Environmental Systems

Office: 188 Galbraith Hall, Revelle College

Program Faculty

Mark H. Thiemens, *Professor, Chemistry and Biochemistry, Program Director*
Jane Teranes, *Associate Director*
Donna Blackman, *Associate Researcher, SIO*
Ronald S. Burton, *Professor, Marine Biology, SIO*
Richard T. Carson, *Professor, Economics*
Colm P. Caulfield, *Associate Professor, MAE*
Christopher D. Charles, *Associate Professor, Oceanography, SIO*
Clark Gibson, *Associate Professor, Political Science*
Sarah T. Gille, *Associate Professor, MAE, SIO*
Philip Hastings, *Associate Professor, Marine Biology, SIO*
Mryl C. Hendershott, *Professor, Oceanography, SIO*
William S. Hodgkiss, *Professor, Electrical Engineering, SIO*
Miriam Kastner, *Professor, Geosciences, SIO*
Joshua R. Kohn, *Associate Professor, Biology*
Paul Linden, *Professor, MAE*
T. Guy Masters, *Professor, Geophysics, SIO*
Kim McDonald, *Lecturer, Director of Science Communication*
Joel Norris, *Assistant Professor, Atmospheric Sciences, SIO*
Brian Palenik, *Associate Professor, Marine Biology, SIO*
Keith Pezzoli, *Lecturer, Urban Studies and Planning*
Frank L. Powell, *Professor, Medicine/Director,White Mountain Research Station*
Jeffrey B. Remmel, *Professor, Mathematics*
Lisa Shaffer, *International Relations, SIO; Associate Adjunct Professor, IR/PS*
Richard C. J. Somerville, *Professor, Meteorology, SIO*
Hubert Staudigel, *Researcher, Institute of Geophysics and Planetary Physics, SIO*
Lynne Talley, *Professor, Oceanography, SIO*
Lisa Tauxe, *Professor, Geosciences, SIO*
Jeffrey R. Vincent, *Professor, Environmental Economics, IR/PS*
David Woodruff, *Professor, Biology*

There can be little doubt that in the twenty-first century the global human community is facing a substantial growth in the environmental consequences of providing food, energy, materials, and basic services to a population of more than six billion inhabitants. The Environmental Systems Program recognizes the growing demand for environmental specialists and is designed to prepare undergraduates to enter a broad spectrum of environmental careers and graduate programs in, for example, the natural sciences, the social sciences, public policy, law, and business.

This interdisciplinary program recognizes that local, national, regional, international, and global environmental problems do not fit neatly into traditional academic departments. A measurable part of society's inability to effectively manage complex environmental problems stems from the lack of specialists who can apply analytical tools that cross disciplinary boundaries. Many environmental specialists possess little training in the natural sciences including both the fundamental ideas and methodologies of the earth and *environmental* sciences. The environmental systems major was created to address both of these shortcomings.

To encourage and foster an interdisciplinary focus in the major, the Environmental Systems Program is supported by a wide range of UCSD faculty representing the natural sciences, the social sciences, the humanities, engineering, and medicine. The program includes a required lower-division core, an upper-division "integrating course sequence," two other upper-division courses and statistics, an advanced track, and a senior integrative project and seminar. There is a strong emphasis on a rigorous natural science foundation as well as an introduction to the policy sciences for all students enrolled in the major.

The Environmental Systems program places a significant value on interdisciplinary problem solving and all majors are expected to complete an integrative Senior Project in their final year. The Senior Project is designed by the student to focus on an interdisciplinary environmental problem or research topic. Appropriate topics for the Senior Project could conceivably include biodiversity conservation, coastal zone management, environmental health, climate change, environmental justice, and/or urban air quality. An important component of the Senior Project is an off-campus or laboratory internship where students might work on, for example, the development of a comprehensive management plan for a threatened ecosystem. The Senior Seminar provides a venue for the presentation and group evaluation of the ESYS Senior Projects.

The Environmental Systems Major

The requirements for completion of the environmental systems major include a lower-division core, two upper-division courses, a three course upper-division integrating sequence (ESYS 101, ESYS 102, ESYS 103), an upper-division statistics course, advanced courses in one of four tracks, and the senior project (ESYS 190A) and senior seminar (ESYS 190B). Any questions concerning the requirements should be directed to the associate director or the program adviser.

Students completing the advanced tracks in "Earth Sciences," "Ecology, Behavior, and Evolution," and "Environmental Chemistry" will be awarded a B.S. in environmental systems. The B.A. in environmental systems will be granted to students completing the "Environmental Policy" track within the major.

A grade-point average of 2.0 or higher in the upper-division major program is required for graduation. Students must receive a grade of C– or better in any course to be counted toward fulfillment of the major requirements. In exceptional cases, students with a grade-point average in the major of 2.5 or greater may petition to have one grade of D accepted.

LOWER-DIVISION CORE REQUIREMENTS
(Should be completed early in student's degree program.)

Biology 3—BILD 3

Chemistry 6A-B, 6BL, 6C

Physics 1A, 1AL, 1B, 1BL, 1C, 1CL (Physics 2A-B-C recommended for Earth Sciences track.)

Mathematics 10A-B-C (Math. 20A-B-C recommended for Earth Sciences track.)

Economics 1

ERTH 50—for Earth Sciences track only

UPPER-DIVISION CORE REQUIREMENTS

Economics 131. Economics of the Environment
Political Science 160AA. Introduction to Policy Analysis

"Integrating Course Sequence"
Environmental Systems 101. The Living Earth
Environmental Systems 102. The Solid and Fluid Earth
Environmental Systems 103. The Human Earth
Environmental Systems 190A. Senior Project (two quarters)
Environmental Systems 190B. Senior Seminar

Environmental Systems Major Tracks

There are four advanced tracks in which students must complete a minimum of seven upper-division courses. Students will select courses following the requirements below in consultation with a faculty adviser.

Earth Sciences
Ecology, Behavior, and Evolution
Environmental Chemistry
Environmental Policy

It is possible to complete the requirements for any of the Environmental Systems tracks with five upper-division electives and a specialization that consists of two additional upper-division electives from any other track. For example, a student interested in the policy and scientific dimensions of habitat conservation planning for endangered species might plan a course of study to include five advanced courses from the Ecology, Behavior, and Evolution track and two advanced courses from the Environmental Policy track.

Earth Sciences Track

Required lower-division course:

ERTH 50. Introduction to Earth and Environmental Systems

Required upper-division courses:
ERTH 102. Introduction to Geochemistry
MATH 183. Statistical Methods

Upper-division electives: Students complete a minimum of seven courses selected from the following list.

ERTH 100. Introduction to Field Methods
ERTH 104. Geobiology
ERTH 105. Sedimentology and Stratigraphy
ERTH 110. Introduction to GIS for Earth and Environmental Scientists
ERTH 112. Urban Landscapes
ERTH 120. Introduction to Mineralogy
ERTH 142. Atmospheric Chemistry and Biochemical Cycles
ERTH 144. Isotope Geochemistry
ERTH 160. Introduction to Tectonics
ERTH 162. Structural Geology
ERTH 185. Applied Complexity
ERTH 199. Independent Study
ESYS 120. Science and Environmental Writing
SIO 210. Physical Oceanography
SIO 240. Marine Geology
SIO 260. Marine Chemistry
SIO 263. Aqueous Chemistry
SIO 280. Biological Oceanography
BIEB 132. Introduction to Marine Biology
BIEB 134. Introduction to Biological Oceanography
Chemistry 149A. Environmental Chemistry
Chemistry 173. Atmospheric Chemistry

Other courses may be substituted by petition.

CURRICULUM GUIDE PLANNING

FALL	WINTER	SPRING
FRESHMAN		
Chem. 6A	Chem. 6B	Chem. 6C
Math. 20A or Math. 10A	Math. 20B or Math. 10B	Math. 20C or Math. 10C
ERTH 50	BILD 3	Chem. 6BL
SOPHOMORE		
Phys. 2A or 1A, 1AL	Phys. 2B or 1B, 1BL	Phys. 2C or 1C, 1CL
Poli. 160AA	Econ. 1	UD ESYS elective
		Econ. 131
JUNIOR		
ESYS 101	ERTH 102	UD ESYS elective
Math. 183	ESYS 102	ESYS 103
	UD ESYS elective	UD ESYS elective
SENIOR		
ESYS 190A	ESYS 190A	ESYS 190B
UD ESYS elective	UD ESYS elective	UD ESYS elective

Ecology, Behavior, and Evolution Track

Required upper-division courses:

BICD 100. Genetics
BIEB 100. Biometry (satisfies upper-division statistics requirement)

Upper-division electives [a total of seven courses required, one of which must be a lab course, selected from the courses below.]

BIBC 100. Structural Biochemistry
BIBC 102. Metabolic Biochemistry
BIBC 103. Biochemical Techniques
BIBC 115. Computer Programming in Biology
BIBC 120. Nutrition
BIBC 130. Marine Biochemistry
BICD 110. Cell Biology
BICD 120. Fundamental of Plant Biology
BICD 130. Embryos, Genes, and Development
BICD 134. Human Reproduction and Development
BIEB 102. Introductory Ecology—Organisms and Habitats
BIEB 120. General Ecology
BIEB 121. Ecology Laboratory
BIEB 126. Plant Ecology
BIEB 131. Marine Invertebrate Ecology Lab
BIEB 132. Introduction to Marine Biology
BIEB 134. Introduction to Biological Oceanography
BIEB 140. Biodiversity
BIEB 150. Evolution
BIEB 156. Population Genetics
BIEB 164. Behavioral Ecology
BIEB 166. Animal Communication
BIEB 167. Animal Communication Lab
BIEB 176. Conservation and the Human Predicament
BIEB 178. Principles of Conservation Ecology
BIEB 179. Conservation Biology Laboratory
BIEB 180. Principles of Conservation Genetics
BIMM 100. Molecular Biology
BIMM 110. Molecular Basis of Disease
BIMM 114. Virology
BIMM 120. Bacteriology
BIMM 121. Laboratory in Microbiology
BIMM 124. Medical Microbiology
BIMM 126. Marine Microbiology (BIMM120/BIBC 102 prerequisites ***WAIVED.***)
BIMM 127. Marine Microbiology Laboratory
BIPN 100. Mammalian Physiology I
BIPN 102. Mammalian Physiology II
BIPN 105. Animal Physiology Lab (6)
BIPN 106. Comparative Physiology (4)
ESYS 120. Science and Environmental Writing
ESYS 150. Environmental Perils

Other courses may be substituted by petition.

CURRICULUM GUIDE PLANNING

FALL	WINTER	SPRING
FRESHMAN		
Chem. 6A	Chem. 6B	Chem. 6C
Math. 10A	Chem. 6BL	Math. 10C
	Math. 10B	BILD 3
SOPHOMORE		
Phys. 1A, 1AL	Phys. 1B, 1BL	Phys. 1C, 1CL
Econ. 1	UD ESYS Elective	Econ. 131
Poli. 160AA	BIEB 100 (statistics)	BICD 100
JUNIOR		
ESYS 101	ESYS 102	ESYS 103
UD ESYS elective lab	UD ESYS elective	UD ESYS elective
SENIOR		
ESYS 190A	ESYS 190A	ESYS 190B
UD ESYS elective	UD ESYS elective	UD ESYS Elective

Environmental Chemistry Track

Students must complete two of the following courses:

Chemistry 149A. Environmental Chemistry
Chemistry 149B. Environmental Chemistry

Chemistry 173. Atmospheric Chemistry

Students must complete:

Math. 183. Statistical Methods OR
Math. 186. Probability Statistics for Bioinformatics
Chemistry 100A. Analytical Chemistry Laboratory
Chemistry 140A and B. Organic Chemistry

One upper-division lab from either:
Chemistry 100B. Instrumental Analysis Laboratory
Chemistry 143A. Organic Chemistry Laboratory

Two upper-division restricted electives from:
Chemistry 124. Bioinorganic Chemistry
Chemistry 126/127. Physical Chemistry
Chemistry 131/132/133. Physical Chemistry
Chemistry 140C. Organic Chemistry
SIO 263. Aqueous Chemistry

Other courses may be substituted by petition.

CURRICULUM GUIDE PLANNING

FALL	WINTER	SPRING
FRESHMAN		
Chem. 6A	Chem. 6B	Chem. 6BL
Math. 10A	Math. 10B	Chem. 6C
BILD 3		Math. 10C
SOPHOMORE		
Phys. 1A, 1AL	Phys. 1B, BL	Phys. 1C, CL
Econ. 1	Chem. 140A	Chem. 140B
Chem. 100A	Math. 183 or 186	Econ. 131
JUNIOR		
*Chem. 149A	*Chem. 149B	*Chem. 173
ESYS 101	Chem. 100B OR	Chem. 143A
Poli. 160AA	ESYS 102	ESYS 103
SENIOR		
ESYS 190A	ESYS 190A	ESYS 190B
UD ESYS elective	UD ESYS elective	

* Choose (2) out of 3

Environmental Policy Track

Required upper-division course

One upper-division Statistics course—Math 183. Statistical Methods or Economics 120A. Econometrics

Upper-division electives

Students complete a minimum of seven courses selected from the following:

Earth Sciences 110. Introduction to GIS for Earth and Environmental Scientists
Earth Sciences 112. Urban Landscapes
Economics 116. Economic Development
Economics 125. Economics of Population Growth
Economics 130. Public Policy
Economics 132. Energy Economics
Environmental Systems 120. Science and Environmental Writing
Environmental Systems 150. Environmental Perils
Political Science 102L. The Politics of Regulation
Political Science 125. The Politics of Conservation in Developing Countries
Political Science 125A. Communities and the Environment
Political Science 150A. Politics of Immigration
Political Science 160AB. Introduction to Policy Analysis
IR-GN 459*. Conflict Resolution of Environmental Issues
IR-GN 488*. Corporate Strategy and the Environment
IR-GN 490*. Political Economy of Energy in Asia
IR-GN 490*. Political Economy of Energy in Latin America
IR-GN 490*. Special Topics
IR-PS 453*. Sustainable Development
IR-PS 458*. International Environmental Policy
HISC 105. History of Environmentalism
HIUS 154. Western Environmental History
ANBI 132. Conservation and the Human Predicament
Com/Cul 148. Communication and the Environment
Env. Studies 102. Selected Topics in Environmental Studies
Env. Studies 110. Environmental Law
Env. Studies 130. Environmental Issues
Philosophy 148. Philosophy of the Environment
Philosophy 164. Technology and Human Values
USP 124. Land Use Planning
USP 144. Environmental and Preventive Health Issues
USP 170. Planning Theory and Practice
USP 171. Sustainable Development

Other courses may be substituted by petition.

* These graduate courses are offered through the Graduate School of International Relations and Pacific Studies. Enrollment in these courses requires the permission of the instructor.

CURRICULUM GUIDE PLANNING

FALL	WINTER	SPRING
FRESHMAN		
Chem. 6A	Chem. 6B	Chem. 6C
Math. 10A	Math. 10B	Math. 10C
	BILD 3	Chem. 6BL
SOPHOMORE		
Phys. 1A, 1AL	Phys. 1B, 1BL	Phys. 1C, 1CL
Econ. 1	Math. 183 or Econ. 120A	Econ. 131
Poli. 160AA	UD ESYS elective	
JUNIOR		
ESYS 101	ESYS 102	ESYS 103
UD ESYS elective	UD ESYS elective	UD ESYS elective
SENIOR		
ESYS 190A	ESYS 190A	ESYS 190B
UD ESYS elective	UD ESYS elective	UD ESYS elective
		UD ESYS elective

SPECIAL STUDIES COURSES

Special Studies in the environmental systems is offered as Esys 199. This course is subject to consent of the instructor and approval by the Environmental Systems faculty adviser. This course is open to students who have accrued at least ninety quarter-units and have a GPA of least 3.0. No more than two quarters of environmental systems special studies may be counted toward the environmental systems major.

Study abroad through the Education Abroad Program or Opportunities Abroad Program can enhance a student's major, particularly as an opportunity for diverse field experiences. However, careful planning is important to meet all major requirements. Please contact the Environmental Systems Office as early as possible if you are planning to study abroad.

Environmental Systems Minor

A minor in Environmental Systems will expose students to the interdisciplinary approach necessary to address environmental problems. The program places a strong emphasis on a rigorous natural science foundation. Thus, most of the courses related to the minor have significant prerequisites; students planning an Environmental Systems minor should check catalog course description carefully.

The minor consists of twenty-eight units, at least twenty of which must be upper-division. Any upper-division course used to satisfy major requirements may not be applied toward a minor. Up to two courses for the minor may be taken on a Pass/Not Pass basis, (upper or lower division). Students must earn at least a letter grade of C– in the remaining five or more courses used for the minor. Students considering the Environmental Systems minor are strongly advised to meet with the associate director or the program adviser.

The minor is structured as followed:

Lower-Division Courses:

Any two of the following lower-division courses, if they are NOT lower-division requirements

for the student's major, may be applied to satisfy eight of the total units necessary for the minor:

Biology 3
Math. 10A-B-C
Chemistry 6A-B-C
Physics 1A-AL, 1B-BL, 1C-CL
Economics 1A
Earth Science: any lower-division course
Environmental Systems 10
Environmental Studies 30

Required core courses:

Environmental Systems 101, offered every fall quarter

Environmental Systems 102, offered every winter quarter

Environmental Systems 103, offered every spring quarter

NOTE: ESYS 102 and ESYS 103 all have significant prerequisites; students planning an Environmental Systems minor should check course descriptions and prerequisites carefully.

Upper-Division Electives:

At least two additional upper-division courses from the advanced tracks in the Environmental Systems major. The lists of upper-division electives are reviewed and updated each quarter. They are available in the Environmental Systems office and on the Program Web site (http://esys.ucsd.edu). Students are advised to consult with the Environmental Systems program advisers or associate director.

SPECIAL STUDIES COURSES

Special Studies in the environmental systems is offered as Esys 199. This course is subject to consent of the instructor and approval by the Environmental Systems faculty adviser. This course is open to students who have accrued at least ninety quarter-units and have a GPA of least 3.0. No more than two quarters of environmental systems special studies may be counted toward the environmental systems major.

Study abroad through the Education Abroad Program or Opportunities Abroad Program can enhance a student's major, particularly as an opportunity for diverse field experiences. However, careful planning is important to meet all major requirements. Please contact the Environmental Systems Office as early as possible if you are planning to study abroad.

COURSES

Many of the courses that are used to fulfill the requirements of the environmental systems major are offered by other departments and programs. Most of these courses are offered on a regular basis. Students should consult the Schedule of Classes or contact the Environmental Systems Office in order to obtain current information. The courses below are offered directly through the Environmental Systems Program.

LOWER-DIVISION

ESYS 10. Introduction to Environmental Systems (4)
This course explores the interdisciplinary character of environmental issues through an examination of a particular topic [climate change, for example] from numerous disciplinary perspectives [e.g., biology, chemistry, physics, political science, and economics]. *Prerequisite: none.* (W)

ESYS 90. Perspectives on Environmental Issues (1)
Provides an introduction to environmental systems. Faculty members from departments in the natural sciences, geosciences, and social sciences will offer perspectives in these areas. (F)

UPPER-DIVISION

ESYS 101. The Living Earth (4)
This course will survey the basic biochemical and physiological processes governing the relationship between organisms and their environments. Fundamentals of molecular biology, enzyme reactions, photosynthesis, and central metabolic processes, mechanisms underlying homeostasis at cellular and organismal levels will be discussed with a view toward understanding the adaptations and sensitivity of biological systems to environmental perturbations. *Prerequisite: none.*

ESYS 102. The Solid and Fluid Earth (4)
The physical Earth system can be divided into three components: the solid earth, the liquid earth, and the atmosphere. These components are all dynamic and interact in complex ways with profound impacts on our environment. We will examine the controls of natural phenomena such as earthquakes, volcanoes, landslides, soil formation (and destruction), and changes in sea-level and climate. *Prerequisites: Math. 10A, 10B, 10C, BILD 3, CHEM 6A-B-C, Physics 1A-B-C plus either Chem/Physics lab.* (W)

ESYS 103. The Human Earth (4)
This course explores the impacts of human, social, economic, and industrial activity on the environment. It highlights the central roles in ensuring sustainable development played by market forces, technological innovation, and governmental regulation on local, national, and global scales. *Prerequisites: grade of C– or better in Math. 20B or Math. 10A-C; Physics 2B or Physics A-C; Chemistry 6B or by consent of instructor. In addition, ESYS majors, must take ESYS 101 and 102 or permission of instructor.* (S)

ESYS 120. Science and Environmental Writing (4)
Course designed to improve the written communication of science majors through frequent writing assignments that develop the practical skills needed to communicate science to lay audiences. Topics include news writing, news releases, grant writing, broadcast script writing, and editorial writing. *Prerequisites: upper-division standing in science or mathematics major and completion of college composition requirement (or consent of instructor).* (W)

ESYS 150. Environmental Perils (4)
An advanced field-oriented course for engineering and science students stressing the geologic basis for environmental perils such as earthquakes, erosion, flooding, and waste disposal. Two one-hour lectures, and a two-hour lab/field trip each week. *Prerequisites: Math. 10 A-B-C sequence and Physics 1A,AL; 1B,BL; 1C,1CL sequence or equivalent.* (S)

ESYS 190A. Senior Project (8)
All majors are required to complete an integrative Senior Project in their senior year. The Senior Project is designed by the student to focus on an interdisciplinary environmental problem or research topic and is developed either individually or as part of a team over two quarters. Appropriate topics could include biodiversity conservation, environmental health, and/or global change. An important component of the Senior Project is an off-campus or laboratory internship. *Prerequisites: ESYS 103 and upper-division standing, departmental approval, majors only.* (F,W)

ESYS 190A(W). ESYS/UCDC Senior Project (4)
ESYS majors may opt to complete the internship portion of their Senior Project through the UCDC Program. Students are expected to apply to the fall or winter quarter of UCDC Program and obtain an internship in a governmental agency, NGO, and/or research laboratory. *Prerequisites: ESYS 103 and upper-division standing, departmental approval, majors only.* (F,W)

ESYS 190B. Senior Seminar (2)
The Senior Seminar provides a venue for the presentation and group evaluation of the ESYS Senior Projects. *Prerequisite: ESYS 190A or 190A(W) (NOTE: After completing (1) quarter of ESYS 190A, ESYS 190B may be taken concurrently), senior standing.* (S)

ESYS 199. Independent Study (2-4)
Individually guided readings or projects in the area of environmental systems.