

Environmental Science

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This major is interdisciplinary, designed for those with environmental interests and career goals. The program emphasizes experiential learning, commonly through field studies and outdoor education. Courses include real projects and original research participation. Students begin their curriculum with the development of a firm base in the sciences and mathematics. Each student develops an area of specialization by selecting a Concentration from one of two Options. Option I Concentrations lead to a heavier emphasis in science and engineering, and include Environmental Biology, Environmental Geology, Environmental Engineering, Environmental Chemistry, and Climate Science. Option II Concentrations result in a stronger emphasis in the social sciences, humanities and business, and include Environmental Policy & Management, Environmental Law & Protection, Environmental Writing, Green Design, and Environmental Education.

All Environmental Science majors take a pair of capstone courses involving an original research project and a seminar designed to synthesize their education and tie scientific thought to issues in society. The Department houses a number of instruments for environmental monitoring and analysis, and students also have access to resources in their area of Concentration.

Goals:

- To provide an interdisciplinary Liberal Arts degree program in Environmental Science having a strong foundation in the physical and life sciences with a focus on relationships connecting society and nature.
- To provide two options, one with a concentration in the sciences and engineering, and the other with a concentration in the social sciences and humanities.
- To provide instruction and experiences with emphasis on field studies, solution of active problems, and communication in a professional format.

Outcomes:

- Understand the physical laws of nature that control the formation and evolution of Earth materials and biological organisms.
- Understand what controls the behavior of the chemical compounds that make up the inorganic and organic materials of the Earth.
- Know how to define a problem, design a study to acquire data, critically analyze and interpret data, and discuss the implications of results and
- Be able to think critically about published work, synthesize the content of such work, and present findings at a professional level both in writing and orally
- Meet the University's General Education Goals.

Careers for this Major:

- Understand the physical laws of nature that control the formation and evolution of Earth materials and biological organisms,
- Understand what controls the behavior of the chemical compounds that make up the inorganic and organic materials of the Earth,
- Know how to define a problem, design a study to acquire data, critically analyze and interpret data, and discuss the implications of results, and
- Be able to think critically about published work, synthesize the content of such work, and present findings at a professional level both in writing and orally.
- Meet the University's General Education Goals.
- Graduate education
- Industry and consulting
- Military
- Environmental agencies
- Non-profit organizations

B.S. in Environmental Science – Curriculum Map

Option I

Concentrations for Option 1 are: Environmental Biology, Environmental Chemistry, Environmental Geology, Environmental Engineering, or Climate Science.

Freshman			
Fall	Credits	Spring	Credits
BI 101 Principles of Biology I ¹	4	BI 102 Principles of Biology II ¹	4
EN 101 Composition and Literature I	3	EN 102 Composition and Literature II	3
GL 110 Introduction to Geology (General Education Lab Science)	4	GL 111 Oceanography (General Education Lab Science)	4
MA 107 Precalculus Mathematics (General Education Math)	4	MA 108 Applied Calculus (General Education Math) ²	4
	15		15
Sophomore			
Fall	Credits	Spring	Credits
CH 103 General Chemistry I	4	CH 104 General Chemistry II	4
Concentration Elective	3-4	Concentration Elective	3-4
ES 251 Sophomores Seminar Environmental Science	1	General Education Literature (or ES 130)	3
ES 270 Fundamentals of Environmental Science (or Free Elective) ³	4	MA 232 Elementary Statistics	3
PH 323 Environmental Ethics (General Education Ethics)	3	Free Elective ³	3-4
	15-16		16-18
Junior			
Fall	Credits	Spring	Credits
Concentration Elective	3-4	ES 130 Introduction to Environmental Law (or General Education Literature)	3
EC 201 Principles of Economics (Macro) or 202 Principles of Economics (Micro) (General Education Social Science)	3	Concentration Elective	3-4
General Education Arts & Humanities (or PH 323)	3	ES 340 Project Development in Environmental Science	1
PS 201 General Physics I	4	PS 202 General Physics II	4
Free Elective (or ES 270) ³	3-4	Free Elective ³	3-4
	16-18		14-16
Senior			
Fall	Credits	Spring	Credits
BI 405 Ecology	4	Concentration Elective	3-4
Concentration Elective	3-4	ES 451 Environmental Seminar (General Education Capstone)	3
ES 440 Research Project in Environmental Science (General Education Capstone)	3	ES 460 Project Completion in Environmental Science/Geology	1
GL 255 Hydrogeology	3	General Education History	3
		Free Elective ³	3-4
	13-14		13-15
Total Credits: 117-127			

¹ EnvCH and EnvEG concentrations students take CH 103 and CH 104 as freshmen, and BI 101 and BI 102 in the second year.

² Or equivalent, especially if needed as a prerequisite for Concentration courses.

³ Can be used out of sequence and to take more than one concentration elective concurrently.

Available Concentrations – Option I Environmental Biology

GL 261	Field Geology	4
CH 205	Survey of Organic Chemistry	4
Two of the following:		8
BI 275	Environmental Biology	4
BI 316	Plant Taxonomy	4

BI 351	Dendrology and Silvics	4
BI 424	Woodland Ecology and Management	4
Two of the following:		8
BI 201	Comparative Vertebrate Anatomy	4
BI 220	Introductory Microbiology	4
BI 325	Invertebrate Zoology	4
BI 326	Natural History of the Vertebrates	4
Total Credits		24

Environmental Geology

GL 253	Geomorphology	4
GL 257	Sedimentation	4
GL 261	Field Geology	4
GL 263	Mineralogy	4
GL 2XX Elective or EG 203 Materials Science		3-4
CH elective: CH204 or above, 3-4 cr. options only		3-4
Total Credits		22-24

Environmental Chemistry

CH 204	Quantitative Analysis	4
CH 205	Survey of Organic Chemistry	4
GL 263	Mineralogy	4
Three of the following:		10-12
GL 261	Field Geology	4
CH 314	Instrumental Methods (+/- CH 315 Lab)	3/4
EG 203	Materials Science	3
BI 220	Introductory Microbiology	4
Total Credits		22-24

Environmental Engineering

EG 109	Introduction to Engineering I	3
CE 211	Surveying	3
EG 203	Materials Science	3
AP 221	Site Development and Design	3
GL 253	Geomorphology	4
One of the following:		3-4
GL 261	Field Geology	4
BI 275	Environmental Biology	4
MA 241	Mathematical Computation and Modeling	3
CH elective: CH 204 or above, 3-4 cr. options only		3-4
Total Credits		19-20

Climate Science

GL 265	Glacial Geology and Paleoclimate	4
CH 204	Quantitative Analysis	4
GL 253	Geomorphology	4
MA 241	Mathematical Computation and Modeling	3
Two of the following:		6-8
CH 314	Instrumental Methods (+/- CH 315 Lab)	3/4
BI 402	Evolution	4
PO 305	Geopolitics (recommended)	3
PO 415	International Law	3
Total Credits		21-23

B. S. in Environmental Science – Curriculum Map Option II

Concentrations for Option 2 are: Environmental Policy and Management, Environmental Law and Protection, Environmental Writing, Green Design, or Education

Freshman			
Fall	Credits	Spring	Credits
BI 101 Principles of Biology I	4	BI 102 Principles of Biology II	4
EN 101 Composition and Literature I	3	EN 102 Composition and Literature II	3
GL 110 Introduction to Geology (General Education Lab Science)	4	GL 111 Oceanography (General Education Lab Science)	4
MA 107 Precalculus Mathematics (General Education Math)	4	MA 108 Applied Calculus (General Education Math)	4
	15		15
Sophomore			
Fall	Credits	Spring	Credits
Concentration Elective	3-4	Concentration Elective	3-4
ES 251 Sophomores Seminar Environmental Science	1	General Education Literature (or ES 130)	3
ES 270 Fundamentals of Environmental Science (or EC 201 or EC 202)	4	MA 232 Elementary Statistics	3
PH 323 Environmental Ethics or EN 276 Environmental Writing (General Education Ethics)	3	PO Elective 2 ¹	3
PO Elective ¹	3	PY 211 Introduction to Psychology (General Education Social Science)	3
	14-15		15-16
Junior			
Fall	Credits	Spring	Credits
CH Chemistry Elective	4	Concentration Elective	3
Concentration Elective	3	ES 130 Introduction to Environmental Law (or General Education Literature)	3
EC 201 Principles of Economics (Macro) or 202 Principles of Economics (Micro) (or ES 270)	3	ES 340 Project Development in Environmental Science	1
EN 276 Environmental Writing	3	General Education History	3
SO 201 Introduction to Sociology	3	GL 253 Geomorphology (or Free Elective) ²	4
		Free Elective ²	3-4
	16		17-18
Senior			
Fall	Credits	Spring	Credits
BI 405 Ecology	4	Concentration Elective	3
Concentration Elective	3	ES 451 Environmental Seminar (Capstone)	3
ES 440 Research Project in Environmental Science (Capstone)	3	ES 460 Project Completion in Environmental Science/Geology	1
General Education Arts & Humanities	3	Free Elective (or GL 253) ²	3-4
		Free Elective ²	3-4
		Free Elective ²	3-4
	13		16-19
Total Credits: 121-127			

¹ Selected from PO 105 American Politics, PO 215 International Relations and PO 305 Geopolitics; Green Design concentration students take EG 109 Introduction to Engineering I and EG 110 Introduction to Engineering II.

² Can be used out of sequence and to take more than on concentration elective concurrently.

Available Concentrations – Option II**Environmental Policy and Management**

MG 101	Introduction to Business	3
CS 120	Business Applications & Problem Solving Techniques	3
SO 202	Problems of Modern Society	3
PO 321	U.S. Constitutional Law	3
MG 309	Management of Organizations	3
MG 341	Business Law I	3
Total Credits		18

Environmental Law and Protection

CJ 101	Introduction to Criminal Justice	3
CJ 102	Substantive Criminal Law	3
CJ 402	Law and Society	3
Two of the following three:		6
PO 321	U.S. Constitutional Law	3
PO 314	The Legislative Process	3
PO 331	State and Local Politics	3
SO 202	Problems of Modern Society	3
Total Credits		18

Environmental Writing

EN 274	Introduction to Creative Writing	3
EN 364	Intermediate Creative Writing	3
Four of the following:		12
EN 203	Advanced Composition	3
EN 227	Survey of American Literature I	3
EN 228	Survey of American Literature II	3
EN 251	Literature of the Sea	3
EN 282	Literary Methods	3
EN 292	American Ethnic Literature & Cultural Literature	3
EN 320	Literature of the Developing World	3
CM 109	Introduction to Mass Media	3
Total Credits		18

Green Design

AP 111	Fundamentals of Architecture	4
AP 118	Fundamentals of Architecture II	4
AP 221	Site Development and Design	3
AP 225	Introduction to Passive Environmental Systems	3
AP 325	Materials, Construction, and Design	3
One of the following three:		3
FA 201	History/Theory of Architecture I	3
FA 202	History/Theory of Architecture II	3
FA 308	History/Theory of Architectural III	3
Total Credits		20

Environmental Education ¹

ED 104	Foundations of Education	3
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Five of the following:		16-19
ED 234	Learning and Teaching Strategies	4
ED 315	Special Needs Child	3
ED 351	Methods of Teaching Science to Elementary Students	3
ED 363	Reading and Writing in the Content Area	4
PY 220	Developmental Psychology	3
PY 324	Adolescent Psychology	3,4
PY 352	Learning and Memory	4
Total Credits		19-22

¹ For Environmental Education concentration students seeking licensure, a double major in Education, Elementary Teacher Licensure is required, and may require an additional semester for student teaching.

Courses**ES 115 Geographic Info. Systems 3 Credits**

Open to all majors; an introduction to Geographic Information Systems (GIS). GIS is a powerful computer mapping tool essential in: the natural, health, and social sciences; engineering; architecture; and the military. It is used for a wide-range of spatial analyses and data management. Students learn basic GIS and cartographic concepts, ArcGIS software, and application of GIS to their own discipline. During the final 4 weeks of the semester students design, implement, and present a GIS project. Offered Fall of odd numbered years.

ES 130 Introduction to Environmental Law 3 Credits

Major Federal pollution regulation schemes, environmental economics, risk analysis, relevant common law, and constitutional and procedural issues are introduced. Vermont Environmental Law is addressed, as is a survey of the extensive and often novel regulatory approaches of the state of Vermont. The course introduces the law pertaining to environmental issues such as population, economic growth, energy, and pollution. Environmental problems are defined and alternative approaches for dealing with them are examined. Existing statutory efforts such as the National Environmental Policy Act, the Clean Air Act, and the Resource Conservation and Recovery Act are analyzed. Does not fulfill a science requirement. Three lecture hours per week. Offered Spring of even numbered years.

ES 251 Sophomores Seminar Environmental Science 1 Credit

This course introduces the fundamentals of scientific investigation and communication. A research project introduces the Scientific Method, while reading and comprehension of scientific literature is coupled with instruction in and application of technical and scientific writing. Other forms of scientific communication, including poster and oral presentations, are addressed. Students learn the appropriate techniques for displaying and interpreting scientific data. Students may not earn credit for both ES 251 and GL 251. Offered Fall semester.

ES 270 Fundamentals of Environmental Science 4 Credits

This lab science course investigates the atmosphere, hydrosphere, lithosphere, and pedosphere and their interrelations as well as the affect they have on humans and the role that humans play in large-scale change within these spheres. Subjects include modern climate principles and global climate change, water as a natural resource, natural hazards such as landslides, earthquakes and volcanoes, soil nutrient loss and erosion, sustainable agriculture, and other topics related to natural-human interactions. Prerequisite, one introductory Geology lab science. Offered Fall semester of even numbered years.

ES 340 Project Development in Environmental Science 1 Credit

A course for students majoring in Environmental Science aimed to develop the skills for designing and executing an original scientific research project. Topics include research plan development, literature research to inform methodology, generation of site maps and protocols for collecting field and laboratory data, and generation of a properly formatted research proposal. Prerequisite: Junior-year status and permission of instructor. Offered spring semesters.

ES 399 Junior Topics 4 Credits**ES 440 Research Project in Environmental Science 3 Credits**

A capstone original research project under the direction of a faculty member in coordination with others taking this course. Field and laboratory work will generate new data on an expanding base; after analysis and interpretation, data will be presented in a technical format. All aspects of the project will be interpreted in the context of the literature. Prerequisite: ES 340/GL 340 or permission of the instructor. Students cannot receive credit for both ES 440 and GL 440. Offered fall semester.

ES 451 Environmental Seminar 3 Credits

A capstone course offered in a seminar format with required reading, writing, and group participation. Designed to provide an integrating experience with sufficient flexibility to pursue individual interests. This course also includes oral and poster presentations of senior research projects and examination of codes of ethics in the environmental sciences. Classroom 3 hours. Prerequisite: junior or senior standing and permission of the instructor. Credit cannot be received both for this course and GL 451. Offered spring semesters.

ES 460 Project Completion in Environmental Science/Geology 1 Credit

Designed to follow senior research work in ES 440, this course provides the support for students to turn their technical product into a professional technical paper in which the research is integrated into the peer-reviewed knowledge base for the subject. The course is writing intensive and self-driven directed, with a student working collaboratively with their research advisor. Prerequisite: ES 440 and permission of the instructor. Offered spring semesters.

ES 499 Env Sci 4 Credits