NATURAL RESOURCES MANAGEMENT AND ENVIRONMENTAL SCIENCES

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Interim Department Head: Chip Appel

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The Natural Resources Management and Environmental Sciences department offers three undergraduate majors – Environmental Earth and Soil Sciences, Environmental Management and Projection, and Forestry and Natural Resources. Students have access to several thousand acres of agricultural, forest, and rangeland managed by the college. Students gain hands-on experience with equipment and techniques in common use by foresters, natural resources managers, soil scientists, agricultural scientists, geologists, and environmental scientists. The department is equipped for analysis of soil, plant, tree, rock, and water samples. Analytical methods available to students include gas chromatography for analysis of greenhouse gases, portable x-ray fluorescence spectroscopy, inductively coupled plasma – atomic emission spectroscopy (ICP-AES), flame atomic absorption spectrometry (FL-AAS), high temperature combustion analysis of carbon, nitrogen, and sulfur, petrographic microscopy with digital image analysis, as well as a suite of microbiological and geographic and geospatial analytical techniques and instrumentation.

The department maintains greenhouse research space and operates state-of-the-art weather monitoring equipment on Cal Poly rangelands, providing data for a wide variety of interdisciplinary research projects.

Experiential Learning

The Natural Resources Management and Environmental Sciences Department has a number of outdoor field sites where faculty and student learn-by-doing projects and research are conducted. Facilities sited at the Cal Poly campus include a Forestry Skills Center, computer labs, GIS laboratories, Coastal Resources Institute Research field lab, and several well-equipped greenhouses. Most importantly, the department plays a lead role in administering the Swanton Pacific Ranch and School Forest near Santa Cruz, California. This 3800-acre ranch includes redwood forests, salmonid-bearing streams, agricultural land, and many other ecosystems. The Swanton Pacific Ranch provides hands-on learning of active forest, ranch, agricultural, and watershed management activities. The management of these forest resources is internationally certified by the Forest Stewardship Council. Students make extensive use of these facilities. Significant field work and laboratory activities occur in all undergraduate and graduate programs requiring field clothing and associated safety equipment.

In addition to these campus-based learning experiences, the department places great importance on work experience before graduation. Work experience validates the student’s career goals, confirms the relevance of their classroom education, while offering a pathway to employment. Students can earn course credit through internships, supervisory courses, and/or for volunteer or paid work positions related to their major.

Students are encouraged to reinforce their education, develop professional contacts, and strengthen their career potential by participating in any of the following activities: the Environmental Sciences Club; the Soil Judging Team; Association of Environmental Professionals Student Chapter (AEP); Society of American Foresters Student Chapter (SAF); Logging Team; Student Association of Fire Ecology; and/or Xi Sigma Pi Forestry Honorary Society; attending international and national conferences; and internships and cooperative education programs with government and industry. Each of these opportunities, combined with a friendly, helpful atmosphere, provide students a college experience that is highly personal as well as rewarding. Students also are encouraged to investigate opportunities for international education. Please see the Cal Poly International Program (http://catalog.calpoly.edu/academicsupportandcampuslife/academicservicesandprograms/calgapolinternationalcenter/).

Undergraduate Programs

BS Environmental Earth and Soil Sciences

The BS in Environmental Earth and Soil Sciences provides a strong foundation for understanding and improving the utilization of land, water, and atmospheric resources. The program emphasizes a wide range of disciplines in natural resources and in the cultures that use and modify them. The core of the Environmental Earth and Soil Sciences curriculum is composed of geology, soil science, geography, and basic science courses and is strengthened by a diverse array of related topical and technical specialties, which include: climate change studies, environmental mitigation strategies, environmental policy and management, forest and environmental practices, geospatial technology, hydrology, soil geotechnical studies, sustainable agriculture, and urban forestry.

The Environmental Earth and Soil Sciences major provides detailed and thorough training in the natural and cultural processes that govern the relationship between humans and their habitats. The program also furnishes students with the marketable expertise to assess, manage, and/or repair, and improve this fragile relationship while acquiring a well-rounded education in the natural sciences. In addition, majors can meet the educational requirements for professional certification in a number of areas (e.g. erosion and sediment control, hydrology, soil conservation, soil science) and find their training ideal for graduate school preparation in a number of related disciplines.

Due to the multidisciplinary nature of the Environmental Earth and Soil Sciences major, students have access to diverse faculty and laboratories in several colleges on campus. California’s Central Coast offers a diverse environmental and cultural setting for real-world training and experiences in earth sciences.

Undergraduate students majoring in Environmental Earth and Soil Sciences earn the credentials for useful careers in resource assessment and administration. They graduate with a substantial and well rounded
education in the natural sciences. Moreover, Environmental Earth and Soil Sciences graduates possess the understanding, flexibility, and tools to appreciate and adapt to a changing world and its employment opportunities.

In addition to the required major courses, students select courses from an expansive list of approved electives, or take a minor, or select one of the following concentrations.

**Concentrations**

**Geology**

Students learn the fundamentals of a broad variety of geologic subdisciplines, including mineralogy, petrology, seismology, stratigraphy, geochemistry, geomorphology and structural geology. Each of these fundamental subdisciplines are supported by curriculum that emphasizes methods of data collection, interpretation and professional communication of results. Upon completion of this concentration, students are able to critically evaluate geologic reports within the context of our evolving societal needs, and are prepared to pursue post graduate degrees in the geosciences and/or careers in the geotechnical industry.

**Hydrology**

Students learn the fundamentals of a broad variety of hydrologic subdisciplines including vadose zone hydrology, groundwater hydrology, soil erosion control, water quality, and watershed management. Each of these fundamental subdisciplines are supported by curriculum that emphasizes methods of data collection and interpretation, and professional communication of results. Upon completion of this concentration, students will be qualified to work in a water-related position for Federal and State agencies, private companies, and environmental consulting firms. Completion of the Hydrology Concentration meets the course requirements of the U.S. Office of Personnel Management (OPM) for employment as a Hydrologist (GS 1315)

**BS Environmental Management and Protection**

The BS in Environmental Management and Protection is an interdisciplinary course of study integrating the biophysical and social/economical/political sciences in natural resource management. The curriculum emphasizes management and protection of ecosystem structures and processes that sustain uses of environmental resources. The major provides students with the science and management background that, when properly integrated, can guide consumptive uses of resources in a sustainable manner for current and future generations.

Since environmental problems arise from human demands and stresses on the environment, solutions must focus on the human dimension of ecosystems. Thus, environmental management is the management of both people and resources to attain human goals while protecting environmental values in order to sustain natural systems.

Graduates are prepared for a broad range of professional careers in environmental assessment, impact analysis, project management, and impact mitigation monitoring.

Knowledge of the legal and regulatory environment is balanced with study of ecological and economic theories and practices to solving social conflicts over environmental uses and impacts.

The Environmental Management and Protection major is endorsed and supported by the California Association of Environmental Professionals (AEP), a professional association representing the full range of environmental professions in both private and public sectors.

In addition to the required major courses, students select courses from an expansive list of approved electives, or take a minor, or select one of the following concentrations.

**Concentrations**

**Watershed Management and Hydrology**

This concentration provides students a focused and encompassing program in watershed management, including a proficiency in watershed hydrology in forest ecosystems, Mediterranean ecosystems, rangeland hydrology, post-fire watershed evaluation, watershed and stream restoration, and urban/wildland hydrologic implications. Students pursuing this concentration can qualify as hydrologists under U.S. Government OPM guidelines (GS 1315).

**Wildlife Biology Concentration**

This specialized course of study prepares students for wildlife biology certification and employment in the fish and wildlife areas of law enforcement, management, and production.

**BS Forestry and Natural Resources**

The BS in Forestry and Natural Resources prepares students for careers in the protection and management of our forest and natural resources. Students may specialize in watershed management and hydrology, wildlife fire and fuels management, or wildlife biology. Optionally, students may select courses from approved electives that are categorized by career area.

Graduates qualify for such positions as: forester, environmental planner and assessor, natural resource manager, urban forester, park administrator, watershed manager, hydrologist, fire and fuels manager, and many other related environmental career areas. Cal Poly graduates are employed throughout the world: establishing, managing and sustaining forests and urban wildland areas; providing opportunities for a full range of uses; teaching; extension; research; and protecting and managing the environment.

Students can complete an internship equivalent to half-time work. Paid internships are available at Swanton Pacific Ranch, or the student may choose to pursue a seasonal job, volunteer work, or a cooperative education program. Work experience for academic credit must be documented by a work supervisor and approved by the student’s academic advisor.

Students are required to purchase 8-inch+ high field boots, hard-hats (OSHA approved), hand calculator capable of linear regression, 10X hand lens, and an engineers scale ruler prior to taking 200- or 300-level major courses. Students are strongly encouraged to purchase a laptop before beginning 300-level major courses.

The Society of American Foresters accredits the Forestry and Natural Resources program. Also, the U.S. Office of Personnel Management (OPM) recognizes employment as a forester with the Federal Government upon graduation.

In addition to the required major courses, students select courses from an expansive list of approved electives, or take a minor, or select one of the following concentrations.
Concentrations

Watershed Management and Hydrology
This concentration provides students a focused and encompassing program in watershed management, including a proficiency in watershed hydrology in forest ecosystems, Mediterranean ecosystems, rangeland hydrology, post-fire watershed evaluation, watershed and stream restoration, and urban/wildland hydrologic implications. Students pursuing this concentration can qualify as hydrologists under U.S. Government OPM guidelines (GS 1315).

Wildlife Biology Concentration
This specialized course prepares students for wildlife biology certification and employment in the fish and wildlife areas of law enforcement, management, and production.

Wildland Fire and Fuels Management
Focused study on the management of fire and fuels on landscapes ranging from the wildlands to the urban interface. Emphasis on the technologies, issues and policies in managing fire, using fire as an ecosystem management tool and social and economic impacts of fire.

Environmental Soil Science Minor
Natural Resources Management & Environmental Sciences Department
Bldg. 180, Room S15
Phone: 805.756.1691
Email: cappel@calpoly.edu

Coordinator: Dr. Chip Appel

Students completing the minor gain skills in understanding and assessing the science and management of soils. Because soils are necessary for sustaining all living organisms, this minor is relevant to all students. Students will gain practical, meaningful, and hands-on experiences in both environmental and agricultural applications of the world’s finite soil resources. This minor allows students the opportunity to relate their interests to the ecology, classification, mineralogy, chemistry, physics, and fertility/health parameters of soils.

Indigenous Studies in Natural Resources and the Environment Minor
Natural Resources Management & Environmental Resources Department
Bldg. 11, Room 217
Phone: 805.756.2702

Coordinators:
Priya Verma, Natural Resources Management and Environmental Sciences
805.756.2773; pverma@calpoly.edu

Kate Martin, Ethnic Studies
805.756.2827; kmartin@calpoly.edu

This interdisciplinary minor is sponsored by the Natural Resources Management and Environmental Sciences department in the College of Agriculture, Food and Environmental Sciences and the Ethnic Studies department in the College of Liberal Arts. The minor consists of innovative coursework and provides research opportunities that incorporate indigenous ecological knowledge in areas such as conservation biology, environmental biology, wildlife and fisheries sciences, forest resources management, environmental studies and environmental sciences: as well as agriculture, ethnic studies, geography, biology, and recreation, parks and tourism.

The Indigenous Studies in Natural Resources Management and the Environment minor aims to bring together principles of both Indigenous knowledge and Western science. Instruction in these two approaches will provide students with the necessary skills, practical research methods and critical thinking abilities for addressing complex environmental and health issues, and resource management problems facing both Indigenous and non-Indigenous communities around the world. Contact the minor coordinator for more details.

Water Science
An interdisciplinary minor sponsored by the departments of BioResource and Agricultural Engineering, and Natural Resources Management and Environmental Sciences, that emphasizes one of three areas of study: irrigation, water policy, or watershed management. For more information, see the College of Agriculture, Food and Environmental Sciences (http://catalog.calpoly.edu/collegesandprograms/collegeofagriculturefoodenvironmentalsciences/) section.

The department also participates in offering minors in Land Rehabilitation and Restoration Ecology, Rangeland Resources, Anthropology-Geography, and Geology. Please see College of Agriculture, Food and Environmental Sciences (http://catalog.calpoly.edu/collegesandprograms/collegeofagriculturefoodenvironmentalsciences/), College of Liberal Arts (http://catalog.calpoly.edu/collegesandprograms/collegeofliberalarts/) or the Physics (http://catalog.calpoly.edu/collegesandprograms/collegeofsciencemathematics/physics/) page for additional information.

Additional Minors

Geographic Information Systems for Agriculture
An interdisciplinary minor sponsored by the departments of BioResource and Agricultural Engineering, Natural Resources Management and Environmental Sciences, and Horticulture and Crop Science. For more information, see the College of Agriculture, Food and Environmental Sciences (http://catalog.calpoly.edu/collegesandprograms/collegeofagriculturefoodenvironmentalsciences/) section.

Land Rehabilitation and Restoration Ecology
For more information, see the College of Agriculture, Food and Environmental Sciences (http://catalog.calpoly.edu/collegesandprograms/collegeofagriculturefoodenvironmentalsciences/) section.

Graduate Program

MS Environmental Sciences and Management

General Characteristics

The Master of Science in Environmental Sciences and Management degree is an interdisciplinary degree designed to provide core knowledge in research methods and planning, environmental science, and environmental management, while providing for sub-disciplinary environmental specialization through directed electives. Primary topics of sub-disciplinary studies are environmental policy, sustainability, forest...
science, hydrology, and soil science. The program prepares students for a broad range of careers in science, research and environmental and resource management.

Admission Requirements

To qualify for admission to a Master’s program, you must meet the Cal Poly university admission requirements for graduate standing, which are described in the Graduate Education (http://catalog.calpoly.edu/graduatededucation/) section of the Cal Poly Catalog, as well as professional, personal, scholastic and other standards as prescribed by the program. The program specific requirements for admission are as follows:

• Statement of purpose
• Transcript(s) from institution granting bachelor’s degree
• Three letters of academic and/or professional recommendation
• Results from Graduate Record Examination (GRE standard test)
• All applicants who do not speak and write English as their primary language are required to complete the Test of English as a Foreign Language (TOEFL), taken within the last 2 years with a minimum score of 550 (paper version), 213 (computerized version), or 80 (internet based). Submit scores electronically to Institution Code: 4038. This requirement does not apply if country citizenship is listed on Cal Poly Admissions website: https://admissions.calpoly.edu/applicants/international/checklist.html.
• Attained a grade point average of at least 3.0 (A = 4.0) in the last 60 semester (90 quarter) units completed for a bachelor’s degree from a regionally accredited college/university

Prerequisites

Completed undergraduate coursework in environmental studies subjects, broadly defined. An applicant who lacks prerequisite coursework may be admitted as a conditionally classified student and must make up any deficiencies (12 unit limit) before advancement to classified graduate standing.

Program of Study

The program requires completion of a core curriculum (research skills, sciences, management) and directed electives for a total of 45 units. Students admitted to the program are expected to begin their studies in the fall quarter as a cohort, but students with prerequisite coursework deficiencies may be admitted in other quarters.

ERSC Courses

ERSC 144. Introduction to Earth Science. 4 units
Survey of fundamental processes of Earth science. Application of systems thinking to understanding the dynamic interactions among geological, geographic, soils and human factors in shaping the Earth. 3 lectures, 1 activity.

ERSC 223. Rocks and Minerals. 4 units
Prerequisite: SS 120; and CHEM 124 or CHEM 127.
Origin, composition, identification and weathering of rocks, minerals, and clays important in the development of soils. Parent materials as related to the nature and properties of soils. 3 lectures, 1 laboratory.

ERSC 250. Physical Geography. 4 units
Addresses the origins and patterns of the earth’s diverse assemblage of climates, landforms, biota and soils. A major focus on relationship between human cultures and these earthly environments. 4 lectures. Crosslisted as ERSC/GEOG 250.

ERSC 270. Selected Topics. 1-4 units
Prerequisite: Consent of instructor.
Directed group study of selected topics. The Class Schedule will list topic selected. Total credit limited to 12 units. 1 to 4 lectures. Crosslisted as ERSC/SS 270.

ERSC 303. Soil Erosion and Water Conservation. 4 units
Prerequisite: LA/NR 218 or GEOG 318; and SS 120.
Evaluation of soil and water conservation with application toward agriculture, rangeland, and urban land uses. Study of process, regulation, and best management practices for soil erosion, water quality, and stormwater. Development of stormwater pollution prevention or farm water quality plans to meet regulatory requirements. 3 lectures, 1 activity.

ERSC 323. Geomorphology. 4 units
Prerequisite: SS 120 or SS 121; and GEOL 201.
Recognizing and identifying major landforms and their components by interpretation of aerial photographs and topographic maps, and observations. Emphasis on analyzing common landforms in the western United States for application in soil science, physical geography, hydrology, and geology. 2 lectures, 1 laboratory, 1 activity.

ERSC 325. Climate and Humanity. 4 units
Prerequisite: Junior standing.
Geographic perspective on the interrelationships between climate and human cultures. Effects of people on climate and the influence of climate and weather upon human activities and behavior. Focus on global human conditions which are responsible for the alteration of climate and in turn are vulnerable to climate change. 4 lectures. Crosslisted as ERSC/GEOG 325.

ERSC 333. Human Impact on the Earth. 4 units
Prerequisite: Junior standing.
Global assessment of the impact of humans on the earth’s vegetation, animals, soil, water and atmosphere. Emphasis on problems stemming from the interactions of human attitudes, technologies, and population with natural resources. 4 lectures. Crosslisted as ERSC/GEOG 333.
ERSC 335. Soil, Water, and Civilization. 4 units
2020-21 or later: Upper-Div GE Area B
2019-20 catalog: GE Area B
2017-19 or earlier catalog: GE Area F
Prerequisite: Junior standing; completion of GE Area A with grades of C- or better; and completion of GE Area B1 through B4, with a grade of C- or better in one course in GE Area B4 (GE Area B1 for students on the 2019-20 or earlier catalogs).

Explore past civilizations and how management of soil, water, and other natural resources allowed them to flourish, decline, or fail. Sustainability of natural resource use in modern/future societies. Issues include sustainability, agricultural practices, deforestation, water quality, and land management. 4 lectures. Fulfills GE Upper-Division B (GE Area B7 for students on the 2019-20 catalog; GE Area F for students on earlier catalogs).

ERSC 339. Internship in Environmental Earth and Soil Sciences. 1-12 units
CR/NC
Prerequisite: Consent of internship instructor.

Selected students will spend up to 12 weeks with an approved firm or agency engaged in work and study related to their major. A detailed written proposal and written interim and final reports required. One unit of credit may be allowed for each full week of internship. Credit/No Credit grading. Crosslisted as ERSC/SS 339.

ERSC 400. Special Problems for Advanced Undergraduates. 1-4 units
Prerequisite: Consent of instructor.

Individual investigation, research, studies or surveys of selected problems. Total credit limited to 12 units. Crosslisted as ERSC/SS 400.

ERSC 401. Field-Geology Methods. 4 units
Prerequisite: GEOL 102 or GEOL 201, GEOL 241, GEOL 415, ERSC 223, ERSC 323.

Collecting and interpreting field-geologic data. Description of sedimentary rocks and construction of stratigraphic columns. Mapping geologic structures in the field. Surficial geologic stratigraphy and surficial geologic mapping. Understanding geologic processes through field study. Communicating results of field study. 1 lecture, 3 activities. Crosslisted as ERSC/GEOL 401.

ERSC 402. Geologic Mapping. 4 units
Prerequisite: ERSC/GEOL 401.

Bedrock geologic mapping on topographic maps and aerial photos. Surficial geologic mapping on topographic maps and aerial photos. Correlating and defining surficial geologic map units on the basis of soil development. Understanding landscape evolution using soil development 4 activities. Crosslisted as ERSC/GEOL 402.

ERSC 414. Global and Regional Climatology. 4 units
Prerequisite: Junior standing.

The earth's pattern of climates and the physical processes that account for them. Focus on interrelationships between climate and the physical/biological and cultural environments. Special emphasis on modern climate changes and their consequences. 3 lectures, 1 laboratory. Crosslisted as ERSC/GEOG 414.

ERSC 415. Applied Meteorology and Climatology. 4 units
Prerequisite: ERSC/GEOG 250.

Physical processes in the atmosphere that determine regional weather, climate and climate variability. Surface and satellite systems for weather observation, and weather/climate modeling. Dynamics of weather systems, including thunderstorms and hurricanes. Emphases on weather/climate affecting agriculture and other human activities. 3 lectures, 1 activity. Crosslisted as ERSC/GEOG 415.

ERSC 442. Applied Environmental Groundwater Hydrology. 4 units
Prerequisite: ERSC 144 or GEOL 201; MATH 141 or MATH 161; and SS 120.

Applied field methods of vadose zone and groundwater flow modeling, resource evaluation, confined and unconfined aquifer characterization, well installation and groundwater monitoring. Introduction to groundwater modeling software including MODFLOW and AQTESOLV. 3 lectures, 1 laboratory. Formerly SS 442.

ERSC 443. Applied Environmental Contaminant Transport. 4 units
Prerequisite: CHEM 125 or CHEM 128; ERSC 144 or GEOL 201; MATH 141 or MATH 161; and SS 120.

Applied study of mechanisms of fate and transport of contaminants in soils and groundwater. Field methods and technologies of soil and groundwater sampling and site characterization. Representative conceptual and mathematical models, case studies, laboratory study of breakthrough behavior, and remediation technologies. Field trip required. 3 lectures, 1 laboratory.

ERSC 470. Selected Advanced Topics. 1-4 units
Prerequisite: Consent of instructor.

Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. The Class Schedule list topic selected. Total credit limited to 12 units. 1 to 4 lectures. Crosslisted as ERSC/SS 470.

ERSC 471. Selected Advanced Laboratory. 1-4 units
Prerequisite: Consent of instructor.

Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. The Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 laboratories. Crosslisted as ERSC/SS 471.

ERSC 476. Senior Project - Advanced Internship Experience in Environmental Science/Management. 3 units
Prerequisite: Completion of GE Area A with grades of C- or better; and ERSC 363 or NR 306 or NR 326.

Independent internship experience conducted under faculty supervision focusing on a discipline area of environmental science/management. Completion of a project as a component of their internship. Satisfies the senior project requirement. Minimum 90 hours required. Crosslisted as ERSC/NR 476.
ERSC 477. Senior Project - Research Experience in Environmental Science. 3 units
Prerequisite: Completion of GE Area A with grades of C- or better; and ERSC 363 or NR 306 or NR 326.
Guided research experience in a specific area of environmental science. Implementation of materials and methods. Collection, analysis and interpretation of data. Completion of formal written report. Satisfies senior project requirement. 1 lecture, 2 laboratories. Crosslisted as ERSC/NR 477.

ERSC 478. Senior Project - Current Topics in Environmental Science/Management. 3 units
Prerequisite: Completion of GE Area A with grades of C- or better; and ERSC 363 or NR 306 or NR 326.
Critical evaluation and formal presentation of current issues in environmental science/management. Evaluation of current topics, analysis of supporting evidence, and synthesis and presentation of resulting perspectives on different approaches to current challenges in environmental science/management. Satisfies the senior project requirement. 3 lectures. Crosslisted as ERSC/NR 478.

ERSC 479. Senior Project - Independent Study. 3 units
Prerequisite: Completion of GE Area A with grades of C- or better; ERSC 363 or NR 306 or NR 326; and consent of instructor.
Selection and completion of a project under faculty supervision. Projects typical of problems which graduates must solve in their fields of employment. Project results are presented in a formal report. Minimum 90 hours total time. Crosslisted as ERSC/NR 479.

ERSC 544. Earth Sciences for Educators. 3 units
Prerequisite: Graduate standing and consent of instructor.
An interdisciplinary earth sciences course which emphasizes the interactions of multiple systems of air, water, land, life, and human society. Designed for teachers and students seeking teaching credential. Incorporates scientific theory, learning resources, and applications in the field. 3 lectures. Not open to students in Soil Science specialization under MS Agriculture.

ERSC 570. Selected Topics in Earth Science. 1-4 units
Prerequisite: Graduate standing or consent of instructor.
Directed group study of selected topics for advanced students. The Class Schedule will list topic selected. Total credit limited to 12 units. 1 to 4 seminars.

ERSC 571. Selected Advanced Laboratory. 1-4 units
Prerequisite: Graduate standing or consent of instructor.
Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. The Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 laboratories.

ESCI Courses

ESCI 500. Individual Study. 1-4 units
Prerequisite: Consent of instructor.
Advanced independent study planned and completed under the direction of a member of the NRES department faculty. Open only to graduate students who have demonstrated ability to do independent work. Total credit limited to 16 units; with a maximum of 4 units per quarter. Formerly NR 500.

ESCI 501. Research Planning. 4 units
Prerequisite: Senior standing.
Problem solving and research planning for agriculture, natural resources and related sciences. Preparation of study plans that identify problems, review appropriate literature, formulate objectives, develop methods and provide for presentation and interpretation of results. Oral reports. 4 lectures. Formerly SS 501.

ESCI 502. Research Methods and Data Analysis. 4 units
Prerequisite: Graduate standing or consent of instructor; ESCI 501; and STAT 217.
Quantitative and qualitative survey of research methods for environmental science and management including research design, sampling, data collection, analysis, and interpretation. 3 lectures, 1 laboratory.

ESCI 550. Advanced Environmental Science. 4 units
Prerequisite: Graduate standing or consent of instructor; ESCI 501; and ERSC 363 or NR 306 or NR 326.
Advanced study of earth system processes and environmental problems. Advanced application of systems thinking to study of energy, geologic systems, groundwater and surface water resources, soils, environmental pollution and degradation, atmospheric and ocean dynamics, and the global climate system. 3 lectures, 1 activity.

ESCI 581. Graduate Seminar in Environmental Sciences. 2 units
Prerequisite: Consent of instructor.
Student study and presentation of selected developments, trends and problems in environmental science, forest and natural resources, earth and soil sciences, and environmental management. Total credit limited to 4 units. 2 seminars. Formerly NR/SS 581.

ESCI 590. Advanced Environmental Management. 4 units
Prerequisite: Graduate standing or consent of instructor; and ESCI 501.
Recommended: An environmental science/management course.
Scientific principles of environmental issues and environmental management practices focusing on sustainable development and systems thinking centered around the health of humans and ecosystems. Analysis of fundamental and emerging environmental factors that impact management practices. 3 lectures, 1 laboratory.
NR 208. Dendrology. 4 units
Recommended: BOT 121.
Identification, classification, silvical characteristics, distribution, environmental requirements and economic importance of woody plants in shrub, woodland, and forest ecosystems of the United States. Emphasis on species located in the Pacific Coastal, Sierran, and Cascade ecosystems. 2 lectures, 2 laboratories.

NR 215. Land and Resource Measurements. 1 unit
Introduction to land and resource measurement technology and methods - field instruments, property description, map and photograph reconciliation, data accuracy and precision. Trigonometric functions as applied to natural resources applications. Field trips required. 1 laboratory.

NR 218. Introduction to Geographic Information Systems (GIS). 3 units
Learn the fundamental concepts and functions of Geographic Information Systems (GIS) using ArcGIS platform. Create, manage, analyze, and display geographically referenced data. Explore how GIS is applied to analyze environmental, social, and natural resource issues. 1 lecture, 2 laboratories. Crosslisted as LA/NR 218.

NR 247. Forest Surveying. 2 units
Prerequisite: NR 215.
Use and care of tapes, staff compass, abney levels, total stations, and GPS receivers. Keeping field notes, measurements by tape. Closed and open traverse by compass and total stations. Turning angles and determining directions of lines. Map reading and public land description. GPS measurements. Weekend field trips required. 1 lecture, 1 laboratory. Crosslisted as BRAE/NR 247.

NR 260. Forest Practices and Environmental Protection. 4 units
Recommended: NR 141 and NR 215.
Relationships between forest ecosystem management, forest practices, harvesting methods, timber harvest planning, components of forest harvesting, harvesting effects; cost analysis of harvesting methods; safety management; value-added forest utilization; environmental protection; and road location. Overnight or weekend field trips required. 3 lectures, 1 laboratory.

NR 270. Selected Topics. 1-4 units
Prerequisite: Open to undergraduate students and consent of instructor.
Directed group study of selected topics. The Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 lectures.

NR 290. Intercollegiate Forestry Activities. 1 unit
CR/NC
Prerequisite: Enrollment limited to those qualified to compete in intercollegiate forestry activities and consent of instructor.
Beginning through advanced skills in the event areas of college forestry activities. Instruction in use of specialized equipment and safety. Minimum of 4 hours of laboratory per week. Total credit limited to 18 units. Credit/No Credit grading only.
NR 305. Forest Ecology and Silvics. 4 units
Prerequisite: Completion of GE Area B2; and completion of GE Area B3 (GE Area B4 for students on the 2019-20 or earlier catalogs).

Examination of major forest types and the processes that determine their development and productivity across the earth (silvics). Integration of ecosystem ecology, plant physiology, and soil science to develop understanding of forest response to disturbance. Field trip required. 3 lectures, 1 laboratory.

NR 306. Natural Resource Ecology and Habitat Management. 4 units
Prerequisite: Completion of GE Area B2; and completion of GE Area B3 (GE Area B4 for students on the 2019-20 or earlier catalogs).

Resource ecology and management implications in the major ecosystems of North America. Importance of maintaining the natural dynamics of energy flow and nutrient cycles at the community and ecosystem level to sustain uses and values. Humanity’s role as a principal factor of change of the resources in natural systems. 3 lectures, 1 laboratory.

NR 307. Fire Ecology. 3 units
Prerequisite: Completion of GE Area B2; and completion of GE Area B3 (GE Area B4 for students on the 2019-20 or earlier catalogs).

Effects of wildland fires on shrub, woodland, and forest environments to include fuels, plants, soil, water, wildlife, and air. Emphasis on western U.S. forest and shrub ecosystems. 2 lectures, 1 laboratory.

NR 308. Fire and Society. 4 units
2020-21 or later: Upper-Div GE Area D
2019-20 or earlier catalog: GE Area D5
Prerequisite: Junior standing; completion of GE Area A with grades of C- or better; one course in GE Area B4 with a grade of C- or better (GE Area B1 for students on the 2019-20 or earlier catalogs); and one lower-division course in GE Area D.

Prehistorical and historical record of human use of and attitude toward fire. Mythology and religion of fire. Traditional, cultural and ethnic variations and their influence on modern U.S. institutions involved in managing fire. 3 lectures, 1 activity. Crosslisted as ES/NR 308. Fulfills GE Upper-Division D (GE Area D5 for students on the 2019-20 or earlier catalogs).

NR 312. Technology of Wildland Fire Management. 4 units
2020-21 or later: Upper-Div GE Area B
2019-20 catalog: GE Area B7
2017-19 or earlier catalog: GE Area F
Prerequisite: Junior standing; completion of GE Area A with grades of C- or better; completion of GE Area B1 (GE Area B3 for students on the 2019-20 or earlier catalogs) or GE Area B2; and one course in GE Area B4 with a grade of C- or better (GE Area B1 for students on the 2019-20 or earlier catalogs).

Models and technology to solve complex land management problems. Historic, current and future perspectives of wildland fire in California. Sustainability and ecosystem health. Assumptions and limitations of fire behavior and suppression models. 3 lectures, 1 activity. Fulfills GE Upper-Division B (GE Area B7 for students on the 2019-20 catalog; GE Area F for students on earlier catalogs).

NR 314. Environmental Life-Cycle Analysis. 4 units
Prerequisite: BIO 263, NR 305, or NR 306.

Estimation and assessment of environmental impacts of human activity and product development using life-cycle analysis methodology; organization and presentation of modeling results. 3 lectures, 1 laboratory.

NR 315. Measurements and Sampling in Forested Environments. 4 units
Prerequisite: BRAE 237 or BRAE 239; NR 215; and STAT 217 or STAT 218. Recommended: MATH 161 or MATH 221.

Principles and methods of sampling and measurement for forest and natural resource quantities and qualities. Modeling and estimation for tree volumes, stand structure and composition, and related forest vegetation. Applications in sampling, statistical and inventory techniques. Field trip required. 2 lectures, 2 laboratories.

NR 317. The World of Spatial Data and Geographic Information Technology. 4 units
2020-21 or later: Upper-Div GE Area B
2019-20 catalog: GE Area B7
2017-19 or earlier catalog: GE Area F
Prerequisite: Junior standing; completion of GE Area A with grades of C- or better; completion of GE Area B2; and one course in GE Area B4 with a grade of C- or better (GE Area B1 for students on the 2019-20 or earlier catalogs).

Basic foundation for understanding the world through geographic information and tools available to utilize spatial data. Application of Geographic Information Systems (GIS) and related technologies, including their scientific basis of operation. Not open to students with credit in LA/NR 218. 3 lectures, 1 activity. Crosslisted as LA/NR 317. Fulfills GE Upper-Division B (GE Area B7 for students on the 2019-20 catalog; GE Area F for students on earlier catalogs).

NR 320. Watershed Processes and Management. 4 units
Prerequisite: NR/LA 218 and SS 120. Recommended: NR 305 or NR 306.

Introduction, analysis, and measurement of watershed processes of precipitation, evapotranspiration, streamflow, stream channels, erosion, and riparian functions. Watershed management toward aquatic habitat and water quality goals. Weekend field trip required. 3 lectures, 1 laboratory.

NR 321. Water Systems Technology, Issues and Impacts. 4 units
2020-21 or later: Upper-Div GE Area B
2019-20 catalog: GE Area B7
2017-19 or earlier catalog: GE Area F
Prerequisite: Junior standing; completion of GE Area A with grades of C- or better; completion of GE Area B2; and one course in GE Area B4 with a grade of C- or better (GE Area B1 for students on the 2019-20 or earlier catalogs).

Sustainable strategies and technologies to enhance freshwater supplies and marine habitats. Systems treated include artificial wetlands, stormwater, drinking water, agricultural and industrial waste water. 3 lectures, 1 activity. Fulfills GE Upper-Division B (GE Area B7 for students on the 2019-20 catalog; GE Area F for students on earlier catalogs).
NR 323. Human Dimensions in Natural Resources Management. 4 units
2020-21 or later: Upper-Div GE Area D
2019-20 or earlier catalog: GE Area D5
Prerequisite: Junior standing; completion of GE Area A with grades of C- or better; one course in GE Area B4 with a grade of C- or better (GE Area B1 for students on the 2019-20 or earlier catalogs); and completion of GE Area D1.

Social, economic, political and ecological conditions and institutions that influence decisions affecting the environment; examination of human-caused environmental impacts and how they in turn influence social institutions. 4 lectures. Fulfills GE Upper-Division D (GE Area D5 for students on the 2019-20 or earlier catalogs).

NR 324. Social Dimensions of Sustainable Food and Fiber Systems. 4 units
2020-21 or later: Upper-Div GE Area D
2019-20 or earlier catalog: GE Area D5
Prerequisite: Junior standing; completion of GE Area A with grades of C- or better; one course in GE Area B4 with a grade of C- or better (GE Area B1 for students on the 2019-20 or earlier catalogs); and two lower-division courses in GE Area D.

Historical, political, socio-economic, and cultural dimensions of sustainable food and fiber systems. Overview of frameworks used for understanding agro-ecological sustainability with an emphasis on human elements. Exploration of core sustainability concepts, practices, and goals through case studies. 4 lectures. Fulfills GE Upper-Division D (GE Area D5 for students on the 2019-20 or earlier catalogs).

NR 326. Natural Resources Economics and Valuation. 4 units
Prerequisite: MATH 161 or MATH 221 or equivalent. Recommended: GE Area D2 (ECON 201 recommended), AGB 212.

Theory of efficient use of renewable and nonrenewable natural resources, including methods for attaching value to marketable and non-market natural resources. Environmental economic theories and techniques to address allocation of water, timber, wildlife/fisheries, open space, and recreation. 3 lectures, 1 activity.

NR 328. Environmental Leadership and Community Engagement. 4 units
2020-21 or later: Upper-Div GE Area D
2019-20 or earlier catalog: GE Area D5
Prerequisite: Junior standing; completion of GE Area A with grades of C- or better; one course in GE Area B4 with a grade of C- or better (GE Area B1 for students on the 2019-20 or earlier catalogs); one lower-division course in GE Area D; and completion of GE Area E (GE Area D4 for students on the 2017-19 or earlier catalogs).

Theories and practices of leadership and community engagement for a wide range of environmental issues. Development of personal leadership skills and methods for effectively working with non-profit organizations, governmental agencies, community groups, and the private sector to advance sustainability principles. 4 lectures. Crosslisted as NR/RPTA 328. Fulfills GE Upper-Division D (GE Area D5 for students on the 2019-20 or earlier catalogs).

NR 335. Conflict Management in Natural Resources. 4 units
Prerequisite: NR 141 or NR 142. Recommended: PSY 201 or PSY 202.

Application of behavioral science principles and techniques in the management of natural resource systems. Management of internal and external human resource issues and concerns in natural resources organizations is emphasized. 3 lectures, 1 laboratory.

NR 339. Internship in Forest and Natural Resources. 1-12 units
CR/NC
Prerequisite: Consent of instructor.

Selected students will spend up to 12 weeks with an approved firm or agency engaged in forest or natural resources management. Applying and developing managerial skills and abilities. One unit of credit may be allowed for each full week of completed and reported internship. Credit/No Credit grading.

NR 340. Wildland Fire Management. 3 units
Prerequisite: NR 204.

Wildland fuels, fire weather, and fire danger ratings in chaparral, grassland, and forested areas. Advanced modeling of surface and crown fire behavior. Fire management strategies and implications, policies and objectives of fire management organizations. Saturday field trips may be required. 3 lectures.

NR 349. Water for a Sustainable Society. 4 units
2020-21 or later: Upper-Div GE Area D
2019-20 or earlier catalog: GE Area D5
Prerequisite: Junior standing; completion of GE Area A with grades of C- or better; one course in GE Area B4 with a grade of C- or better (GE Area B1 for students on the 2019-20 or earlier catalogs); and two lower-division courses in GE Area D.

Historical, political, economic, socio-technical, and cultural dimensions of water sustainability. Overview of complex systems with an emphasis on individual choices and their impact on water sustainability. Exploration of core sustainability concepts; practices, barriers and goals related to water resources. Course offered online only. 4 lectures. Crosslisted BRAE/ NR 349. Fulfills GE Upper-Division D (GE Area D5 for students on the 2019-20 or earlier catalogs).

NR 350. Urban Forestry. 3 units
Prerequisite: NR 208.

Establishment and management of municipal forests, wildland-urban interface, wildlife habitat, and pollution abatement. Management of forest areas requiring special attention because of heavy recreational use, fire hazard, watershed, and societal values. Full-day field trips may be required. 2 lectures, 1 laboratory.

NR 351. Introduction to Emergency Management in California. 3 units
Prerequisite: Completion of GE Area B1 (GE Area B3 for students on the 2019-20 or earlier catalogs) or GE Area D.

Emergency management emphasizing the Standardized Emergency Management System (SEMS) and Emergency Operations Center (EOC) operations. Earthquake hazard used as the case to explore potential wide geographic impacts, multiple secondary hazards, and multidisciplinary problem-solving methods in natural disasters faced by local governments and communities. 2 lectures, 1 activity. Crosslisted as CRP/NR 351.
NR 355. Drone Assisted Surveying. 4 units
Prerequisite: BRAE 239; GEOG 328 or BRAE 345; NR 218 or GEOG 318; and STAT 217 or STAT 218.


NR 360. Ethnicity and the Land. 4 units
2019-20 or earlier: Upper-Div GE Area C
2019-20 or earlier catalog: GE Area C4
USCP
Prerequisite: Junior standing; completion of GE Area A with grades of C- or better; one course in GE Area B4 with a grade of C- or better (GE Area B1 for students on the 2019-20 or earlier catalogs); and one lower-division course in GE Area C. Recommended: Lower-division Ethnic Studies (ES) course and introductory natural resources course.

Comparative study of how race and culture shape landscapes, and how social hierarchies allocate the use of natural resources and the burdens of environmental pollution. 4 lectures. Crosslisted as ES/NR 360. Fulfills GE Upper-Division C (GE Area C4 for students on the 2019-20 or earlier catalogs); and USCP.

NR 363. Undergraduate Seminar. 2 units
Prerequisite: Junior standing.

Review of current research, experiments, and problems related to the student’s major field of interest. Presentation of reports on problems or research activities in preparation for the senior project. Introduction to professional practices within a student’s major field of interest. 2 seminars. Formerly ERSC 363.

NR 365. Silviculture and Vegetation Management. 4 units
Prerequisite: NR 208 and NR 315. Corequisite: NR 260; and NR 305 or NR 306.

Applied forest ecology focusing on development of prescriptions for achieving diverse forest ecosystem management objectives. Topics include natural stand dynamics, traditional/contemporary silvicultural systems, forest health assessments/diagnoses, emulating natural disturbances, and managing ecosystem services. Overnight and/or weekend field trips required. 2 lectures, 2 laboratories.

NR 400. Special Problems for Advanced Undergraduates. 1-4 units
Prerequisite: Consent of instructor.

Individual investigation, research, studies or surveys of selected problems. Total credit limited to 12 units.

NR 401. Disaster Recovery. 3 units
Prerequisite: CRP/NR 351.

Strategies and procedures for public sector management of recovery from disasters. Understanding the role of, and relationship between, federal, state and local agencies to provide assistance to individuals and communities in the post-disaster environment. Issues in the recovery process. 2 lectures, 1 activity. Crosslisted as CRP/NR 401.

NR 402. Forest Health. 4 units
Prerequisite: NR 208; and NR 305 or NR 306; or consent of instructor.

Impact and losses to forested areas caused by physical and biotic agents (such as insects and diseases) other than fire; relation of direct and indirect control practices to forest management. Saturday field trips required. 3 lectures, 1 laboratory.

NR 404. Environmental Law. 3 units
Prerequisite: Junior standing.

Detailed examination of the law governing use and protection of natural resources with focus on the legal institutions entrusted with the public duty of protecting the environment. 3 lectures. Crosslisted as CRP/NR 404.

NR 406. Indigenous Peoples and International Law and Policy. 4 units
Prerequisite: ES 241; and NR 141 or NR 142; and junior standing required.

Interdisciplinary examination of the evolution of international law effecting indigenous peoples in the U.S. and in the Americas. Development of international legal and sociological norms and their impact on human rights of indigenous peoples with particular attention to environmental issues. 4 lectures. Crosslisted as CRP/NR 406.

NR 408. Water Resource Law and Policy. 3 units
Prerequisite: Junior standing.

Detailed examination of the various legal systems of water use, regulation and management in California and the United States. Discussion on the key concepts and principles of state, federal and interstate water quantity and quality control; focusing on issues and problems, why conflicts occur and how solutions evolve. 3 lectures. Crosslisted as CRP/NR 408.

NR 412. Senior Assessment Project. 3 units
Prerequisite: NR 326 and completion of GE Area A3 with grades of C- or better.

Principles and practices of integrated sampling and inventory of natural resource values in terrestrial ecosystems, culminating in a student project report. 2 lectures, 1 laboratory.

NR 413. Agricultural Law. 4 units
Prerequisite: Junior standing.

Analysis of agricultural law and policy including the business of agriculture, agricultural legislation, and coverage of contemporary agricultural issues such as water, food safety, and labor. Examination of statutory, judicial, policy and administrative areas in agriculture. 4 lectures.

NR 414. Sustainable Forest Management. 4 units
Prerequisite: NR 326, NR 365.

Biophysical, economic, social and political influences on optimal forest management for purposes of providing sustained yields of goods and services. Growth and yield modeling; forest investment analysis; sustainable forest production; harvest schedule modeling. Day field trip required. 3 lectures, 1 laboratory.
NR 416. Environmental Impact Analysis and Management. 4 units  
Prerequisite: one of the following: BIO 263, NR 305, or NR 306.  
National Environmental Policy and California Environmental Quality Acts as applied to environmental and natural resource management problems and projects. Intent, purpose and history of the laws; differences between laws identified. Request for proposals and preparation of environmental assessment documents covered. 3 lectures, 1 laboratory.

NR 418. Applied GIS. 3 units  
Prerequisite: LA/NR 218 or GEOG 318.  
Acquisition, organization and analysis of spatial data from diverse sources using Geographic Information System (GIS) software. GIS modeling applications and validation techniques used in development and preparation of client-driven projects. 1 lecture, 2 activities.

NR 420. Watershed Assessment and Protection. 4 units  
Prerequisite: NR 320; or graduate standing.  
Analysis of streamflow, peak flows, and land management effects using established techniques and hydrologic models. Fluvial processes, sediment transport, and channel restoration techniques. Assessment and restoration of watersheds toward protection of aquatic and public resources. Weekend field trips required. 3 lectures, 1 laboratory.

NR 421. Wetlands. 4 units  
Prerequisite: BOT 121 or BIO 162; CHEM 127; and SS 120 or SS 130. Recommended: one of the following: BIO 327, BOT 313, BOT 326, MSCI 300, NR 305, or NR 306.  

NR 422. Stream Measurements and Water Quality Monitoring. 1 unit  
Prerequisite: Junior standing or consent of instructor.  
Field measurement of streamflow, water quality, and water resources to support environmental evaluations of local water resources. Application of quality assurance procedures for monitoring water resources. Field trip required. Total credit limited to 2 units. 1 laboratory.

NR 425. Applied Resource Analysis and Assessment. 4 units  
Prerequisite: NR 416.  
Environmental impacts in responses to resource management, projects, programs and activities. Preparation, implementation, and coordination of environmental plans. Criteria for measurements, interpretation, and evaluation. Resource inventories, analysis, evaluation, synthesis, environmental assessment writing and preparation. 3 lectures, 1 laboratory.

NR 434. Wood Properties, Products and Sustainable Uses. 4 units  
Prerequisite: Completion of GE Areas B1 through B4, with a grade of C- or better in one course in GE Area B4 (GE Area B1 for students on the 2019-20 or earlier catalogs).  
Principles of wood properties, green building practices, sustainable and efficient use of renewable wood resources including methods for using wood as an energy source. Field trips required. 3 lectures, 1 laboratory.

NR 435. Environmental Policy Analysis. 4 units  
Prerequisite: NR 326. Recommended: NR 335.  
Policy process approach to understanding the efforts to resolve natural resource problems in the public and private sector. Principles and techniques used to analyze the effects of environmental policies. Analysis of major federal and state environmental laws. 4 lectures.

NR 445. Systems Thinking in Environmental Management. 4 units  
Prerequisite: one of the following: BIO 263, NR 305, NR 306, or SS 321. Recommended: MATH 161.  
Analysis of environmental challenges by incorporating systems thinking. Emphasis on developing quantitative and modeling skills to articulate and communicate alternative solutions for advancing environmental sustainability. 3 lectures, 1 laboratory.

NR 455. Wildland-Urban Fire Protection. 4 units  
Prerequisite: NR 340.  
Biophysical and socioeconomic issues affecting wildland fire management in urbanized landscapes. Fire risk assessment. Pre-fire prevention, mitigation, and preparedness, during-fire response, and post-fire recovery actions by public- and private-sector agencies and residents. 3 lectures, 1 laboratory.

NR 465. Senior Project - Ecosystem Management. 4 units  
Prerequisite: NR 326 and NR 416.  
Capstone course integrating biophysical, economic and socio-political sciences. Principles, concepts and techniques designed to utilize resources while sustaining ecosystem health within acceptable limits of change. Ecosystem assessment, planning, management and monitoring project. Satisfies the senior project requirement. 3 lectures, 1 laboratory.

NR 470. Selected Advanced Topics. 1-4 units  
Prerequisite: Consent of instructor.  
Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. The Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 lectures.

NR 471. Selected Advanced Laboratory. 1-4 units  
Prerequisite: Junior standing.  
Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. The Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 laboratories.

NR 472. Leadership Practice. 1 unit  
Prerequisite: Junior standing.  
Tasks associated with development of personal leadership skills. Study and practice in setting goals and objectives; developing, evaluating and implementing a project independently and as part of a team; decision making and problem-solving emphasized. Total credit limited to 4 units. 1 laboratory. Crosslisted as NR/RPTA 472.
NR 474. Forest Stewardship Practices. 8 units
Prerequisite: Completion of GE Areas B1 through B4, with a grade of C- or better in one course in GE Area B4 (GE Area B1 for students on the 2019-20 or earlier catalogs); and junior standing. Concurrent: NR 475.

Sustainable forest management, ecosystem sampling and inventory methods, photo interpretation, hydrologic resources, road condition, project impact analysis, and best management practices related to forest stewardship. Guest lecturers from industry, agencies and universities share their perspectives on forest stewardship practices. Field trip required. 5 lectures. 3 activities.

NR 475. Senior Project - Forest Stewardship. 4 units
Prerequisite: Completion of GE Areas B1 through B4, with a grade of C- or better in one course in GE Area B4 (GE Area B1 for students on the 2019-20 or earlier catalogs); and junior standing. Concurrent: NR 474.

Sustainable forest practices and regulatory compliance issues related to Timber Harvest Plans (THP). Development of THP for specified project sites. Collection, assessment, interpretation of data culminating in production of a THP acceptable for interagency review. Satisfies senior project requirement. Field trip required. 3 lectures, 1 activity.

NR 476. Senior Project - Advanced Internship Experience in Environmental Science/Management. 3 units
Prerequisite: Completion of GE Area A with grades of C- or better; and ERSC 363 or NR 306 or NR 326.

Independent internship experience conducted under faculty supervision focusing on a discipline area of environmental science/management. Completion of a project as a component of their internship. Satisfies the senior project requirement. Minimum 90 hours required. Crosslisted as ERSC/NR 476.

NR 477. Senior Project - Research Experience in Environmental Science. 3 units
Prerequisite: Completion of GE Area A with grades of C- or better; and ERSC 363 or NR 306 or NR 326.

Guided research experience in a specific area of environmental science. Implementation of materials and methods. Collection, analysis and interpretation of data. Completion of formal written report. Satisfies senior project requirement. 1 lecture, 2 laboratories. Crosslisted as ERSC/NR 477.

NR 478. Senior Project - Current Topics in Environmental Science/Management. 3 units
Prerequisite: Completion of GE Area A with grades of C- or better; and ERSC 363 or NR 306 or NR 326.

Critical evaluation and formal presentation of current issues in environmental science/management. Evaluation of current topics, analysis of supporting evidence, and synthesis and presentation of resulting perspectives on different approaches to current challenges in environmental science/management. Satisfies the senior project requirement. 3 lectures. Crosslisted as ERSC/NR 478.

NR 479. Senior Project - Independent Study. 3 units
Prerequisite: Completion of GE Area A with grades of C- or better; ERSC 363 or NR 306 or NR 326; and consent of instructor.

Selection and completion of a project under faculty supervision. Projects typical of problems which graduates must solve in their fields of employment. Project results are presented in a formal report. Minimum 90 hours total time. Crosslisted as ERSC/NR 479.

NR 532. Applications in Biometrics and Econometrics. 4 units
Prerequisite: One course in undergraduate statistics, graduate standing, or consent of instructor.

Parametric and semi-parametric statistical methods in modeling biological and economic phenomena. Biometric modeling of stand growth and inventory. Econometric modeling of market and environmental values. 3 lectures, 1 laboratory.

NR 534. Environmental Modeling. 3 units
Prerequisite: One course in statistics or graduate standing.

Methods and modeling approaches used in quantifying ecological and environmental processes and conditions, such as fire behavior, wildland hydrology, terrestrial and aquatic habitat condition, using GIS and other models. 2 lectures, 1 laboratory.

NR 539. Graduate Internship in Forest Resources. 1-9 units
Prerequisite: Consent of internship instructor.

Application of theory to the solution of problems of forest resources or related businesses in the field. Analyze specific management problems and perform general management assignments detailed in a contract between the student, the firm or organization, and the faculty advisor before the internship commences. Degree credit limited to 6 units.

NR 570. Selected Topics in Forest Resources. 1-4 units
Prerequisite: Consent of instructor.

Directed group study of selected topics for advanced students. The Class Schedule will list topic selected. Total credit limited to 12 units. 1 to 4 seminars.

NR 571. Selected Topics Forest Resources Laboratory. 1-4 units
Prerequisite: Consent of instructor.

Directed group laboratory of selected topics for advanced students. The Class Schedule will list topic selected. Total credit limited to 12 units. 1 to 4 laboratories.

NR 575. Applications in Advanced Watershed Hydrology. 2 units
Prerequisite: Consent of instructor. Recommended: NR 420.

Techniques and applications in watershed hydrology to real-world projects. Projects could include water quality or quantity assessments, water quality or channel morphology monitoring, and structural and non-structural enhancements for channel and upland watersheds, culminating in a final report and presentation. 2 laboratories.
SS Courses

SS 120. Introductory Soil Science. 4 units
2020-21 or later catalog: GE Area B1
2020-21 or later catalog: GE Area B3
2019-20 or earlier catalog: GE Area B3
2019-20 or earlier catalog: GE Area B4
Biological, chemical, physical and genetic properties of soils. Application of scientific principles to solving land use, water management, and soil conservation problems. Interpretation of soils data for making environmental decisions, applying management practices, and sustainable food production. 3 lectures, 1 laboratory. Fulfills GE Areas B1 and B3 (GE Areas B3 and B4 for students on the 2019-20 or earlier catalogs). Formerly SS 121.

SS 130. Soils in Environmental and Agricultural Systems. 4 units
2020-21 or later catalog: GE Area B1
2020-21 or later catalog: GE Area B3
2019-20 or earlier catalog: GE Area B3
2019-20 or earlier catalog: GE Area B4
Soils' ecological functions; soil and the water cycle; soil in production of food, fiber, and forest materials; techniques and reports of soil analyses with agricultural and environmental applications; soil quality; introductory overview of soils and civilizations. Not open to students with credit in SS 120. 3 lectures, 1 laboratory. Fulfills GE Areas B1 and B3 (GE Areas B3 and B4 for students on the 2019-20 or earlier catalogs). Formerly SS 131.

SS 221. Soil Health and Plant Nutrition. 4 units
Prerequisite: SS 120 or SS 121.
Plant nutrient requirements in the context of soil health. Composition, value, and use of fertilizer materials, conditioners and agricultural minerals for sustainable crop production and environmental quality. 3 lectures, 1 laboratory.

SS 270. Selected Topics. 1-4 units
Prerequisite: Consent of instructor.
Directed group study of selected topics. The Class Schedule will list topic selected. Total credit limited to 12 units. 1 to 4 lectures. Crosslisted as ERSC/SS 270.

SS 321. Soil Morphology. 4 units
Prerequisite: SS 120 or SS 121.
Identification of soil morphological and site properties. Correlation of soil physical and chemical properties with soil taxonomy and land use. Techniques of interpretations for agriculture, forest lands, wetlands, range lands and urban development. 3 lectures, 1 laboratory.

SS 322. Soil Plant Relationships. 4 units
Prerequisite: one of the following: AEPS 120, BOT 121, or SS 120; and CHEM 124 or CHEM 127.
Investigation and evaluation of soil functions. Nutrient supplying ability, conditions and processes involved in the delivery of soil functions. Effects of cultural treatments on soil fertility. Diagnostic techniques and data interpretation in soil health. 3 lectures, 1 laboratory.

SS 339. Internship in Environmental Earth and Soil Sciences. 1-12 units
CR/NC
Prerequisite: Consent of internship instructor.
Selected students will spend up to 12 weeks with an approved firm or agency engaged in work and study related to their major. A detailed written proposal and written interim and final reports required. One unit of credit may be allowed for each full week of internship. Credit/No Credit grading. Crosslisted as ERSC/SS 339.

SS 400. Special Problems for Advanced Undergraduates. 1-4 units
Prerequisite: Consent of instructor.
Individual investigation, research, studies or surveys of selected problems. Total credit limited to 12 units. Crosslisted as ERSC/SS 400.

SS 402. Soil, Compost, and Water Testing Enterprise. 3 units
Prerequisite: CHEM 111, CHEM 125 or CHEM 128; SS 221; and junior standing.
Experience in soil, compost, and water testing. Sampling rationale and protocol. Analyses of compost feedstocks and finished compost; monitoring for consistency. Theory and practice in use of analytical instrumentation. Interpretation of results for soil, compost, and water management. Total credit limited to 6 units for SS or ERSC majors. Total credit limited to 3 units for Soil Science minor.

SS 421. Wetlands. 4 units
Prerequisite: BOT 121 or BIO 162; CHEM 127; and SS 120 or SS 130. Recommended: one of the following: BIO 327, BOT 313, BOT 326, MSCI 300, NR 305, or NR 306.

SS 422. Soil Ecology. 4 units
Prerequisite: CHEM 212, CHEM 312, or CHEM 313; and SS 221; or graduate standing.
Biochemical activities, ecology and environmental implications of soil organisms. Effects on the formation, characteristics, and productivity of soils. Methods of studying soil organisms. 3 lectures, 1 laboratory.

SS 423. Environmental Soil and Water Chemistry. 5 units
Prerequisite: CHEM 129; CHEM 212, CHEM 216, CHEM 312, or CHEM 316; ERSC 223; MATH 118, MATH 141, or MATH 161; or graduate standing.
Chemical processes governing weathering, soil mineral formation and stability, common solubility equilibria. Use of chemical principles to explain surface chemical properties of soils and environmental problems in water and soil chemical systems. Preparation of professional quality reports based on laboratory data and library research. 3 lectures, 1 laboratory, 1 activity.
SS 424. Senior Project - Environmental Soil Physics. 5 units
Prerequisite: CHEM 125 or CHEM 128; MATH 141 or MATH 161; PHYS 121 or PHYS 141; SS 120; NR 363; or graduate standing.

Matter and energy in soils, with emphasis on properties and behavior of solids, water, air, and heat. Applications to agriculture, forestry, range management, engineering, and environmental sciences. Preparation of professional reports based on laboratory data and library research. Satisfies senior project requirement. 3 lectures, 1 laboratory, 1 activity. Formerly SS 432.

SS 431. Digital Soil Mapping. 4 units
Prerequisite: GEOG 318 or LA/NR 218; SS 321; STAT 217 or STAT 218; or graduate standing.

Development and production of digital soil surveys for interpretive purposes. Use of soil taxonomy, land classification systems, geographic information system (GIS) software, and geostatistics to evaluate land for best management practices. 2 lectures, 2 laboratories.

SS 440. Forest and Range Soils. 4 units
Prerequisite: SS 120 or SS 121; and SS 321.

Ecosystem approach to chemical, biological, physical and mechanical properties of forest and range soils. Site quality, nutrient cycling, erosion and mass movement, fire effects. Preparation of soil management reports similar to those required by various land management organizations. Overnight field trips. 3 lectures, 1 laboratory.

SS 444. Soil Judging. 2 units
Prerequisite: SS 321.

Morphological description of soils in the field. Taxonomic determination of classifications and interpretive properties from soil descriptions. Participation in collegiate soil judging contests. Total credit limited to 12 units. 1 lecture, 1 laboratory.

SS 463. Undergraduate Seminar. 2 units
Prerequisite: SS 461.

Review of current research, experiments, and problems related to the student's major field of interest. Preparation and presentation of reports on problems or research activities. 2 seminars.

SS 470. Selected Advanced Topics. 1-4 units
Prerequisite: Consent of instructor.

Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. The Class Schedule list topic selected. Total credit limited to 12 units. 1 to 4 lectures. Crosslisted as ERSC/SS 470.

SS 471. Selected Advanced Laboratory. 1-4 units
Prerequisite: Consent of instructor.

Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. The Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 laboratories. Crosslisted as ERSC/SS 471.

SS 500. Individual Study in Soil Science. 1-6 units
Prerequisite: Consent of instructor.

Advanced independent study planned and completed under the direction of a member of the Earth and Soil Sciences faculty. Total credit limited to 6 units.

SS 508. Environmental Assessment for Erosion Control. 3 units
Prerequisite: SS 120 or SS 121; and graduate standing.

Assessment techniques for the development of soil erosion control and the dispersal of surface runoff water on urban, agriculture, riparian, and rangelands. Development of a water quality management plan for a specific land use. 3 lectures.

SS 522. Advanced Soil Fertility. 3 units
Prerequisite: SS 322, graduate standing or consent of instructor.


SS 570. Selected Topics in Soil Science. 1-4 units
Prerequisite: Graduate standing or consent of instructor.

Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. The Class Schedule will list topic selected. Total credit limited to 12 units. 1 to 4 seminars.

SS 571. Selected Advanced Laboratory. 1-4 units
Prerequisite: Graduate standing or consent of instructor.

Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. The Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 laboratories.

SS 582. GIS in Advanced Land Management. 3 units
Prerequisite: Graduate standing, NR/LA 318, or consent of instructor.

Development of plans and practices for the management of crop, range, urban and wood land. 2 seminars, 1 laboratory.

SS 599. Thesis. 1-6 units
Prerequisite: Graduate standing and consent of instructor.

Individual research in soil science under faculty supervision, leading to a scholarly written presentation exhibiting originality, clarity, critical and independent thinking, proper analysis of data, appropriate organization and format, and accurate and thorough documentation. Six units required for the M.S. degree.