

# Earth and Environmental Systems

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Website: [sewanee.edu/academics/forestry-geology/](http://sewanee.edu/academics/forestry-geology/)

Forestry, geology, watershed analysis, and environmental study are the emphases of the Department of Earth and Environmental Systems. Students analyze the physical, biological, hydrological, and chemical components of natural landscapes, and they also address the economic, social, and political aspects of environmental issues as part of their study. The department stresses work both within and outside the classroom, and trains students to integrate their field observations with theoretical concepts and analytical data.

The department offers four majors, three minors, and a certificate of curricular study.

## Majors

- **Environment and Sustainability:** The study of environmental policies and sustainability issues from a variety of perspectives.
- **Forestry:** A study of forest ecosystems and the environmental components and processes (biological, physical, and chemical) that affect them.
- **Geology:** A study of processes affecting the earth — geological, hydrological, and chemical.
- **Natural Resources and the Environment:** An interdisciplinary environmental major that integrates coursework in forest ecosystems and geology with other environmental coursework.

All majors in the Department of Earth and Environmental Systems emphasize an interdisciplinary study of the natural world, the interrelationships between geological, hydrological, and forest ecological processes, and the connections among issues such as climate change, land use, sustainable development, pollution, human health, and food systems. The forests and geological exposures on the University Domain and its environs, along with the stream drainages that comprise local watersheds, are the focus of both lab and field study. Other sites in the Appalachians, Rocky Mountains, Colorado Plateau region, and St. Catherine's barrier island are also studied in specific courses. Students in all majors develop skills appropriate to the study of natural systems. These include skills in computer use/analysis (database, word processing, and/or GIS software), field identifications, laboratory analysis, and mapping and spatial analysis of variables in the field. Graduating seniors must demonstrate a broad knowledge of environmental issues (local, regional, and global) and must be competent in both oral and written communication skills. As part of this goal, all juniors in the department complete an oral presentations course or colloquium, and all seniors complete a collaborative and interdisciplinary senior field research project.

Students interested in majoring in environment and sustainability, forestry, geology, or natural resources have choices in required coursework, and they are advised to consult with a member of the department early in their college career to plan a sequence of courses appropriate to their interests and objectives.

## Minors

- **Environmental Studies:** A study of environmental policy and sustainability issues from a variety of perspectives.
- **Forestry:** A study of forest ecosystems and the environmental components and processes (biological, physical, and chemical) that affect them.
- **Geology:** A study of processes affecting the earth — geological, hydrological, and chemical.

## Watershed Science Certificate

The watershed science certificate is designed for students interested in gaining a better understanding of the interactions among physical, chemical, and biological factors that affect our watersheds and wetlands. Students pursuing the certificate take a range of courses focusing on water resources and watershed science, their work culminating in the Watershed Science Capstone course.

## Faculty

Assistant Professor Fielding

Professors Knoll, Kuers, Potter, Shaver, K. Smith (Chair), Torreano

Associate Professor Sherwood

## Majors

## Majors

- **Environment and Sustainability** (<http://e-catalog.sewanee.edu/archives/2015-2016/arts-sciences/departments-interdisciplinary-programs/earth-environmental-systems/environment-sustainability-major>)

- Forestry (<http://e-catalog.sewanee.edu/archives/2015-2016/arts-sciences/departments-interdisciplinary-programs/earth-environmental-systems/forestry-major>)
- Geology (<http://e-catalog.sewanee.edu/archives/2015-2016/arts-sciences/departments-interdisciplinary-programs/earth-environmental-systems/geology-major>)
- Natural Resources and the Environment (<http://e-catalog.sewanee.edu/archives/2015-2016/arts-sciences/departments-interdisciplinary-programs/earth-environmental-systems/natural-resources-environment-major>)

## Minors

### Minors

- Environmental Studies (<http://e-catalog.sewanee.edu/archives/2015-2016/arts-sciences/departments-interdisciplinary-programs/earth-environmental-systems/environmental-studies-minor>)
- Forestry (<http://e-catalog.sewanee.edu/archives/2015-2016/arts-sciences/departments-interdisciplinary-programs/earth-environmental-systems/forestry-minor>)
- Geology (<http://e-catalog.sewanee.edu/archives/2015-2016/arts-sciences/departments-interdisciplinary-programs/earth-environmental-systems/geology-minor>)

## Certificate

The watershed science certificate of curricular study is designed for students interested in gaining a better understanding of the interactions among the physical, chemical, and biological factors that affect our watersheds and wetlands. Students pursuing the certificate take a range of courses that focus on water resources and watershed science. In addition to hydrology, students take at least one half-course in applied watershed science, and choose additional watershed science courses from a list that contains offerings in a variety of disciplines, including biology, chemistry, forestry, geology, and environmental studies. Each student completes the certificate with the watershed science capstone course, a multidisciplinary, project oriented course in which students address issues related to two or more of the following topic areas: the interaction of biological processes and watershed function, chemical processes in streams and watersheds, the relationship between forested landscapes and hydrologic systems, or geological processes in terrestrial aquatic systems. The capstone project may be a semester project created solely for the capstone, or may begin as a watershed-related summer internship project that is further developed by the student during an academic semester.

Students who obtain the certificate will be better prepared to pursue graduate training in watershed science and other hydrologic disciplines, or to begin careers associated with watershed science and management.

Students deciding to pursue the certificate should contact one of the faculty members of the Watershed Certificate Organizing Committee to develop his or her study plan. The Organizing Committee is also available to help a student identify his or her area of emphasis and primary faculty supervisor for the ESCI 430; together the student and primary supervisor identify the second discipline and arrange to work with a faculty member in that area. The Watershed Certificate Organizing Committee is comprised of Professor Knoll, Earth and Environmental Systems; Associate Professor McGrath, Biology; and Assistant Professor White, Chemistry.

## Requirements for the Certificate in Watershed Science

The certificate of curricular study requires successful completion of the following:

### Course Requirements

ESCI 430	Watershed Science Capstone	4
FORS/GEOL 314	Hydrology (Lab)	4
Select one of the following:		2
ESCI 444	Independent Study (approved by the Organizing Committee)	
FORS 260	Forest Watershed Measurements	
GEOL 315	Watershed Contaminant Hydrology	
Select twelve hours from the following:		12
BIOL 210	Ecology (Lab)	
BIOL 237	Freshwater Biology (Lab)	
ENST 217	Fundamentals of GIS	
ENST 235	Freshwater Conservation	
ENST 240	Island Ecology (Lab)	
ENST 301	Introduction to Spatial Information Systems and Field Mapping	
ENST 310	Comparative Watershed Studies	
ENST 311	Comparative Watershed Studies Field Course	

ENST 317	Advanced Applications of GIS
FORS 215	Fisheries Ecology and Management (Lab)
FORS 262	Forest and Watershed Restoration (Lab)
FORS 270	Water Resource Policy and Law
FORS 303	Soils (Lab)
FORS 305	Forest Ecology (Lab)
GEOL 303	Soils (Lab)
GEOL 411	Geochemistry of Natural Waters

**Total Semester Hours**

**22**

## Off-Campus Study

### Island Ecology Program

The island ecology program is an interdisciplinary summer field school in the sciences. Following a seminar during the Easter (spring) semester, students study geological, biological, and broadly ecological topics for five weeks on St. Catherines Island, an undeveloped barrier island off the coast of Georgia. The experience emphasizes the interdependence of these disciplines by exploring how the fragile ecosystem of the island functions. The program is limited to ten Sewanee students but is open to non-science as well as science majors. Four faculty members from two departments teach in the program each spring and summer.

### Courses

#### Environmental Sciences Courses

##### ESCI 430 Watershed Science Capstone (4)

Capstone course for students pursuing the watershed science certificate. A multidisciplinary, project-oriented course in which students address issues related to two or more of the following topic areas: the interaction of biological processes and watershed function, chemical processes in streams and watershed, the relation between forested landscapes and hydrologic systems, or geological processes in terrestrial aquatic systems. *Open only to seniors pursuing curricular certificates in watershed science.*

##### ESCI 444 Independent Study (2 or 4)

A supervised field or laboratory investigation of an interdisciplinary topic in environmental science. May be taken more than once for credit. *Prerequisite: Professor consent and prerequisite override required.*

#### Environmental Studies Courses

##### ENST 100 Walking the Land (4)

A field-oriented geology and writing course, conducted on the Cumberland Plateau and surrounding provinces. The emphasis will be on observation of geological features, particularly geomorphology, and how these relate to other natural parts of the landscape. Historical aspects of human use of the land will also be emphasized. Extensive walking and hiking. Field journals will be part of the writing-intensive approach.

##### ENST 101 Introduction to Environmental Studies (4)

An interdisciplinary introduction to Environmental Studies through the examination of the scientific and social aspects of environmental issues. Field components of the course focus on the University Domain and the surrounding area. This course is required for all students who major or minor in environmental studies and should be taken before the junior year.

##### ENST 140 Readings in Island Ecology (2)

Supervised readings and discussion in geology, hydrology, invertebrate zoology, marine zoology, maritime plant communities, and wildlife behavior as preparation for participation in the interdisciplinary summer Island Ecology program. *Prerequisite: Approval of the Island Ecology program director.*

##### ENST 201 Foundations of Food and Agriculture (4)

Integrating local, regional, and global perspectives, this course outlines the history of agriculture, introduces the development of food systems and policy, and reviews the environmental impact of food production. Among topics addressed are the history of agricultural expansion in the US, the development of agriculture and food policies, interaction among agricultural markets at home as well as abroad, and sustainable agriculture. Classroom activities emphasize the involvement of multiple constituencies in identifying and articulating agricultural issues. Field opportunities include garden activities and local trips aimed at relating broader issues to how livelihoods are pursued on the Cumberland Plateau.

##### ENST 211 Sustainability and Global Environmental Change Seminar (2)

This seminar-style course exposes students to literature on a variety of issues related to climate change and other examples of our dynamic global environment including natural resource use and natural hazards. *Prerequisite: Approval of the Sustainability and Global Environmental Change program director.*

**ENST 212 Sustainability and Global Environmental Change Field Studies (2)**

This course is an interdisciplinary field immersion into a selected location that provides tangible experience of the concepts introduced in ENST 211. Students travel throughout the field site, exploring real-world examples of sustainability efforts in the context of our changing global environment. Concepts of sustainability, climate change, natural resource use, and natural hazards will be explored in the field context. Field sites may change from year to year.

**ENST 217 Fundamentals of GIS (4)**

An introduction to the basic concepts and applications of geographic information systems (GIS). Topics include geographic data acquisition, data management, cartography, and methods of geospatial analysis. Laboratory exercises and projects focus on applications of GIS in understanding and managing the environment. Laboratory course.

**ENST 220 Reading the Landscape (4)**

A study of how patterns in the current biological and physical landscape of the Cumberland Plateau can be explained by historical human land use and natural disturbances. Landscape change is examined through field investigation of specific places on the Domain conducted in combination with the analysis of aerial imagery and other geospatial data resources. The course also addresses how disturbance history can influence one's aesthetic valuation of the landscape and guide landscape-level conservation efforts. This course may count as a non-laboratory science course.

**ENST 235 Freshwater Conservation (4)**

A survey of existing and emerging threats to wetland ecosystems and the consequences for animal and human populations. This course discusses causes, consequences, and solutions for issues of international and local concern based on an understanding of freshwater ecology and function. Also considers multiple perspectives on water use and attempts to reconcile these differences so as to identify and publicize potential conservation solutions. *Prerequisite: BIOL 130 or ENST 101 or FORS 121.*

**ENST 240 Island Ecology (Lab) (8)**

This interdisciplinary field course combines the study of geology, oceanography, marine biology, botany, and wildlife behavior in a single coastal island ecosystem. *Prerequisite: ENST 140 and approval of the Island Ecology program director.*

**ENST 250 Environmental and Biological Non-Fiction (4)**

An examination of contemporary intersections among literature, journalism, biological science, and the study of the environment, supplemented by readings of nineteenth- and twentieth-century antecedents. Assignments allow students to develop their own writing abilities in these areas. Consideration is also given to the relationships among non-fiction, fiction, and other forms of creative expression.

**ENST 285 The Development of Aldo Leopold's Land Ethic (4)**

This course traces the development of Aldo Leopold's famous essay "The Land Ethic" through his 40-year career at the beginning of the ecology and conservation movements. Early writings by this noted conservationist are analyzed from the perspectives of environmental history and natural resource management and policy. Leopold essays from a broad spectrum of time (1915-1949) are discussed. Topics include ecosystem management, wildlife conservation and utilization; outdoor recreation, public lands, and wilderness; and agriculture as a land use. To contextualize Leopold's historical voice, perspectives on modern issues are contrasted with perspectives contemporary to Leopold. *Not open to new first-year students.*

**ENST 300 Seminar in Ecology and Ethics (4)**

Students will analyze and evaluate scientific and ethical arguments from selected environmental issues. Emphasis will be on exploring the relationship between science and ethics. A research project is required.

**ENST 301 Introduction to Spatial Information Systems and Field Mapping (4)**

An introduction to the ArcView Geographic Information System and the concepts and uses of Spatial Information Systems, the analytic side of GIS. The course will focus on the use of GIS in natural systems but will not have modules and exercises in the social science aspects including crime mapping and human demographics. The course will also contain three modules on field mapping. Knowledge of trigonometry is very useful and students should know the basics of Windows and Excel. Not open for credit to students who have completed FORS/GEOL 410.

**ENST 302 Ecology, Evolution, and Agriculture (4)**

An investigation of the reciprocal interaction between human and the organisms that nourish us. The class examines the origins and subsequent evolution of domesticated plants, animals, and agricultural pests, and the ways in which these organisms have shaped our bodies and communities. The class will also focus on the relationship between food production and hunger. Class will involve reading, writing, and discussions, invited speakers, field trips, and the study of ecological processes and natural history in and around an organic garden.

**ENST 305 Ecological Integrity in Agriculture (4)**

This course develops a critique of problems and solutions relating to agricultural technology, policy, and practice with a specific focus on ecology and ecological integrity. The course begins with a brief survey of agricultural history, through the era of modern food systems, with emphasis on the development of industrial agriculture. After evaluating the environmental impact of modern agriculture, the course addresses the foundations of sustainability, with specific reference to the ecology of sustainable agriculture. Field opportunities are provided for students to interact with local producers on their farms and to engage directly the ecological processes involved in food production on the Domain. *Prerequisite: BIOL 130.*

**ENST 310 Comparative Watershed Studies (2)**

The course compares watersheds of the Cumberland Plateau to those of the Kraichgau region of southwestern Germany. Emphasis is on the hydrology, geology, forest cover, and history of human use of select watersheds and how these factors have defined the present natural and cultural landscapes. *Prerequisite: GEOL 121.*

**ENST 311 Comparative Watershed Studies Field Course (2)**

A two-week field course in the Kraichgau region of southwestern Germany. The course is hiking-based and requires students to keep a detailed notebook. *Prerequisite: ENST 310.*

**ENST 317 Advanced Applications of GIS (4)**

This course uses spatial analysis methods for environmental analysis and management. Topics include remote sensing and image analysis, surface analysis, spatial statistics, internet mapping, visualization of geographic data, and other advanced GIS methods. *Prerequisite: ENST 217.*

**ENST 320 Environment and Sustainability Colloquium (4)**

This required course for junior environment and sustainability majors addresses some topical themes from an interdisciplinary perspective and with focus on the connections between science and policy. Colloquium themes vary from year to year, and students present relevant research articles and lead discussions with emphasis on developing skill in public speaking. Students also work with course instructors and faculty mentor(s) to propose a research project to be completed as part of their senior environment and sustainability capstone. *Open only to juniors pursuing majors in environment and sustainability. Prerequisite: ENST 101 and completion of the foundational science requirement in major.*

**ENST 334 Environmental Policy and Law (4)**

This course combines the study of public policy with the study of major environmental problems. Students will explore public policy concepts and the instruments used in environmental regulation. Topics will include air and water quality issues hazardous waste and risk management, natural resources and biological diversity. The course will also discuss the impact of environmental groups and citizen activism on this highly complex area of public policy. Not open for credit to students who have completed POLS 334. *Prerequisite: ENST 101 or ENST 200.*

**ENST 336 Environmental Land-Use Policy (4)**

This course examines the complex systems and values influencing land-use decision-making in both rural and urban settings throughout the U.S. and abroad. Students learn how government agencies and local citizens often conflict in their attitudes and values regarding the costs and benefits of growth and development. Particular attention is paid to forest conversion issues on the South Cumberland Plateau. Students attend local planning sessions and meetings with local officials. *Prerequisite: ENST 101 or ENST 200.*

**ENST 340 Tools for Environmental Policy Analysis (4)**

This course introduces students to quantitative tools applicable to the analysis of environmental policy—including forecasting methods, simulation modeling, and mathematical programming. Probability distributions, risk modeling, and decision-making under uncertainty are also addressed. Students apply such tools to a range of policy analyses and also, where relevant, learn to work with large-scale models developed by others.

**ENST 341 Environmental Data Analysis (4)**

A survey of the principles of study design and data analysis in the field of environmental studies. Topics include study design, hypothesis testing, sampling methodology, exploratory data analysis, and the graphical presentation of results. These concepts and techniques are examined through discussion of the primary literature and problem sets.

**ENST 350 "Nature" Writing (4)**

An exploration of the literature of "nature." Students interrogate ideas of nature and investigate literary responses to these ideas. Readings for the class include works from multiple cultural perspectives, including texts by writers for whom the idea of nature is alien or oppressive.

**ENST 351 Field Studies in "Nature" Writing (4)**

Students conduct experiments in writing and critique, informed by contemplative engagement with the community of life on the University's land. *Prerequisite: ENST 350.*

**ENST 400 Environmental Arts and Humanities Capstone (4)**

A capstone experience for Environmental Arts and Humanities majors. An examination of selected environmental issues from a variety of perspectives in the natural and social sciences and humanities. Special emphasis on student research on the Domain and in the region. *Open only to seniors.*

**ENST 421 Environment and Sustainability Capstone (4)**

This course provides a capstone experience for the Environment and Sustainability major. Major components include independent student research projects and an examination of selected environmental issues from a variety of perspectives in the natural and social sciences. *Open only to seniors pursuing majors in environment and sustainability. Prerequisite: ENST 320.*

**ENST 431 Practicum in Religion and Environment (2)**

This course, which calls for involvement in some faith-based or otherwise engaged form of appropriate activity or service, offers students a capstone opportunity to examine their spiritual experiences and religious beliefs in the context of active engagement with environmental issues in a variety of ways. Reflection on the engagement experience, expressed both in written form and through oral presentation, is required. *Open only to juniors or seniors pursuing minors in religion and the environment. Prerequisite: Professor consent and prerequisite override required.*

**ENST 444 Independent Study (2 or 4)**

An opportunity for students to explore a topic of interest in an independent or directed manner. *Prerequisite: Professor consent and prerequisite override required.*

**Forestry Courses****FORS 121 Introduction to Forestry (Lab) (4)**

An environmental survey course which addresses the important features, processes, and issues of forested landscapes. Topics include major tree species, forest biology and ecology, tree structure and function, silviculture, forest management, forest products, and U.S. forest policy and laws. The focus on North American forests is set within a context of global forest issues. Lab exercises emphasize fieldwork, utilizing the diverse array of local forest types present on the Cumberland Plateau and nearby Appalachian Mountains. Lecture, three hours, laboratory and field trips.

**FORS 201 Natural Resources Issues and Policies (4)**

An overview of the contemporary use of renewable and nonrenewable natural resources on local, national, and international scales. This discussion-oriented class focuses on the controversial social and environmental issues that have shaped the formation of natural resource policy in the United States and the world.

**FORS 203 Soils and Cultivation (4)**

This course focuses on how agricultural practices alter the chemical and physical properties of soil. Students examine the origins of a select group of major crops, how humans have used and altered the plant over time, and the soil and environmental conditions that these crops prefer. Approximately half of the class is conducted in the student-community garden. In the process of starting a winter garden and preparing it for spring planting, students take soil samples and measure variables such as nutrient and organic matter analysis, soil temperatures, and soil moisture contents. They also learn to identify relevant plant species. *Prerequisite: FORS 121 or BIOL 130 or GEOL 121 or CHEM 101.*

**FORS 204 Forest Wildlife Management (4)**

A survey and analysis of how vertebrate animals affect forest processes, with particular emphasis on forest regeneration on the Cumberland Plateau. This discussion-oriented class will also address the history and current status of U.S. and international wildlife management, and the effects of forest management on game and non-game species. Students will interact with wildlife management professionals in Tennessee and will design and implement a field study to quantify the effects of vertebrate animals on forest growth and development. *Prerequisite: FORS 121 or BIOL 130.*

**FORS 211 Dendrology (Lab) (4)**

This course explores the identification, biology and morphology of woody plants, with emphasis on the major forest species of North America. Primary focus is on the ecophysiological characteristics of species and their roles in forest succession, species distribution across the landscape, and responses to disturbance and environmental stress. Includes field identification of native trees and shrubs of the eastern U.S., with special emphasis on the Cumberland Plateau and the southeast. Lecture, laboratory, and weekend field trips. *Open only to sophomores, juniors, and seniors.*

**FORS 212 Forestry in the Developing World (4)**

An introduction to the use and management of trees in the developing world. Social and technical aspects of forestry will be considered. Topics will include the role of forestry in development, land and tree tenure, the role of women in forestry projects, agroforestry, trees in traditional systems, the forest as habitat, and the role of western technology as applied to forestry in the developing world.

**FORS 215 Fisheries Ecology and Management (Lab) (4)**

An introduction to the theory and practice of fisheries science. Particular emphasis is placed on approaches and techniques for assessing and managing fish populations, habitats, and ecosystems under commercial and recreational harvest; on human dimensions in fisheries management and policy; and on case studies of flawed management approaches throughout history. *Prerequisite: FORS 121 or BIOL 130.*

**FORS 230 Urban Forest Management (4)**

Study of the environmental stresses associated with urban landscapes and their impact on establishing and maintaining trees in urban environments. Topics include the theory and practice of individual tree care; biology of tree response to stress, disease, and nutrient assessment; impacts of trees on urban climate; and urban forest inventory and planning. *Prerequisite: FORS 121.*

**FORS 240 Special Topics (2 or 4)**

A seminar on a topic related to forestry and natural resources. May be repeated indefinitely. *Prerequisite: FORS 121.*

**FORS 250 Forests: Food, Medicine, and More (4)**

An exploration of the wide range of edible, medicinal, and otherwise useful forest products found in forests of western and eastern North America, including the forests of Sewanee. In addition to learning about the biology and distribution of these plants, and about how they are gathered and processed, students discuss the ecological implications of harvesting these interesting plants and fungi. Note: The class involves some eating. *Prerequisite: FORS 121 or BIOL 130.*

**FORS 260 Forest Watershed Measurements (2)**

A field and analysis course in which students learn the techniques of stream and watershed evaluation through active participation in a watershed monitoring project. Activities will focus upon stream and watershed sampling procedures, analytical laboratory techniques, and the synthesis, analysis, and reporting of data. Non-laboratory course. *Prerequisite: FORS 314 or GEOL 314.*

**FORS 262 Forest and Watershed Restoration (Lab) (4)**

A study of the principles and practices employed in forest and watershed restoration across North America. Emphasis placed on the scientific tenets of restoration (ecosystem function and process), field monitoring techniques, the concept of adaptive management, collaboration and conflict resolution, and the development of restoration policy. Laboratory course. *Prerequisite: FORS 121 or GEOL 121 or BIOL 130.*

**FORS 270 Water Resource Policy and Law (4)**

This case-studies based course focuses on the protection and management of water resources and associated biodiversity. Students are introduced to the principal federal and state laws governing the rights and responsibilities of landowners, with emphasis on how such regulation affects management decisions and economic outcomes. The course promotes understanding of the legal/regulatory environment through study of common and statutory law, as well as critical analysis of the outcomes. Case studies involve both international and local problems. Students gain practical experience by applying science-based monitoring guidelines and methods, together with opportunities for community engagement work.

**FORS 303 Soils (Lab) (4)**

A study of soils as they relate to land use, bedrock and geomorphology, site quality, and vegetation processes. Emphasizes field interpretation of soils as one component of terrestrial ecosystems. Lecture, three hours; laboratory and field trips. *Prerequisite: FORS 121 or GEOL 121.*

**FORS 305 Forest Ecology (Lab) (4)**

Explores the interrelationships between structure and function of forested ecosystems, approaching the forest community from a physiological perspective. Emphasizes the influence of microclimate, nutrient cycling, and disturbance on community productivity and composition. Lecture, three hours; laboratory and field trips. *Prerequisite: FORS 121 and one forestry course numbered 200 or above.*

**FORS 307 Biometrics (4)**

Principles and methods employed in the estimation of forest and other natural resource parameters. Introduction to the uses of statistical models in drawing inferences about biological populations with an emphasis on sampling theory and field methods. Topics include: the scientific method, methods to assist students in the interpretation of both experimental and observational data, and elements of experimental design with an emphasis on biological applications. *Prerequisite: FORS 121 and (MATH 101 or STAT 204).*

**FORS 312 Silviculture (Lab) (4)**

Principles and practices of establishing, tending, and harvesting forest stands on a sustainable basis. Emphasis on ecologically sound techniques of managing forests to meet diverse landowner objectives such as watershed management, wildlife habitat enhancement, recreational use, insect and disease control, and/or timber production. *Prerequisite: FORS 121 and one forestry course numbered 200 or above.*

**FORS 314 Hydrology (Lab) (4)**

Occurrence, movement, quality, and behavior of water in the hydrologic cycle with emphasis on surface and underground water. Includes techniques and problems of measurement and utilization. Lectures, three hours; laboratory and field trips, three hours. *Prerequisite: GEOL 121.*

**FORS 316 Tropical and Boreal Forest Ecosystems (4)**

A detailed examination of important components and processes in tropical and boreal forest ecosystems, which collectively comprise over 75% of the earth's forests. Topics will include: the climate, soils, and unique plant life that characterize these two biomes; carbon and nutrient dynamics in undisturbed forests; and the effects of land-use change on properties of these forested systems. *Prerequisite: FORS 121 or BIOL 130.*

**FORS 319 Natural Resource Management and Decisions (4)**

A survey of theory and methods used in natural resource management analysis and decision making with an emphasis on forests and some other renewable resources such as wildlife. Students will use resource modeling and decision-making software to address problems in managing multiple resources. Emphasis will be on (1) evaluation of the effects of land characteristics, tax policy, risk, and interest rates on management; (2) choice among policy alternatives proposed by competing groups; and (3) application of concepts of management, policy, economics, and spatial analysis to land management. Practicums will involve analysis of resource data and presentation of preferred strategies. *Prerequisite: ECON 101 and (FORS 121 or BIOL 130).*

**FORS 332 Oral Presentations (2)**

Oral presentations of important topics and published data in forestry, geology, and other environmental sciences. Course goal is to train students through practice to give and critique oral presentations appropriate for scientific or other professional research. Each student gives several presentations and formally critiques other presentations as part of the course. *Open only to juniors or seniors pursuing majors in forestry, geology, or natural resources and the environment. Prerequisite: FORS 121 or GEOL 121.*

**FORS 432 Senior Field Project (4)**

An interdisciplinary field-based study of a selected portion of the university Domain or surrounding area. The primary focus of the study is to conduct a detailed analysis of interrelationships between the project area's geology, forest cover, hydrology, archeology, economics, history, and current use, and to use these parameters to critically evaluate the land-use issues of the area. Students produce a professional-quality written report of their analysis and also orally present their results to department faculty and seniors. *Open only to seniors pursuing majors in forestry, geology, or natural resources and the environment. Prerequisite: FORS 121.*

**FORS 444 Independent Study (2 or 4)**

An opportunity for students to explore a topic of interest in an independent or directed manner. *Prerequisite: Professor consent and prerequisite override required.*

**Geology Courses****GEOL 121 Physical Geology (Lab) (4)**

A study of the geological features and processes that shape the earth's surface and subsurface. Lectures detail major components of the earth and the dynamic processes that generate them (including rocks, minerals, fossils, mountain belts, ocean basins, tectonic activity, magma formation, and climate change). Environmental issues related to geology (earthquakes, landslides, volcanic activity, groundwater contamination, and coastal and stream erosion) are major topics of discussion. Field-oriented lab exercises utilize excellent geological exposures of the Cumberland Plateau and the nearby Appalachian Mountains. Lecture, three hours; laboratory and field trips (including one weekend trip).

**GEOL 221 Mineralogy (Lab) (4)**

A study of the occurrence, crystal structure, chemistry, and origin of minerals, with special emphasis on geological environments that form or modify them. Laboratory work includes hand-lens, microscopic, and X-ray diffraction analysis of minerals. Lecture, three hours; laboratory and field work. *Open only to juniors or seniors pursuing majors in forestry, geology, or natural resources and the environment. Prerequisite: GEOL 121 and one geology course at the 200 level or higher.*

**GEOL 222 Historical Geology (Lab) (4)**

A study of the history of the earth, including its physical environments, the history of life, and the tectonic development of the earth throughout geologic time as recorded in the rock record. Emphasis on North America and paleoenvironments of the Cumberland Plateau. Lecture, three hours; laboratory and field trips. *Prerequisite: GEOL 121.*

**GEOL 225 Sedimentology (Lab) (4)**

A study of sedimentary rocks and the processes that form them. Field and class studies stress the link between modern sedimentary environments and their ancient counterparts. Emphasis on rocks of the Cumberland Plateau and other nearby areas. Lecture, three hours; laboratory and field trips. *Prerequisite: GEOL 121.*

**GEOL 230 Paleocology (4)**

A study of individuals, populations, and communities of plants and animals of the geologic past: their taphonomic histories, interactions with changing environments, and relationships to the sedimentary rock record. One weekend field trip. *Prerequisite: GEOL 121.*

**GEOL 235 Earth Systems and Climate Change (4)**

A study of climate change, its causes, and the impact of such change on sea level, glacial regimes, and the development of life through geologic time. Special emphasis on evidence for past and recent climate change. *Prerequisite: GEOL 121.*

**GEOL 250 Special Topics (2 or 4)**

A seminar on a topic related to geology. May be taken more than once for credit. *Prerequisite: GEOL 121.*

**GEOL 303 Soils (Lab) (4)**

A study of soils as they relate to land use, bedrock and geomorphology, site quality, and vegetation processes. Emphasizes field interpretation of soils as one component of terrestrial ecosystems. Lecture, three hours; laboratory and field trips, three hours. *Prerequisite: FORS 121 or GEOL 121.*

**GEOL 305 Economic Geological Resources (Lab) (4)**

A study of economically valuable minerals and rocks (including metals, nonmetals, industrial minerals, and hydrocarbons) in terms of their origin, tectonic settings, extraction, and use. Topics include global distribution and genesis of deposits in relation to plate tectonic theory, prospecting techniques, mining methods, mining laws, economics of the mineral and petroleum industries, and environmental problems associated with exploration and development. Lecture, three hours; laboratory and field trips. *Open only to juniors or seniors pursuing majors in geology or natural resources and the environment. Prerequisite: GEOL 121 and one geology course at the 200 level or higher.*



**GEOL 314 Hydrology (Lab) (4)**

Occurrence, movement, quality, and behavior of water in the hydrologic cycle with emphasis on surface and underground water. Includes techniques and problems of measurement and utilization. Lectures, three hours; laboratory and field trips, three hours. *Prerequisite: GEOL 121.*

**GEOL 315 Watershed Contaminant Hydrology (2)**

This is a field and project-based course that investigates the movement of natural and man-made contaminants through the ground water and surface water systems of watershed. Non-laboratory course. *Prerequisite: GEOL 314.*

**GEOL 318 Geomorphology (Lab) (4)**

Geomorphology is the study of surficial landforms (erosional and depositional) and the processes that create them. This course investigates major controls on landform development, geologic structures, lithology, and erosional/depositional processes. Significant emphasis is on climatic, pedogenic (soil-related), and fluvial processes, with additional consideration given to glacial, eolian, karst, weathering, and slope-related (mass-wasting) processes. Labs focus on describing and measuring landforms in the field and quantitatively analyzing this data to understand better how local geomorphologic features form and evolve. Further course in introductory physics highly recommended. *Prerequisite: GEOL 121.*

**GEOL 320 Igneous and Metamorphic Petrology (Lab) (4)**

Systematic study of the genesis, occurrence, composition, and classification of igneous and metamorphic rocks. Topics to include origin and crystallization of different magma types, metamorphic processes, and tectonic environments specific to certain rock suites. Laboratory work includes hand specimen and microscopic examination of igneous and metamorphic rock suites. Lecture, three hours; laboratory and field trips. *Prerequisite: GEOL 221.*

**GEOL 322 Geology of the Western United States (4)**

The course focuses on the geological evolution of the Colorado Plateau, the Rio Grande Rift, and the Rocky Mountains. Extensive use of geologic maps and periodicals. An additional half course may be earned with successful completion of a field trip to the western United States. *Open only to juniors or seniors pursuing majors in forestry, geology, or natural resources and the environment. Prerequisite: One laboratory course in geology numbered 200 or above.*

**GEOL 323 Geology of the Western United States Field Trip (2)**

A detailed field notebook is kept by students on this three-week trip. *Prerequisite: GEOL 322 and approval of the Geology of the Western United States Field Trip program director.*

**GEOL 325 Field and Structural Geology (Lab) (4)**

A study of deformed rocks and an introduction to tectonics. Preparation and interpretation of geologic maps; solution of basic structural problems. Field work emphasizes geologic mapping on the Cumberland Plateau and in more structurally deformed areas in eastern Tennessee. Lecture, three hours. *Prerequisite: GEOL 121.*

**GEOL 332 Oral Presentations (2)**

Oral presentations of important topics and published data in forestry, geology, and other environmental sciences. Course goal is to train students through practice to give and critique oral presentations appropriate for scientific or other professional research. Each student gives several presentations and formally critiques other presentations as part of the course. *Open only to juniors or seniors pursuing majors in forestry, geology, or natural resources and the environment. Prerequisite: FORS 121 or GEOL 121.*

**GEOL 411 Geochemistry of Natural Waters (4)**

A quantitative examination of the chemical processes that occur in aquatic environments, including precipitation, gas exchange, acid-base, redox, complexation, and adsorption reactions. Emphasis is on equilibrium and steady-state calculations as a tool for understanding the distribution and fate of inorganic chemical species in natural waters. Examples and case studies are used to address a variety of water types (e.g., lakes, oceans, rivers, estuaries, groundwaters, and wastewaters), pollutant fate, and geochemistry. CHEM 311 and CHEM 352 recommended. *Prerequisite: CHEM 102 or CHEM 111.*

**GEOL 432 Senior Field Project (4)**

An interdisciplinary field-based study of a selected portion of the university Domain or surrounding area. The primary focus of the study is to conduct a detailed analysis of interrelationships between the project area's geology, forest cover, hydrology, archeology, economics, history, and current use, and to use these parameters to critically evaluate the land-use issues of the area. Students produce a professional-quality written report of their analysis and also orally present their results to department faculty and seniors. *Open only to seniors pursuing majors in forestry, geology, or natural resources and the environment. Prerequisite: GEOL 121.*

**GEOL 444 Independent Study (2 or 4)**

An opportunity for students to explore a topic of interest in an independent or directed manner. *Prerequisite: Professor consent and prerequisite override required.*