

Environmental Studies

Students interested in studying the environment can choose among three majors in the following academic departments: Biology; Earth and Planetary Sciences; and Political Science. The curriculum for these majors is integrated and interdisciplinary, drawing from many disciplines across Arts & Sciences and the university as a whole, and the majors thus capture the strengths of both the traditional academic departments and the interdisciplinary innovation necessary to explore fully the multiple issues and questions posed in the study of the environment. Please visit the Environmental Studies website (<http://enst.wustl.edu>) for more information.

Environmental Studies offers two minors. The environmental studies minor (<https://enst.wustl.edu/programs/minor>) includes core course work in biology, earth science, and political science. Students may choose upper-level elective courses in a variety of natural and social science disciplines.

The interdisciplinary environmental analysis minor (<https://enst.wustl.edu/interdisciplinary-environmental-analysis-minor>) is designed to prepare students to tackle real-world environmental challenges by providing more robust opportunities for interdisciplinary knowledge and skill development. In particular, the minor is structured to provide students with opportunities to strengthen their critical analysis and problem-solving skills through participation in team-based learning experiences, and where possible by engaging on real-world issues.

For more information about the related majors, please visit the following *Bulletin* pages:

Environmental Biology (<http://bulletin.wustl.edu/undergrad/artsci/biology/#majors>)

Environmental Earth Sciences (<http://bulletin.wustl.edu/undergrad/artsci/earthplanetarysciences/#majors>)

Environmental Policy (<http://bulletin.wustl.edu/undergrad/artsci/politicalscience/#majors>)

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PhD, University of Georgia
(Biology)

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Additional Faculty

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(Environmental Studies)

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Majors

Students interested in studying the environment can choose among three majors in the following academic departments: Biology; Earth and Planetary Sciences; and Political Science.

Please visit the following *Bulletin* pages for more information on these majors:

Environmental Biology (<http://bulletin.wustl.edu/undergrad/artsci/biology/#majors>)

Environmental Earth Sciences (<http://bulletin.wustl.edu/undergrad/artsci/earthplanetarysciences/#majors>)

Environmental Policy (<http://bulletin.wustl.edu/undergrad/artsci/politicalscience/#majors>)

Minors

The Minor in Environmental Studies

Required Units: 19

Required Courses:

Code	Title	Units
EPSc 201	Earth and the Environment	4
Biol 2950	Introduction to Environmental Biology	3
Pol Sci 2010	Introduction to Environmental Policy	3
Total Units		10

Elective Courses: 9 units — one course from each of the three categories below

One advanced science course:

Code	Title	Units
Biol 372	Behavioral Ecology	4
Biol 381	Introduction to Ecology	3
EnSt 375	Urban Ecology	3
EPSc 323	Biogeochemistry	3
EPSc 401	Earth Systems Science	3
EPSc 413	Introduction to Soil Science	3

One advanced political science or law course:

Code	Title	Units
Pol Sci 3240	The Political Economy of Public Goods	3
Pol Sci 331	Topics in Politics: Theories of Social Justice	3
Pol Sci 332B	Environmental and Energy Issues	3
Pol Sci 340	Topics: Environmental Justice	3
Pol Sci 3752	Topics in American Politics: Globalization, Urbanization and Environment	3
Pol Sci 4043	Public Policy Analysis, Assessment and Practical Wisdom	3
L82 EnSt 539	Interdisciplinary Environmental Clinic	var.; max 6

One advanced anthropology or ethics course:

Code	Title	Units
EnSt 235F	Introduction to Environmental Ethics	3
Anthro 3053	Nomadic Strategies and Extreme Ecologies	3
Anthro 3322	Brave New Crops	3
Anthro 3472	Global Energy and the American Dream	3
Anthro 361	Culture and Environment	3
Anthro 3615	Environmental Anthropology	3
Anthro 4211	Paleoethnobotany and Ethnobotany	3
History 3068	An Inconvenient Truth: The Human History of Climate Change	3

Courses that are offered less frequently or have **more prerequisites** but that are **preapproved substitutions** for these requirement categories include:

Advanced science:

Code	Title	Units
EPSc 408	Earth's Atmosphere and Global Climate	3
EPSc 429	Environmental Hydrogeology	3
EPSc 444	Environmental Geochemistry	3
EPSc 484	Paleoenvironmental Reconstruction	3

Advanced political science or law:

Code	Title	Units
Econ 451	Environmental Policy	3

Advanced anthropology or ethics:

Code	Title	Units
Anthro 3612	Population and Society	3
Anthro 4215	Anthropology of Food	3

Other advanced courses:

Code	Title	Units
EnSt 405	Sustainability Exchange: Community and University Practicums	3
EnSt 406	Urban Ecosystem Principles Integration	3

The Minor in Interdisciplinary Environmental Analysis

Required Units: 18

Required Courses:

Code	Title	Units
EnSt 350W	Environmental Issues: Writing	3
EnSt 357	Environmental Problem Solving	3
EnSt 380	Applications in GIS	3
Total Units		9

One interdisciplinary environmental capstone course:

Code	Title	Units
EnSt 405	Sustainability Exchange: Community and University Practicums	3
EnSt 406	Urban Ecosystem Principles Integration	3
EnSt 452	International Climate Negotiation Seminar	var.; max 6

L82 EnSt 539	Interdisciplinary Environmental Clinic	var.; max 6
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One advanced elective in natural science:

Code	Title	Units
EnSt 365	Applied Conservation Biology	3
EnSt 481	Advanced GIS	3
EPSc 454	Exploration and Environmental Geophysics	4

One advanced elective in social science and humanities:

Code	Title	Units
Econ 451	Environmental Policy	3
EnSt 235F	Introduction to Environmental Ethics	3
EnSt 310	Ecological Economics	3
EnSt 315	Fallout: Analyzing Texts and Narratives of the Nuclear Era	3
EnSt 461	Intro to Environmental Law and Policy	3
History 3068	An Inconvenient Truth: The Human History of Climate Change	3
Pol Sci 4043	Public Policy Analysis, Assessment and Practical Wisdom	3

Courses

Visit online course listings to view semester offerings for L82 EnSt (<https://courses.wustl.edu/CourseInfo.aspx?sch=L&dept=L82&crslvl=1:4>).

L82 EnSt 101 Earth's Future: Causes and Consequences of Global Climate Change

Earth's Future: Causes and Consequences of Global Climate Change examines 1) the physical basis for climate change; 2) how climates are changing and how we know and assess that climates are changing; and 3) the effects of climate change on natural and human systems. The course is team-taught and will involve participation by scholars across the university with expertise in specific subjects. This is a broad, introductory course for first year students and presumes no special subject matter knowledge on the part of the student.

Same as I50 InterD 101

Credit 3 units. A&S: FYBB A&S IQ: NSM Arch: NSM Art: NSM BU: SCI

L82 EnSt 105 Sustainability in Business

In today's complex business environment, organizations are constantly challenged to develop and execute innovative policies and processes that ensure profitable growth. Some leaders believe that the sole purpose of business is to maximize shareholder wealth and that profitability (or fiscal sustainability) is not compatible with environmental responsibility. In reality, ecological and economic performance need not-and should not-be mutually exclusive. Fortunately, the outmoded mindset of "profit-at-any-cost" is beginning to shift as organizations recognize the importance of adopting balanced business

practices that promote economic prosperity, social equity, and environmental quality. Organizations that embed sustainability into their corporate strategies increase operational efficiency by using resources more responsibly and minimizing waste. In an increasingly crowded and competitive marketplace, sustainability has become a source of competitive advantage through which an organization can have a positive impact not only on the "bottom line" but also on the environment and society. In this course, we explore key concepts, debates, and issues driving sustainability in business. We will also look at various sustainability tools, principles, and frameworks that business can use to better understand the natural systems from which sustainability is derived and upon which all organisms and organizations rely to sustain their own existence.

Credit 3 units. A&S IQ: SSC Arch: SSC Art: SSC BU: BA EN: S

L82 EnSt 109A Quantitative Reasoning in Environmental Science

Introduction to practical mathematical methods for understanding environmental aspects of our planet, particularly how the environment changes with time through human interactions. Emphasis on intuitive approaches in devising simple relationships for understanding quantitative outcomes of natural processes. Introduction to basic statistical methods, including hypothesis testing, and how statistics can be applied to environmental problems.

Same as L19 EPSc 109A

Credit 3 units. A&S IQ: NSM, AN Art: NSM BU: SCI

L82 EnSt 110 Environmental Issues

This course examines the science behind current environmental issues, with emphasis on ecology and conservation. Students will gain an understanding about the consequences of the way that humans currently interact with the natural environment and potential solutions that would allow long-term sustainability of the Earth. Topics will include: human population growth, ecosystem structure and diversity, types and origin of pollution, global climate change, energy resources and use, challenges to feeding the world, and the interaction between the environment and human health.

Credit 3 units. A&S IQ: NSM Arch: NSM Art: NSM BU: SCI

L82 EnSt 115 Introduction to Conservation Biology

This course is introductory level and appropriate for both non-science majors as well as potential science majors who may be investigating their interests. Conservation Biology will focus on biodiversity, its preservation and current threats, as well as obstacles to its preservation for the future. We will examine the different levels of biodiversity present in nature as well as highlighting its importance, and why it matters to the human population. In studying Conservation Biology, students will also learn key concepts from related fields such as evolution and ecology that are necessary to understand concepts and concerns. Course topics include species and ecosystem management, restoration, strategies to combat threats, and past successes and failures relating to biodiversity conservation.

Credit 3 units. A&S IQ: NSM Arch: NSM Art: NSM BU: SCI

L82 EnSt 122 First-Year Seminar: A Sense of Place: Discovering the Environment of St. Louis

Go exploring in and around St. Louis. You'll learn about the St. Louis backyard and your "home" for the next four years. Through field trips, readings and discussion, you'll see first-hand what challenges face the environment and the people who live here.

You will learn how to examine multiple perspectives, how to think critically and how to approach problems from an interdisciplinary and holistic approach. You'll also learn why it is important to know a community at the local level if you're going to affect change on any level — state, national or international. In addition to weekly readings and discussion, this class includes several field trips.

Credit 3 units. A&S: FYS A&S IQ: NSM BU: SCI

L82 EnSt 171A Physics and Society

Introduction to physics: its goals, methods, and relevance for society. Topics include energy as a unifying principle of physics and society's use of energy: resources and costs. Nuclear energy: history, technology, radiation, waste, weapons. Global climate change: the greenhouse effect, the hole in the ozone layer. Science and government. Bad science, pseudoscience, antiscience. Intended for science and nonscience majors. Must be taken for a letter grade.

Same as L31 Physics 171A

Credit 3 units. A&S IQ: NSM, AN Art: NSM BU: SCI

L82 EnSt 201 Earth and the Environment

Introduction to the study of the Earth as a dynamic, evolving planet. Emphasis on how internal and surface processes combine to shape the environment. Themes: Earth's interior as revealed by seismic waves; Earth history and global tectonics shown by changes to ocean floors, mountain-building, formation of continents, earthquakes and volcanism; climate history and global biogeochemical cycles, influenced by circulation of atmosphere and oceans, ice ages and human activity. Composition and structure of rocks and minerals. Part of the introductory sequence of courses for all Earth and planetary sciences and environmental studies majors. Three class hours and one two-hour lab a week.

Same as L19 EPSc 201

Credit 4 units. A&S IQ: NSM Arch: NSM Art: NSM BU: SCI

L82 EnSt 210 Undergraduate Teaching Assistant

Credit 3 units.

L82 EnSt 215 Introduction to Environmental Humanities

In this environmental humanities seminar we will consider texts illustrating how American citizens evolved in their perception, use, and expectations of the natural world during the 19th and early 20th centuries, especially but not limited to the practice of agriculture. How did the mandatory short-term goals of health and economic security sought so eagerly by citizens, and supported by evolving technologies, foreshadow the unintended consequences of long-term environmental damage that would contribute to climate change, and how can we understand this using a critical and hopeful lens? Considering contemporary writings on our perception of "environmentalism" will help us nuance our analysis. Topics will include: agrarian democracy; settlement of the Great Plains by immigrant farmers; the Dust Bowl; fragmentation of the Sioux ecosystem. This cultural research will frame our visits to the Tyson Research Center, Washington University's field laboratory in west St. Louis County. Tyson's mission is to provide a living landscape for environmental research and education as a component of Washington University's International Center for Energy, Environment and Sustainability (InCEES). As a class we will meet with faculty researchers (from both science and the humanities) and hear about their work on ecosystem sustainability, that is, thinking long-term for

human and environmental health. We will use texts such as: government reports, history, literature, environmental policy and autobiography. This course is for freshmen and sophomores only.

Credit 3 units. A&S IQ: HUM EN: H

L82 EnSt 221A Human Use of the Earth

Examination of the impacts of a growing population on the Earth, including habitat destruction, resource depletion, and air and water pollution. Population growth, landscape change, and the distribution and uses of the water, mineral, and energy-producing resources of the Earth.

Same as L19 EPSc 221A

Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI

L82 EnSt 222 Topics in Japanese Literature and Culture: Environmental Consciousness in Modern Japanese Literature

A topics course on Japanese literature and culture; topics vary by semester.

Same as L05 Japan 221

Credit 3 units. A&S IQ: HUM, LCD BU: IS EN: H

L82 EnSt 235F Introduction to Environmental Ethics

A general survey of current issues in environmental ethics, focusing on problems such as the obligation to future generations, protection of endangered species, animal rights, problems of energy and pollution, wilderness, global justice, and business obligations. Students will also learn some ethical and political theory.

Same as L30 Phil 235F

Credit 3 units. A&S IQ: HUM Arch: HUM Art: HUM BU: ETH EN: H

L82 EnSt 2431 Ampersand: Missouri's Natural Heritage, Part 1

Missouri's Natural Heritage is a multidisciplinary two-semester Ampersand course. The first semester of the sequence will focus on Missouri geology, climate, archaeology, and native megafauna. This will provide a foundation on which to examine the ecology, restoration, and management of our diverse habitats (prairie, forest, glade and stream) and the biology of our diverse plant and animal wildlife (arthropods, mollusks, fish, salamanders, lizards, birds and mammals) in the second semester. We will also introduce basic concepts in biodiversity and resource management with attention to resolution of conflicts of interest. In addition to weekly lecture and discussion, students in this class will visit sites across the state during three weekend camping trips and a longer camping trip during winter break. Attendance on field trips is an essential component of the course and grade. Lab fee covers transportation and meals for all field trips.

Same as L61 FYP 2431

Credit 3 units. A&S: AMP A&S IQ: NSM Arch: NSM Art: NSM BU: SCI

L82 EnSt 290 Sophomore Seminar in Sustainability and the Environment

This course will provide an opportunity for students to evaluate and explore potential paths in environmental studies, and learn presentation skills to carry forward in their careers. Students

will also get the opportunity to get out of the classroom and participate in environmental field trips and activities.

Credit 3 units. A&S IQ: NSM

L82 EnSt 2950 Introduction to Environmental Biology

Introduction to Environmental Biology is designed to teach important principles of environmental biology and general science literacy skills. We cover the foundational biological principles and contemporary issues within four main topics: human population growth, transfer of energy and carbon in the ecosystem, biodiversity, and food production. We focus on the biological principles involved as we examine these topics in the context of some contentious and confusing issues related to environmental biology in everyday life. The science literacy skills that you master in this course will help you address the issues you face in your everyday life regarding scientific and pseudoscientific claims about the environment and society and will form the foundation for your development as a critical consumer of science information in the media. This course is required for all environmental biology majors and environmental studies minors. We recommend you take this course in your first- or second-year if possible. If your interests align and your schedule allows, we recommend co-enrolling in ENST 215: Introduction to Environmental Humanities.

Same as L41 Biol 2950

Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI

L82 EnSt 299 Directed Internship

Internship with an environmental organization (commercial, not-for-profit, governmental, etc.) where the primary objective is to obtain professional experience outside of the classroom. Student must have a faculty sponsor and must file a Learning Agreement with the Career Center, the faculty sponsor and the site supervisor. A final written project is agreed upon between the student and faculty sponsor before work begins, and is evaluated by the faculty sponsor at the end of the internship. Detailed supervision of the intern is the responsibility of the site supervisor.

Credit variable, maximum 3 units.

L82 EnSt 3068 An Inconvenient Truth: The Human History of Climate Change

While climate change has become a hot-button issue in recent decades, it is by no means a new concern. Advisers to the king of France were warning against deforestation in the 18th century and 19th century. Scientific experiments revealed the arrival of acid rain in the industrial centers of Great Britain. This course will examine the longer history of climate change and how it has been addressed as a scientific, political and environmental issue. Students will be introduced to the field of environmental history and explore how the methods of this field of inquiry challenge traditional historical categories.

Same as L22 History 3068

Credit 3 units. A&S IQ: HUM Arch: HUM Art: HUM BU: HUM, IS EN: H

L82 EnSt 306B Africa: Peoples and Cultures

An anthropological survey of Africa from the classic ethnographies to contemporary studies of development. Emphasis on the numerous social and economic changes African peoples have experienced from precolonial times to the present.

Same as L48 Anthro 306B

Credit 3 units. A&S IQ: LCD, SSC Arch: SSC Art: SSC BU:
HUM, IS

L82 EnSt 310 Ecological Economics

Our planet is finite but our economic theories and practices assume that our economy can grow forever. The paradoxical pursuit of infinite growth on a finite planet has real-world consequences: from climate change to increasing income inequality to stagnant and declining quality of life for most of us to the ongoing mass extinction of species that are not economically useful to us, but whose loss simplifies ecosystems to the point of collapse. If these trends continue we will face some very difficult times ecologically and socio-politically. One alternative to infinite-planet economic theory is Ecological Economics, which can be described as economics as if the laws of thermodynamics are true and apply to us. Alone among disciplines with any aspiration to analytic rigor, the field of economics has remained unaffected by the thermodynamic revolution that transformed such fields as biology, chemistry, physics, even history in the late 19th and early 20th centuries. This failure to take physical law into account is one great source of our society's environmental (and social and political) problems. Ecological economics thus represents the continuation of the thermodynamic revolution begun in the 1880s. This course is designed to give you an appropriate grounding in the fundamental assumptions, the conceptual novelties, and the distinctive tools of analysis that comprise this emergent school of economic theory, while placing this theorizing in historical (and ecological) context. We'll pay particular attention to how the precepts and practice of Ecological Economics illuminate the largest challenge facing humans today, the necessity of developing an ecologically sustainable society, one that is sized to the limits of our finite planet.

Credit 3 units. A&S IQ: SSC Arch: SSC Art: SSC BU: BA EN: S

L82 EnSt 315 Fallout: Analyzing Texts and Narratives of the Nuclear Era

In this environmental humanities course we will compare and integrate diverse texts and narratives through which Americans have developed a complex relationship to nuclear technology. Nuclear technology has long been developed, used and debated. Capable of both healing and harm, it challenges our notions of risk versus benefit at every level. It is also poised to potentially play a significant environmental role in climate mitigation by delivering large amounts of nearly carbon-free energy. Using texts such as literary nonfiction, history, environmental anthropology, natural history and public health, we will explore aspects of the Manhattan Project, the Chernobyl Nuclear Reactor accident, the presence of fear in the public perception of nuclear technology, and debates regarding the current and future use of nuclear energy. Two or three Saturday field site visits will be required, one to Weldon Springs Interpretive Center.

Credit 3 units. A&S IQ: HUM Arch: HUM Art: HUM BU: HUM EN:
H

L82 EnSt 323 Biogeochemistry

Survey of biogeochemical interactions among Earth's crust, oceans and atmosphere, including perturbations due to human activities. Carbon, nitrogen, phosphorus and sulfur biogeochemical cycles. Greenhouse warming of atmosphere from carbon dioxide and chlorofluorocarbons: effects of inorganic and organic wastes in groundwater systems. Introductory course

for students of environmental science and nonscience majors.
Prerequisite: permission of instructor.
Same as L19 EPSc 323

Credit 3 units. A&S IQ: NSM Arch: NSM Art: NSM BU: SCI

L82 EnSt 350W Environmental Issues: Writing

For students interested in environmental issues — natural science, social science and policy. This course aims to provide students with the writing skills they need to be successful in the environmental field once they graduate. In doing so, students examine environmental issues and decision-making processes by examining data and facts underlying positions and decisions. They explore the role of audience, purpose and author angle of vision as they examine the role of multiple stakeholders in environmental issues and processes. Students also are exposed to different types of writing used in environmental studies professions. When the course includes a service learning component, students are exposed to the types of writing that are necessary in environmental careers and in environmental non-profits and governmental agencies in particular.

Credit 3 units. A&S IQ: NSM, WI BU: SCI

L82 EnSt 357 Environmental Problem Solving

This course aims to provide students with the opportunity to develop and apply problem-solving skills in the context of environmental challenges. Students will learn basic frameworks of decision-making through readings and role-play. Through the role-play, students will grapple with the perspectives of multiple stakeholders, the interplay of science and policy, and the ambiguity and uncertainty inherent in decision-making processes.

Credit 3 units. A&S IQ: SSC Arch: SSC Art: SSC BU: BA EN: S

L82 EnSt 3615 Environmental Anthropology

This course will provide students with a working knowledge of how the study of humans across space and time has fundamentally impacted the way we understand the idea of nature, the environment and what it means to be human. The course will ground students in both historical and cutting-edge anthropological theories with units on subsistence, transformative nature, imagining wilds in the Anthropocene and pluralizing environmentalisms.

Same as L48 Anthro 3615

Credit 3 units. A&S IQ: SSC Arch: SSC Art: SSC BU: BA EN: S

L82 EnSt 364 Field Methods for Environmental Science

This course provides a broad survey of practical and applied methods for environmental field work for site assessments, ecological studies, conservation land management, habitat monitoring, and ecological restoration. A primary focus will be sources and techniques for obtaining and interpreting field data across a range of abiotic, organismal and system/community parameters, with emphasis on hands-on field experience providing students with direct knowledge highlighting the advantages and limitations of various methods. In the process, students will learn about multiple taxonomic and organismal groups and natural community types, and the relationships among these and the physical environment in functional natural systems. Course topics include theory and practice of methods for sampling biotic and abiotic resources, including vegetation, fauna, aquatic systems, stream geomorphology, and soils, as well as using these data for assessments, habitat monitoring, land management decisions, and developing ecological restorations. Students will gain familiarity with responding to

issues driving applied environmental science and related fields today, including data quality, sampling design, field techniques, viability and threat analyses, and incorporating field data into multi-scale conservation planning and design work. The course consists of instructor presentations, guest lectures, readings and written response papers, student projects and presentations, classroom discussions, and extensive field exercises and hands-on training. Class logistics: one lecture (1.5 hours) and one lab (5 hours) per week, plus 2-3 all day Saturday field trips (see policy on absences for back-up plan regarding field trips).
Credit 3 units. A&S IQ: NSM

L82 EnSt 374 Social Landscapes in Global View

From the beginning of the human campaign, societies have socialized the spaces and places where they live. This socialization comes in many forms, including the generation of sacred natural places (e.g., Mt. Fuji) to the construction of planned urban settings where culture is writ large in overt and subtle contexts. Over the past two decades or so, anthropologists, archaeologists and geographers have developed a wide body of research concerning these socially constructed and perceived settings — commonly known as "landscapes." This course takes a tour through time and across the globe to trace the formation of diverse social landscapes, starting in prehistoric times and ending in modern times. We cover various urban landscapes, rural landscapes, nomadic landscapes (and others) and the intersection of the natural environment, the built environments and the symbolism that weaves them together. Chronologically, we range from 3000 BCE to 2009 CE and we cover all the continents. This course also traces the intellectual history of the study of landscape as a social phenomenon and investigates the current methods used to recover and describe social landscapes around the world and through time. Join in situating your own social map alongside the most famous and the most obscure landscapes of the world and trace the global currents of your social landscape!
Same as L48 Anthro 374

Credit 3 units. A&S IQ: LCD, SSC Art: SSC BU: BA EN: S UColl: NW

L82 EnSt 375 Urban Ecology

Urban Ecology is a field of study within ecology that focuses on the urban environment as an ecosystem and attempts to understand how humans and nature can better coexist in these highly modified environments. The ultimate goal is to aid efforts for more sustainable cities through better urban planning and practices. It is a multidisciplinary study including topics from ecology, evolution and conservation biology, as well as architecture, economics and business. The class format will include both lectures and discussions.

Credit 3 units. A&S IQ: NSM Arch: NSM Art: NSM BU: SCI

L82 EnSt 380 Applications in GIS

This introductory course in Geographic Information Systems (GIS) is designed to provide basic knowledge of GIS theory and applications using the existing state-of-the-art GIS software. The course is taught using a combination of lectures, demonstrations and hands-on, interactive tutorials in the classroom. The first week of the course provides a broad view of how students can display and query spatial data and produce map products. The remainder of the course focuses on applying spatial analytical tools to address questions and solve problems. As the semester develops, more tools are added to students' GIS toolbox so that they can complete a final independent project that integrates

material learned during the course. Students are encouraged to design individualized final projects using their own or other available data; however, some already-prepared final projects also are available.

Credit 3 units. A&S IQ: NSM Arch: NSM Art: NSM

L82 EnSt 381 Introduction to Ecology

This course explores the science of ecology, including factors that control the distribution and population dynamics of organisms, the structure and function of biological communities, how energy and nutrients flow across ecosystems, and what principles govern ecological responses to global climatic and other environmental changes. The class format includes lectures, discussions and small group exercises. Assignments include quantitative data analysis, ecological modeling and scientific writing.

Same as L41 Biol 381

Credit 3 units. A&S IQ: NSM Arch: NSM Art: NSM BU: SCI

L82 EnSt 390 Independent Study

Independent study for undergraduates, supervised by a faculty member. Prerequisite: permission of instructor.

Credit variable, maximum 6 units.

L82 EnSt 391 Directed Research in Environmental Studies

Research activities or project in environmental studies done under the direction of an instructor in the program. Permission of an instructor and the chair of the program is required.

Credit variable, maximum 6 units.

L82 EnSt 392 Directed Fieldwork in Environmental Studies

Fieldwork carried out under the direction or supervision of an instructor in the Program. Permission of an instructor and of the chair of the program is required.

Credit variable, maximum 6 units.

L82 EnSt 400 Topics in Environmental Science

Why, when all evidence points to the growing threats of climate change, is it so difficult to create movement toward addressing it? Why, when we have so much evidence that vaccines reduce illness and death and are extremely safe, do individuals still choose not to vaccinate their children? What if I told you that the scientific evidence does not matter? Over the last few decades, neither better education, nor guilt, nor fear have worked to produce change on these important issues. In this class we will explore different factors contributing to why scientific evidence doesn't matter for the individual choices we make or policies we support, how we might talk to one another in a way that might shift thinking or behavior, and how we can create evidence-based policy. We will explore themes of argumentation, worldview, cognitive linguistics and framing, cognitive dissonance, risk perception, empathy, habit changes, bungles in messaging, and difficult dialoguing through the examples of climate change and vaccination. Course activities will consist of reading, some online research, and reflective journaling at home, and engaging in conversation during class. There are no pre-requisites but the class is designed to target upper level students in environmental majors and pre-health studies.

Credit 2 units. A&S IQ: NSM Arch: NSM Art: NSM BU: SCI

L82 EnSt 402 Topics in Environmental Science

Topics course: International Energy Politics. This course analyzes long-term political, economic and security trends in the international energy markets (oil, natural gas, coal, nuclear, wind and solar). It examines the effects of energy resources on peace and conflict, on the stability and well-being of democracies and dictatorships, and on the domestic and foreign politics of the United States, the European Union, Russia, Saudi Arabia, Iran, Iraq, Nigeria and Venezuela. The course also deals with various issues in global environmental politics, as well as global trends in the use of renewable and nuclear energy. It will include a guest lecture by an executive from a major coal producer operating in St. Louis, and an optional class visit to a renewable energy project in the city. Grades are based on a short presentation in class (10%), class participation (10%), a final research project (40%) and a mid-term exam (40%).

Credit 3 units.

L82 EnSt 405 Sustainability Exchange: Community and University Practicums

The Sustainability Exchange will bring together students working in transdisciplinary teams to tackle real-world energy, environmental, and sustainability problems through an experiential form of education. Students will participate in projects with clients and partners on- or off-campus, developed with and guided by faculty advisers drawn from across the university, with the intention of delivering an applicable end-product that explores "wicked" problems requiring innovative methods and solutions. These projects matter to the client or partner. The team-based project will be complemented by a seminar that will explore the field of design and design thinking through problem-solving strategies and methodologies drawn from a wide range of creative practices, including design, engineering and science, as well as contemporary topics in energy, environment and sustainability. Students will draw on these topics to influence their projects. This course is open to all undergraduate juniors and seniors. An application is required; students will be accepted off the wait list following the application process. CET (<https://gephardt.institute.wustl.edu/cec/college-of-arts-sciences>) course.

Same as I50 InterD 405

Credit 3 units. A&S IQ: SSC Arch: SSC Art: SSC EN: S

L82 EnSt 406 Urban Ecosystem Principles Integration

In today's world, your discipline has grand challenges whose solutions often lay in other realms. How will you train yourself to leverage the interdisciplinary partnerships required to innovatively solve and evolve in a rapidly changing world? The mission of this interdisciplinary course is to "Advance the interrelationships of ecological and human systems toward creating a healthy, resilient, and biodiverse urban environment," and bring together experts and students in ecology, urban design, architecture/landscape architecture, economics, social work and engineering, drawing from inside and outside the Washington University community. Building from our knowledge of ecosystem principles and function, a diverse group of leaders in their fields provides lectures, readings and student project leadership to understand and test Healthy Urban Ecosystems Principles among human and ecological (nonhuman) systems and the range of sociopolitical processes entailed with their implementation. Class content is developed by Washington University leaders in their disciplines as well as external organizations such as the Missouri Botanical Garden, the Field Museum in Chicago and others. This course builds upon a 1-unit fall seminar (not a prerequisite) that introduces challenges and

solutions to achieving healthy urban ecosystems, and provides students an opportunity to more deeply engage and manipulate the interrelationships of symbiotic urban systems, and apply those concepts in multidisciplinary project applications. Projects leverage student-defined challenges in the evolving laboratory of urban St. Louis using Healthy Urban Ecosystems Principles to develop multidisciplinary integrated solutions to challenges encountered in urban areas such as climate change and resilience, security of ecosystem services, social inequity, economic strife, and community vitality. Students present their work in a public forum at semester's end. CET (<https://gephardt.institute.wustl.edu/cec/college-of-arts-sciences>) course.

Same as I50 InterD 406

Credit 3 units. A&S IQ: SSC Arch: SSP EN: S

L82 EnSt 408 Earth's Atmosphere & Global Climate

Structure and dynamics of Earth's atmosphere. Basic factors controlling global climate of Earth. Quantitative aspects of remote sensing of atmosphere. Remote sensing instrumentation. Prerequisites: Math 233 and Phys 117A (or Phys 197); or permission of instructor.

Same as L19 EPSc 408

Credit 3 units. A&S IQ: NSM Arch: NSM Art: NSM

L82 EnSt 413 Introduction to Soil Science

Physical, chemical and biological processes that occur within soil systems. Types of soils and how these relate to soil formation. Major components of soil, including soil water, minerals, organic matter and microorganisms. Soils in wetlands and arid regions. Cycling of nutrients and contaminants in soils. Soil quality, conservation and sustainability. Two one-day field trips required. Prerequisites: EPSc 323 or Chem 112A (or AP Chem score of 4) or permission of instructor.

Same as L19 EPSc 413

Credit 3 units. A&S IQ: NSM Arch: NSM Art: NSM

L82 EnSt 419 Community Ecology

Basic principles of community ecology, including species interactions, spatial and temporal patterns of biodiversity, and ecosystem functioning. Analytical theory, statistical patterns, and experimental approaches are emphasized. Intended for students wanting a rigorous overview of ecological principles. Prerequisite: at least one of the following courses: Biol 3501, 372, 381, 4170, 4193, EnSt 370 or permission of instructor.

Same as L41 Biol 419

Credit 4 units. A&S IQ: NSM Arch: NSM Art: NSM

Credit 4 units. A&S IQ: NSM Arch: NSM Art: NSM

L82 EnSt 4193 Experimental Ecology Laboratory

Design and interpretation of ecological experiments, with an emphasis on hypothesis testing, sampling methodology, and data analyses. Sessions address fundamental ecological questions and include field, greenhouse, and laboratory (microcosm) studies on a variety of taxa and ecosystems. Generally work is done before dark (5-6 p.m.), although occasionally goes later (7 p.m.). Includes occasional required Saturday field trips to local sites (e.g., forests, wetlands, prairies, streams) for in-depth study. Assignments are primarily written assignments, including final projects and in-class participation. Fulfills the upper-level laboratory requirement for the Biology major. One hour of lecture and 4 hours of laboratory per week. Prerequisites: permission of instructor and at least one of the following: Introduction to Ecology (Biol 381), Behavioral Ecology (Biol 372), Biological Conservation (EnSt 370), Population Ecology (Biol 4170), Community Ecology (Biol

419), or Evolution (Biol 3501). Credit will not be awarded for both 4191 and 4193. Enrollment is limited to 15 students.

Same as L41 Biol 4193

Credit 4 units. A&S IQ: NSM, WI Arch: NSM Art: NSM

L82 EnSt 428 Hydrology

Survey of principles that govern the flow of water in river and groundwater systems in deep geologic environments. Basic equations of fluid flow, dynamics, and the characteristics of drainage basins, rivers, floods, and important aquifers.

Exploitation of ground water systems. Prerequisite: EPSc 353; or permission of instructor.

Same as L19 EPSc 428

Credit 3 units. A&S IQ: NSM Art: NSM

L82 EnSt 432 Environmental Mineralogy

Topics connected with environmental mineralogy, some selected by students. Topics may include: mineral dust such as asbestos, containment materials for nuclear waste disposal, environmental ramifications of the processing and use of phosphate fertilizers, lead in the environment, acid mine drainage, microbial mediation of sulfide oxidation, minerals in the human body, weathering of building materials, materials engineering, and engineering of materials for more effective recycling. Three class hours and one two-hour laboratory a week. Participation in discussions, term paper, two field trips required. Most readings from primary sources. Prerequisite: EPSc 352 or permission of instructor.

Same as L19 EPSc 430

Credit 4 units. A&S IQ: NSM Art: NSM

L82 EnSt 444 Environmental Geochemistry

Introduction to the geochemistry of natural waters and the processes that alter their composition. Key principles of aqueous geochemistry and their application to describe the main controls on the chemistry of pristine and polluted soil, surface, and ground water environments. Acids and bases, mineral solubility, carbonate chemistry, chemical speciation, redox reactions, adsorption and ion exchange, and the speciation, mobility and toxicity of metals. Prerequisites: EPSc 201 and Chem 112A (or AP Chem score of 4); or permission of instructor.

Same as L19 EPSc 444

Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI

L82 EnSt 451 Environmental Policy

This course examines the relationship between environmental economics and environmental policy. The course focuses on air pollution, water pollution, and hazardous wastes, with some attention given to biodiversity and global climate change. The course examines critically two prescriptions that economics usually endorses: (1) "balancing" of benefits against costs (e.g., benefit-cost analysis) and the use of risk analysis in evaluating policy alternatives; (2) use of market incentives (e.g., prices, taxes or charges) or "property rights" instead of traditional command-and-control regulations to implement environmental policy. Prerequisite: Econ 1011.

Same as L11 Econ 451

Credit 3 units. A&S IQ: SSC Art: SSC BU: BA, ETH EN: S

L82 EnSt 452 International Climate Negotiation Seminar

This course is a 3-credit advanced seminar for students who will represent Washington University at the annual United Nations Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC).

Attending the meetings provides student delegates with a unique educational experience to observe interdisciplinary negotiations and interactions inside the negotiating space. Students see the interaction between climate policy, science and technology as they identify and analyze policy decisions as they prepare for and observe the negotiations. The number of students who can attend COP is limited by the United Nations. We are usually able to take six students, three each week of the conference. Participation in the course is possible without traveling to the COP. COP 24 will be held in Katowice, Poland December 3-14, 2018. Enrollment is limited. Indicate your interest by placing yourself on the waitlist and completing an application. The application must be completed by noon on April 20. All students will be placed on the waitlist upon registration and students will be selected to enroll from the waitlist after all the applications are reviewed. Enrollment decisions will be made by April 27.

The course is currently scheduled for M/W 11:30-1:00. There is an option to possibly move it to Tuesday evening. If you have a course time conflict, you are encouraged to complete the application and note the alternate time option.

Credit variable, maximum 6 units. A&S IQ: SSC EN: S

L82 EnSt 461 Intro to Environmental Law and Policy

Survey of the most prominent federal laws designed to control pollution and protect human health and the environment. Examines laws applicable to environmental impact statements, biodiversity, air pollution, water pollution, and hazardous waste. Discusses the role of state law and cooperative federalism, as well as the roles of the courts, the legislature, and the administrative state in protecting the environment.

Credit 3 units. A&S IQ: SSC BU: BA EN: S

L82 EnSt 481 Advanced GIS

This course is designed to move beyond tools and skills learned in Applications in GIS (EnSt 380/580). Classes will feature hands-on exercises selected to help students master advanced GIS analysis tools and techniques, while providing experience in the planning and execution of real-world projects. Primary emphasis will be on applying fundamental GIS concepts, performing spatial analysis, developing proficiency with core ArcGIS software (e.g., Network Analyst extension), resolution of problems, and efficient delivery of results. Readings from books and scientific literature will introduce key concepts and provide real-world examples that will be reinforced in the hands-on exercises, assignments and projects. As the semester develops, students will gain a variety of new tools and techniques that will allow them to complete a final independent project that integrates the material learned during the course.

Credit 3 units. A&S IQ: NSM Arch: NSM Art: NSM

L82 EnSt 4980 Undergraduate Research Seminar

Provides an opportunity for advanced undergraduates to synthesize many of the diverse subdisciplines of Earth and Planetary Sciences while focusing on a research topic. Subject changes each offering. Each subject is unique and timely, but broad enough to encompass wide-ranging interests among students. Students conduct original research, make written reports of the results, and make oral presentations of their projects in class. Prerequisite: senior standing or permission of instructor.

Same as L19 EPSc 498

Credit 3 units. A&S IQ: NSM, WI Art: NSM
