 Hours)

Describes the advanced statistical concepts and approaches needed to analyze complex biological data. Examines the theoretical underpinnings of modern statistical methods and discusses their suitability for addressing questions from a variety of biological fields. Studies how to apply these methods using the R programming environment. Topics include a brief review of general linear models, likelihood and optimization, generalized linear models and survival analysis, model selection and regularization, generalized mixed-effects models, generalized additive models, Bayesian modeling, constrained and unconstrained ordination, supervised and unsupervised classification, ensemble modeling, and machine learning.

Prerequisite(s): ENVR 2500 with a minimum grade of C- or graduate program admission

Attribute(s): NUpath Analyzing/Using Data, NUpath Formal/Quant Reasoning

ENVR 5563. Advanced Spatial Analysis. (4 Hours)

Offers an in-depth evaluation of theoretical, mathematical, and computational foundations of geographic information systems (GIS). Examines advanced concepts and techniques in GIS analysis and spatial statistics methods. Topics include spatial information theory, database theory, mathematical models of spatial objects, and GIS-based representation.

Prerequisite(s): ENVR 3300 with a minimum grade of D- or ENVR 5260 with a minimum grade of C- or ENVR 5260 with a minimum grade of C-

ENVR 5600. Coastal Processes, Adaptation, and Resilience. (4 Hours)

Introduces the forcing and response of the built and natural coastal environment, including hurricanes and extratropical storms, wind waves, astronomical tides, storm surges, currents, sediment transport, and morphological changes. Seeks to provide an overview of the physical processes and interaction with human activity at the water and land interface, including anthropogenic, natural, and nature-based features for coastal defense. Uses examples and case studies of climate adaptation plans to illustrate alternatives to increase coastal resiliency. Emphasizes the challenges to developing resilience solutions in urban coastal areas, where population growth coupled with sea-level rise and climate extremes exacerbate exposure of people and infrastructure to flood hazards.

ENVR 5984. Research. (1-4 Hours)

Offers an opportunity to conduct research under faculty supervision. May be repeated without limit.

ENVR 6000. Professional Development for Co-op. (0 Hours)

Introduces the cooperative education program. Offers students an opportunity to develop job-search and career-management skills; to assess their workplace skills, interests, and values and to discuss how they impact personal career choices; to prepare a professional résumé; and to learn proper interviewing techniques. Explores career paths, choices, professional behaviors, work culture, and career decision making.

ENVR 6102. Environmental Science and Policy Seminar 2. (4 Hours)

Critically explores fundamental and modern theory, methodologies, and practices for conserving and managing coupled social-ecological systems (SES). Focuses on science and policy of environment management through the lens of coupled SES. Historically, the majority of studies focused on human-environment interactions have typically involved measuring and describing the negative impacts of human populations and development on natural ecosystems. More recently, however, environmental science and practice have experienced a paradigm shift to where now humans and the natural environment are recognized as tightly coupled systems. From an SES perspective, humans continue to shape the structure and function of ecosystems through both stressors and stewardship. However, a key advancement is the recognition that people and their behavior are directly influenced by structure, function, and services of ecosystems.

ENVR 6150. Food Security and Sustainability. (4 Hours)

Explores the science of sustainable food production around the world and examines the issues related to nutrition and hunger, food safety, and food production. Discusses issues such as population growth, climate change, and sustainability, which are presented as thematic topics. Also discusses issues such as soil health, genetically modified (and engineered) foods, water use, governmental food guidelines, and human health. Pulls focus on the thematic topics from scientific literature but also includes additional sources of information, such as gray literature, media coverage, documentaries, and popular nonfiction. Explores local examples of sustainable agriculture, including incentives in food security and sustainability in New England.

ENVR 6200. Water Resources. (4 Hours)

Focuses on the hydrologic cycle, including global and regional patterns of water movement; characteristics of surface and groundwater systems, including the linkage between streams, rivers, lakes, wetlands, groundwater, and the sea; water management issues and regulations that have been enacted to control the use of water as a resource; water quality measures for surface water and groundwater; and examples of water use conflicts and emerging water issues. Case studies of specific water challenges include examples from the United States, Asia, Africa, the Middle East, and Europe.

ENVR 6500. Biostatistics. (4 Hours)

Offers an in-depth overview of statistical methods used to analyze data, with a focus on the biological sciences as well as nonbiological applications. Covers probability theory, Bayes' theorem, hypothesis testing, derivations of statistical distributions, models used for inference with categorical and/or continuous data, linear models, model selection, information theory, and nonparametric methods in statistics. Offers students an opportunity to learn how to apply models to data in supervised lab sessions in the R programming environment.

Corequisite(s): ENVR 6501

ENVR 6501. Lab for ENVR 6500. (1 Hour)

Accompanies ENVR 6500. Introduces the core principles for programming in R, key functions, and application to real datasets.

Corequisite(s): ENVR 6500

ENVR 6900. Topics: Networks and Biology. (4 Hours)

Studies the properties of diverse biological networks. Covers foundational computational methods for analyzing, visualizing, and performing statistical investigations of networked data. From social networks and cities, to ecosystems and evolution, methods from network science provide powerful tools for understanding and investigating the natural and modern world. Offers students an opportunity to develop material for a postdoctoral fellowship application around research and training in network science, learn about and present on topics related to multilayer networks, and write a short review paper on how networks are (or could be) used in their field. Expects successful students to gain pragmatic instruction on grant writing; navigating the publication process; computational, mathematical, and statistical methods; talk delivery; and mentorship training.

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.