ARIZONA STATE UNIVERSITY
PROPOSAL TO ESTABLISH A NEW GRADUATE DEGREE

This template is to be used only by programs that have received specific written approval from the Provost's office to proceed with internal proposal development and review. A separate proposal must be submitted for each individual new degree program.

DEGREE PROGRAM

College/School(s) offering this degree: College of Liberal Arts and Sciences

Unit(s) within college/school responsible for program: School of Life Sciences

If this is for an official joint degree program, list all units and colleges/schools that will be involved in offering the degree program and providing the necessary resources:

School of Life Sciences, School of Earth and Space Exploration, Department of Chemistry and Biochemistry, School of Human Evolution and Social Change, School of Sustainability, Department of Mathematics and Statistics, School of Geographical Sciences and Department of Civil and Environmental Engineering, Fulton School of Engineering.

Proposed Degree Name: PhD in Environmental Life Sciences

Master's Degree Type: N/A

Doctoral Degree Type: Doctor of Philosophy (Ph.D.)

If Degree Type is Other, provide proposed degree type:

and proposed abbreviation:

Proposed title of major: Environmental Life Sciences

Is a program fee required? Yes ☐ No ☑

Requested effective term: Select term and year: Fall 2009
(The first semester and year for which students may begin applying to the program.)

PROPOSAL CONTACT INFORMATION
(Person to contact regarding this proposal)

Name: Susanne Neuer
Title: Assoc. Professor

Phone: 7-7254
email: Susanne.neuer@asu.edu

DEAN APPROVAL

This proposal has been approved by all necessary unit and College/School levels of review, and the College/School(s) has the resources to offer this degree program. I recommend implementation of the proposed degree program. (Note: An electronic signature, an email from the dean or dean's designee, or a PDF of the signed signature page is acceptable.)

College Dean name:

College Dean signature ___________________________ Date: __________

College Dean name:
(if more than one college involved)

College Dean signature ___________________________ Date: __________
ARIZONA STATE UNIVERSITY
PROPOSAL TO ESTABLISH A NEW GRADUATE DEGREE

This proposal template should be completed in full and submitted to the University Provost's Academic Council [mailto:curriculum@asu.edu]. It must undergo all internal university review and approval steps including those at the unit, college, and university levels. A program may not be implemented until the Provost's Office notifies the academic unit that the program may be offered.

DEGREE PROGRAM INFORMATION

Doctoral: Doctor of Philosophy (Ph.D.)

If Degree Type is Other, provide proposed degree type:
and proposed abbreviation:

Proposed title of major: Environmental Life Sciences

1. PURPOSE AND NATURE OF PROGRAM

A. Brief program description (This is a catalog type description of no more than 250 words. Include the distinctive features of the program that make it unique. Do not include program or admission requirements.)

Environmental Life Sciences (ELS) is a graduate degree program that will provide Ph.D.-level training in several complementary fields focused on interactions between organisms (plant, animal or microbe) and their environment. ELS will provide trans-disciplinary training that includes aspects of geosciences, chemistry/biochemistry, environmental engineering, sustainability, social sciences, and mathematics, by merging elements of already strong Ph.D. programs in Biology, Plant Biology, Microbiology, Geological Sciences, Civil and Environmental Engineering, and Anthropology. As such, the program will be administered by a formal Program Committee comprised of a steering committee of faculty from the School of Life Sciences, the School of Earth and Space Exploration, the Department of Mathematics and Statistics, the Department of Chemistry and Biochemistry, the School of Human Evolution and Social Change, the School of Sustainability, the School of Geographical Sciences and the Fulton School of Engineering. A focus will be collaborative and integrative study of the effects of environmental variation on fluxes of materials and energy across scales ranging from the organism to the globe. Our overall goal is to provide a unique Ph.D. degree program that produces students with a broad appreciation of environment-organism questions in the context of natural and anthropogenic environmental change.

B. Total credit hours required for the program: 84 credit hours

C. Are any concentrations to be established under this degree program? □ Yes ☒ No

2. PROGRAM NEED. Explain why the university needs to offer this program (include data and discussion of the target audience and market).

Drought and climate change are projected to have multi-trillion dollar impacts on the US, with major effects on every aspect of life including hydrological cycles, organisms and ecosystems, agriculture, industry and society. Arizona's state universities have developed tremendous expertise in related sciences with a variety of relevant centers and programs (e.g. ASU's Central Arizona Phoenix Long Term Ecological Research project, the University of Arizona's Sustainability of Semi-Arid Hydrology and Riparian Areas, the U of A's Arizona Water Resources Center, ASU's Decision Center for a Desert City, and the statewide Arizona Water Institute). ASU currently lacks a graduate program designed to focus on the natural science aspects of organism-environment interactions.
This proposed graduate program in Environmental Life Sciences will train Ph.D.'s with the skills to evaluate and test important hypotheses concerning the linkages between environmental variation and biological and geological processes. This Ph.D. program will provide a strong interdisciplinary training in the environmental life sciences, rather than a disciplinary training on one of the related disciplines (Biology, Geology, Geography, Mathematics, Engineering, Sociology, Anthropology), enabling Ph.D. students to address broad questions in environmental science and sustainability. This natural system science-focused Ph.D. program will complement ASU's PhD in Sustainability, as well as the interdisciplinary Ph.D. in Environmental Social Science administered by the School of Human Evolution and Social Change which seek sustainable solutions to environmental challenges, and provide ASU with the paired interdisciplinary natural and social science training programs necessary to meet the global challenges arising from human development and environmental change.

3. **IMPACT ON OTHER PROGRAMS.** List other academic units that might be impacted by the proposed program and describe the potential impact (e.g., how the implementation of this program might affect student headcount/enrollment, student recruitment, faculty participation, course content, etc. in other programs). Attach letters of collaboration/support from impacted programs.

This interdisciplinary degree program will involve faculty from the School of Life Sciences, the School of Earth and Space Exploration, the Department of Chemistry and Biochemistry, the Department of Mathematics and Statistics, the School of Human Evolution and Social Change, the School of Sustainability, the School of Geographical Sciences and the Fulton School of Engineering. It has the full support from the directors/chairs of those units (see attached Memoranda of Understanding - MOU). We anticipate new collaborations among graduate students and faculty in these different units. We expect that the ELS graduate program will attract highly competitive students to the participating units. Furthermore, two new core courses will be formed which will be a significant enrichment to the spectrum of courses available to graduate students of the participating units.

4. **PROJECTED ENROLLMENT** How many new students do you anticipate enrolling in this program each year for the next five years? Please utilize the following tabular format.

We expect that some of the first year Ph.D. students in the existing Ph.D. programs would matriculate into the ELS Ph.D. degree program, hence, we project that 5 incoming students and 5 current students would enroll in the first year. We anticipate increasing the enrollment to at least 50 within 5 years, given vigorous recruitment.

<table>
<thead>
<tr>
<th>5-YEAR PROJECTED ANNUAL ENROLLMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1st Year</strong></td>
</tr>
<tr>
<td>(Yr 1 continuing + new entering)</td>
</tr>
<tr>
<td>Number of Students Majoring (Headcount)</td>
</tr>
</tbody>
</table>

5. **STUDENT LEARNING OUTCOMES AND ASSESSMENT**

   **A.** List the knowledge, competencies, and skills students should have when they graduate from the proposed degree program. (You can find examples of program Learning Outcomes at [http://www.asu.edu/oue/assessment.html](http://www.asu.edu/oue/assessment.html). See below.

   **B.** Describe the plan and methods to assess whether students have achieved the knowledge, competencies and skills identified in the Learning Outcomes. (You can find examples of assessment methods at [http://www.asu.edu/oue/assessment.html](http://www.asu.edu/oue/assessment.html).

   **Outcome:** Core competency in related discipline principles.
Assessment: Students must receive a 3.0 or better in the two 3 credit core courses. In addition, they must maintain a cumulative 3.0 GPA in the courses on their plan of study in their particular concentration. This capability will also be critically assessed in the oral exam for qualification to candidacy.

Outcome: Ability to independently conduct research in science, including planning experiments, mastery of skills needed to execute the plans and interpretation of results.

Assessment: The assessment of this status will be through the dissertation advisor on a continuous basis. In addition, the student will organize and present their research progress to their dissertation committee meetings annually. The dissertation advisor will prepare an annual evaluation of the student’s progress that incorporates committee input; this evaluation will be given to the student for comment, and then the report and any student comments will be provided to the ELS executive committee. As part of the comprehensive exam, students will prepare a research proposal and be evaluated on it. The final assessment will be the final defense of the dissertation.

Outcome: The students will learn how to present and publish their research project results in a manner that makes a significant contribution to science.

Assessment: The student’s research should be submitted for publication in one or more peer-reviewed journals (actual publication may occur after graduation). The student’s contribution may be part of a large report, but the aspect that the student contributed should be clearly identifiable and represent independent research. The total accomplishment of the student will be presented in a written dissertation that will be evaluated by the dissertation committee.

Outcome: Ability to function productively in an interdisciplinary scientific endeavor. This includes the ability to make critical evaluations of the relative merit of research projects in regard to environmental research.

Assessment: As part of the core course sequence, students will be presented with problems in interdisciplinary research and asked to evaluate literature and presentations in diverse areas. They will be graded on this ability. In addition, students will be engaged in dissertation projects that explicitly involve interdisciplinary research and will be evaluated on it. The dissertation committee will judge how well the student’s research proposal is designed and justified.

Outcome: The student will learn to effectively communicate scientific principles and issues.

Assessment: In addition to laboratory meetings and their required works-in-progress annual presentations to the dissertation committee, students will be given frequent opportunities to present their research in public at national/international meetings.

6. ACCREDITATION OR LICENSING REQUIREMENTS (if applicable). Provide the names of the external agencies for accreditation, professional licensing, etc. that guide your curriculum for this program, if any. Describe any requirements for accreditation or licensing.

N/A

7. FACULTY, STAFF AND RESOURCE REQUIREMENTS
A. Faculty

i. Current Faculty. List the name, rank, highest degree, area of specialization/expertise and estimate of the level of involvement of all current faculty who will teach in the program.

Level of involvement:

1 = High: Member of current planning committee, likely teaching core course, supervising graduate students
2 = Intermediate: Graduate faculty member, teaching elective, supervising students
3 = Low: Graduate faculty member, teaching elective, no student supervision

Academic unit abbreviation

CEE, Department of Civil and Environmental Engineering, Fulton School of Engineering
DCB, Department of Chemistry and Biochemistry
DMS, Department of Mathematics and Statistics
SESE, School of Earth and Space Exploration
SHESC, School of Human Evolution and Social Change
SoGS, School of Geographical Sciences
SoLS, School of Life Sciences
SOS, School of Sustainability

Faculty

Morteza Abbaszadeh, Professor, CEE, PhD, health-related water microbiology, 2-3
Ariel Anbar, Associate Professor, SESE, DCB, PhD, Isotope Biogeochemistry, 1
John Anderies, Associate Professor, SHESC, SOS, PhD, Human Ecology, Human-Environment Interaction, Mathematical Bioeconomics, Modeling and Simulation, 3
Carlos Castillo-Chavez, Regents Professor, DMS, PhD, mathematical ecology and epidemiology, social dynamics, evolutionary biology, 2
Dan Childers, Professor, SOS, PhD, wetland ecology, 3
Tad Day, Professor, SoLS, Plant Ecology, 2
Pierre Deviche, Professor, SoLS, PhD, Vertebrate Physiology, Endocrinology, Behavior, 2
Dale DeNardo, Associate Professor, SoLS, Ph.D., Environmental Physiology, 2
James Eiser, Professor, SoLS, PhD, Limnology and biological stoichiometry, 1
Ananias Escalante, Associate Professor, SoLS, PhD, Ecology and Evolutionary Biology of Infectious Diseases – Molecular Epidemiology, 1
Jack Farmer, Professor, SESE, PhD, Geobiology, Astrobiology, 2-3
Stuart Fisher, Professor, SoLS, PhD, ecosystem ecology, 1
Janet Franklin, Professor, SoGS, PhD, Landscape ecology, biogeography, remote sensing of terrestrial ecosystems, 2
Ferran Garcia-Pichel, Professor, SoLS, PhD, microbial ecology, geomicrobiology, 2
Leah Gerber, Associate Professor, SoLS, PhD, conservation biology, population ecology and marine science, 2
Nancy Grimm, Professor, SoLS, SOS, PhD, ecosystem ecology and biogeochemistry, urban, aquatic, and aridland ecosystems, 1
Sharon Hall, Asst. Professor, SoLS, PhD, ecosystem ecology, terrestrial biogeochemistry, 2
Jon Harrison, Professor, SOS, PhD, ecological and evolutionary physiology of insects, 1
Hilary Hartnett, Assistant Professor, SESE, DCB, PhD, biogeochemistry, aquatic chemistry, 2
Pierre Herckes, Assistant Professor, DCB, Ph.D., Physical, Atmospheric Chemistry and Environmental Analytical Chemistry, 2
Ann Kinzig, Assoc. Prof., SoLS, SOS, PhD, urban ecology, biodiversity and ecosystem services, 2
Jeffrey Klopatek, Professor, SoLS, PhD, Ecosystems Analysis, 2-3
Rosa Krajmalnik-Brown, Assistant Professor, CEE, PhD, 2
Yang Kuang, Professor, DMS, PhD, mathematical and computational ecology, 1-2
Kevin McGraw, Assistant Professor, SoLS, PhD, Evolutionary and Systems Biology, 3
Michael Moore, Professor, SoLS, PhD, Behavioral Neuroendocrinology, Physiological Ecology, Animal Behavior, 2
Tom Nash, Professor, SoLS, PhD, lichenology and plant ecology, 2
Susanne Neuer, Associate Professor, SoLS, PhD, Ocean Biogeochemistry, Plankton Ecology, 1
Miles Orchinik, Professor, SoLS, PhD, Neurophysiology of Stress, 3
Bruce Rittmann, Professor, Center for Environmental Biotechnology, Biodesign Institute, CEE, PhD, Environmental Biotechnology and Microbial Ecology, 2-3
Ron Rutowski, Professor, SoLS, PhD, Visual ecology, 2
John Sabo, Associate Professor, SoLS, PhD, Ecology of Riparian Areas and Rivers, 1
Everett Shock, Professor, SESE/DCB, PhD, Biogeochemistry, 1
Milton Sommerfeld, Professor, Professor, ASU Polytechnic, Applied Bio Sciences, PhD, phycology, 2
Paul Westerhoff, Professor, CEE, PhD, water quality monitoring and analysis, contaminant removal, 2-3
Martin F. Wojciechowski, Associate Professor, SoLS, PhD, plant systematics and evolution, phylogenetic biology, 2
Jingle Wu, Professor, SoLS, PhD, urban ecology, biodiversity and ecosystem services, 2
Weiwen Zhang, Associate Professor, Center for Ecogenomics, Biodesign Institute, PhD, microbial genomics, microbial ecology, 1

ii. **New Faculty.** Describe the new faculty hiring needed during the next three years for sustaining the program and list the anticipated schedule for addition of these faculty.

N/A

iii. **Administration of the program.** Explain how the program will be administered for the purposes of admissions, advising, course offerings, etc. Discuss the available staff support.

**Executive Committee:** The activities and requirements for this program will be determined and overseen by an Executive Committee. The Executive Committee will include representatives from all participating units. An acting Director of the program has been voted by the participating faculty. After the approval of the degree program, an official director will be elected by the committee. An acting Working Committee has been formed from faculty volunteers across the participating units by the acting director and will constitute the future Executive Committee if approved by the Vice Provost and Dean of the Graduate College.

**Responsibilities of the Executive Committee**

Oversee the effort of recruitment of new students; recommend admission of new students in consultation with participating units (see MOUs), approval of and subsequent oversight of student’s programs of study (POS) and progress, oversight of interdisciplinary composition of supervisory committees. In the future, as the program expands, we anticipate that a separate Graduate Committee will be formed, which will oversee student progress, and will be chaired by a member of the executive committee who will report to the Director and the Executive Committee.

Oversee the content and execution of the core courses. We expect that there will be a need for constant updating of material and organization of the courses. These courses will be essential for introduction not only of advanced concepts and techniques in environmental life sciences, but also for introduction of students to a broad spectrum of research. Thus an emphasis will be placed on

Request to implement a new degree program
highlighting the kinds of teamwork necessary for building a successful environmental life sciences research program.

**Administrative support**

Administrative staff support for the administration of the program will be provided by the School of Life Sciences. The program will be overseen by an Executive Committee of Faculty representing the units involved.

Student support will primarily come from block grants distributed to the units by the graduate college, research grants by the faculty advising the students, departmental teaching opportunities and fellowships established through private donations (see MOUs). Students will have the opportunity to choose any laboratory in the program.

B. **Resource requirements to launch and sustain the program.** Describe any new resources required for this program's success such as new staff, new facilities, new library resources, new technology resources, etc

No new resources are needed.

8. **CURRICULAR STRUCTURE OF THE PROPOSED PROGRAM**

A. **Admission Requirements** The requirements listed below are Graduate College requirements. Please modify and/or expand if the proposed degree has additional admissions requirements.

i. **Degree.** Minimum of a bachelor's degree (or equivalent) or a graduate degree from a regionally accredited College or University or of recognized standing in a related field.

   Modify or expand, if applicable:

ii. **GPA.** Minimum of a 3.00 cumulative GPA (scale is 4.0=A) in the last 60 hours of a student's first bachelor's degree program Modify or expand, if applicable

iii. **English Proficiency Requirement for International Applicants.** If applicable list any English proficiency requirements that are higher than and/or in addition to the Graduate College requirement. (See Graduate College policy and procedures http://graduate.asu.edu/admissions/international.html#proficiency): N/A

iv. **Required Admission Examinations.**
   - [x] GRE
   - [ ] GMAT
   - [ ] Millers Analogies.

v. **Application Review Terms.** Indicate all terms for which applications for admissions are accepted and the corresponding application deadline dates, if any:

   - [x] Fall Deadline (month/year):
   - [x] Spring Deadline (month/year): 15 December 2008 and yearly thereafter
   - [x] Summer Deadline (month/year):

B. **Degree Requirements.** Below provide the curricular requirements for the proposed degree program.

i. **Total credit hours (cr hrs) required for the degree program:** 84 credit hours
ii. **Core courses.** List all required core courses and total credit hours for the core (required courses other than internships, thesis, dissertation, capstone course, etc). Omnibus number courses can not be used as core courses. Permanent numbers must be requested by submitting course proposal to ACRES for approval.

*Total cr hrs for required core courses:* 7 credit hours

<table>
<thead>
<tr>
<th>Course prefix &amp; number</th>
<th>Course title</th>
<th>Credit hours</th>
<th>New course?</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELS 501</td>
<td>Environmental Life Sciences, Lecture</td>
<td>3</td>
<td>Y □ N □</td>
</tr>
<tr>
<td>ELS 502</td>
<td>Environmental Life Sciences, Field Camp</td>
<td>4</td>
<td>Y □ N □</td>
</tr>
</tbody>
</table>

(Please expand table as needed. Right click in white space of last cell. Select "Insert Rows Below"

iii. **Elective Courses**

1. At least two courses (6 credit hours) selected from two different broad categories of Earth Sciences (e.g., geology, hydrology)
   Organismal Biology (e.g., physiology and behavior)
   Evolutionary Biology (e.g., population genetics)
   Ecology/ecosystems
   Sustainability/Social/Policy

2. One course (3 credit hours) in quantitative/modeling/statistics

*Total cr hrs for program electives:* 9 credit hours

Provide a sample list of elective courses:

<table>
<thead>
<tr>
<th>Course prefix &amp; number</th>
<th>Course title</th>
<th>Credit hours</th>
<th>New course?</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO 411</td>
<td>Populations: Advanced Conservation Biology</td>
<td>3</td>
<td>Y □ N □</td>
</tr>
<tr>
<td>BIO 415</td>
<td>Biometry</td>
<td>3</td>
<td>Y □ N □</td>
</tr>
<tr>
<td>BIO 423</td>
<td>Population and Community Ecology</td>
<td>3</td>
<td>Y □ N □</td>
</tr>
<tr>
<td>BIO 425</td>
<td>Animal Ecology</td>
<td>3</td>
<td>Y □ N □</td>
</tr>
<tr>
<td>BIO 431</td>
<td>Genes, Development, and Evolution</td>
<td>3</td>
<td>Y □ N □</td>
</tr>
<tr>
<td>BIO 464</td>
<td>Photobiology</td>
<td>3</td>
<td>Y □ N □</td>
</tr>
<tr>
<td>BIO 465</td>
<td>Neurophysiology</td>
<td>3</td>
<td>Y □ N □</td>
</tr>
<tr>
<td>BIO 426</td>
<td>Limnology</td>
<td>3</td>
<td>Y □ N □</td>
</tr>
<tr>
<td>BIO 461</td>
<td>Comparative Animal Physiology</td>
<td>3</td>
<td>Y □ N □</td>
</tr>
<tr>
<td>BIO 462</td>
<td>Endocrine Physiology</td>
<td>3</td>
<td>Y □ N □</td>
</tr>
<tr>
<td>BIO 494</td>
<td>Marine Biology</td>
<td>3</td>
<td>Y □ N □</td>
</tr>
<tr>
<td>BIO 494/598</td>
<td>Ecological Stoichiometry</td>
<td>3</td>
<td>Y □ N □</td>
</tr>
<tr>
<td>BIO 522</td>
<td>Populations: Evolutionary Ecology</td>
<td>3</td>
<td>Y □ N □</td>
</tr>
<tr>
<td>BIO 524</td>
<td>Ecosystems</td>
<td>3</td>
<td>Y □ N □</td>
</tr>
<tr>
<td>BIO 526</td>
<td>Quantitative Ecology</td>
<td>3</td>
<td>Y □ N □</td>
</tr>
<tr>
<td>BIO 561</td>
<td>Environmental Physiology</td>
<td>3</td>
<td>Y □ N □</td>
</tr>
<tr>
<td>BIO 598</td>
<td>Soil Ecology</td>
<td>3</td>
<td>Y □ N □</td>
</tr>
<tr>
<td>BIO 598</td>
<td>Urban Ecological Systems</td>
<td>3</td>
<td>Y □ N □</td>
</tr>
<tr>
<td>BIO/GLG 598</td>
<td>Biogeochemistry seminar/field</td>
<td>3</td>
<td>Y □ N □</td>
</tr>
<tr>
<td>BIO/GLG/CHM 494/598</td>
<td>Marine Biogeochemistry</td>
<td>3</td>
<td>Y □ N □</td>
</tr>
<tr>
<td>BIO/GPH 598</td>
<td>Climate change</td>
<td>3</td>
<td>Y □ N □</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
<td>Credits</td>
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</tr>
<tr>
<td>-------------</td>
<td>------------------------------------------------------------</td>
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</tr>
<tr>
<td>BIO 591 / ASM 591</td>
<td>Dynamic Modeling in Social and Ecological Systems</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>BCH 568</td>
<td>Molecular Mechanisms of Photosynthesis</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>BCM 461/462</td>
<td>Biochemistry</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>BCM 494</td>
<td>Advanced Biogeochemistry</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>CHM 460</td>
<td>Biological Chemistry</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>CHM 501</td>
<td>Current topics in Environmental Chemistry</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>CHM 598</td>
<td>Chemistry for Sustainability</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>CHM 598</td>
<td>Chemical Biology</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>CHM 598</td>
<td>Bioinorganic Chemistry</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>CHM 598</td>
<td>Protein Design and Evolution</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>CHM 598</td>
<td>Nucleic Acids</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>CHM 598</td>
<td>Quantitative Foundations of Modern Biochemistry</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>CHM 501</td>
<td>Science Policy for Scientists and Engineers</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>CEE 563</td>
<td>Environmental Chemistry Laboratory</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>CEE 564</td>
<td>Contaminant Fate and Transport</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>CEE 567</td>
<td>Environmental Microbiology</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>CEE 598</td>
<td>Biotransformations</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>CEE 598</td>
<td>Advanced Environmental Biotechnology</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>ESS 514/SSH 505</td>
<td>Urban and Environmental Health</td>
<td>4</td>
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<tr>
<td>ESS 501</td>
<td>Environmental Social Science: Theory and Practice I</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>ESS 502</td>
<td>Environmental Social Science: Theory and Practice II</td>
<td>3</td>
<td>Y</td>
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<tr>
<td>ESS 513</td>
<td>Institutions, Society and Environment</td>
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<td>Y</td>
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<tr>
<td>ASB/SSH 500</td>
<td>Ethnographic Research Methods</td>
<td>3</td>
<td>Y</td>
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<tr>
<td>ASB 591 / MAT 598</td>
<td>Agent-Based Modeling</td>
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<td>Y</td>
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<tr>
<td>ASB 598 / BIO 598 / POS 598</td>
<td>Science, Technology, and Societal Outcomes</td>
<td>3</td>
<td>Y</td>
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<tr>
<td>ASB 591</td>
<td>Social Dimensions of Science</td>
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<tr>
<td>GLG 410</td>
<td>Computers in Geology</td>
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<tr>
<td>GLG 435</td>
<td>Sedimentology</td>
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<tr>
<td>GLG 470</td>
<td>Hydrogeology</td>
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<tr>
<td>GLG 490/598</td>
<td>Remote Sensing</td>
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</tr>
<tr>
<td>GLG 490/598</td>
<td>Analytical Instrumentation</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>GLG 490/598</td>
<td>Advanced Biogeochemistry</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
<td>Credits</td>
<td>Y</td>
</tr>
<tr>
<td>------------</td>
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</tr>
<tr>
<td>GLG490/5</td>
<td>Tectonic Geomorphology</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>98</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>GLG 501</td>
<td>Geology of Arizona</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>GLG 547</td>
<td>Science, Technology, and Public Affairs</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>GLG 581</td>
<td>Isotope Geochemistry</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>GLG 598</td>
<td>Advanced Sedimentology (Farmer)</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>GLG 598</td>
<td>Topics in Paleobiology and Evolution</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>GLG 598</td>
<td>Geomorphology</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>GLG/BIO/</td>
<td>Biogeochemical Cycles</td>
<td>3</td>
<td>Y</td>
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<tr>
<td>CHM 598</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>GLG/CHM</td>
<td>Weathering, Diagenesis and Alteration</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>598</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>GLG/CHM</td>
<td>Theoretical Geochemistry</td>
<td>3</td>
<td>Y</td>
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<tr>
<td>598</td>
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<tr>
<td>GPH/PLB</td>
<td>Plant Geography</td>
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<tr>
<td>422</td>
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<tr>
<td>KIN 440</td>
<td>Exercise Biochemistry</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>KIN 494</td>
<td>Comparative Biomechanics</td>
<td>3</td>
<td>Y</td>
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<tr>
<td>MAT 451</td>
<td>Mathematical Modeling</td>
<td>3</td>
<td>Y</td>
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<tr>
<td>MAT 591 B</td>
<td>S: MATH BIOLOGY</td>
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<td>Y</td>
</tr>
<tr>
<td>MAT 598</td>
<td>Mathematical Ecology</td>
<td>3</td>
<td>Y</td>
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<tr>
<td>MCB/MIC</td>
<td>Techniques in Molecular Biology/Genetics</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>445</td>
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<tr>
<td>MCB/MIC</td>
<td>Techniques in Molecular Biology/Genetics Lab</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>446</td>
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<td></td>
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<tr>
<td>MCB 555</td>
<td>Advanced Molecular/Cell Biology</td>
<td>6</td>
<td>Y</td>
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<tr>
<td>MIC 491/591</td>
<td>Topic: Microbial Ecology</td>
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<td></td>
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<tr>
<td>MCB 555</td>
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<tr>
<td>MIC 591</td>
<td>Microbial Ecology</td>
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<td>Y</td>
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<tr>
<td>MIC/GLG</td>
<td>Geomicrobiology</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>461</td>
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<td></td>
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<tr>
<td>PLB 420</td>
<td>Plant Ecology: Organisms and Populations</td>
<td>3</td>
<td>Y</td>
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<tr>
<td>PLB 421</td>
<td>Terrestrial Communities and Ecosystems</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>PLB 411</td>
<td>Trees and Shrubs of Arizona</td>
<td>3</td>
<td>Y</td>
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<tr>
<td>PLB 583</td>
<td>OTS: Fieldwork in Tropical Biology</td>
<td>3</td>
<td>Y</td>
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<tr>
<td>PLB/CBS</td>
<td>Phylogenetic analysis</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>494/591</td>
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<td></td>
<td></td>
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<tr>
<td>STP 530</td>
<td>Applied Regression</td>
<td>3</td>
<td>Y</td>
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<tr>
<td>STP 531</td>
<td>Applied Analysis of Variance</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>STP 532</td>
<td>Applied Nonparametric Statistics</td>
<td>3</td>
<td>Y</td>
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<tr>
<td>STP 535</td>
<td>Applied Sampling Methodology</td>
<td>3</td>
<td>Y</td>
</tr>
</tbody>
</table>

(Please expand table as needed. Right click in white space of last cell. Select "Insert Rows Below")

iv. 400-Level Courses. No more than 6 credit hours of 400-level coursework can be included on graduate student program of study.

1. Are 400-level ASU courses allowed on student program of study for this degree? ☒ Yes ☐ No

2. If yes, how many credit hours? 6 credit hours
v. **Additional Requirements (if applicable)**. Provide a brief description of any additional requirements (e.g. internships, clinicals, field study, etc.) N/A

**Total cr hrs for other required courses**: N/A

List course info for any additional requirements (e.g. internships, clinicals, field study, etc.)

<table>
<thead>
<tr>
<th>Course prefix &amp; number</th>
<th>Course title</th>
<th>Credit hours</th>
<th>New course?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Y □ N □</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Y □ N □</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Y □ N □</td>
</tr>
</tbody>
</table>

(Please expand table as needed. Right click in white space of last cell. Select "Insert Rows Below")

vi. **Total cr hrs required for research (if applicable)**: N/A

vii. **Culminating experience** for the proposed program (please check all that apply and provide requested information):

<table>
<thead>
<tr>
<th>Required?</th>
<th>Brief description of the applied project or the capstone course, as applicable.</th>
<th>Course prefix and number</th>
<th>Credit hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thesis (master's only)</td>
<td>□</td>
<td></td>
<td>6 cr hrs</td>
</tr>
<tr>
<td>Applied Project (master's only)</td>
<td>□</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capstone course (master's only)</td>
<td>□</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dissertation (doctoral only)</td>
<td>☒</td>
<td></td>
<td>12 cr hrs</td>
</tr>
</tbody>
</table>

(Please expand table as needed. Right click in white space of last cell. Select "Insert Rows Below")

viii. **For Doctoral Degrees, indicate the Master's Degree Credit Allowance**. If approved by the student’s supervisory committee, does the program allow up to 30 credit hours from a previously awarded master’s degree to count towards the degree requirements for this doctoral program? ☒ Yes or □ No

ix. **Committee**: Required Number of Thesis or Dissertation Committee Members (must be at least 3 including chair or co-chairs): 4

x. **Foreign Language Exam**.

Foreign Language Examination(s) required? ☐ Yes ☒ No

If yes, list all foreign languages required:

xi. **Course Prefix(es)** Provide the following information for the proposed graduate program.

a. Will a new course prefix(es) be required for this degree program? Yes ☒ No □

b. If yes, complete the Request for establishment of a new prefix for each prefix and submit with this proposal. See accompanying proposal

xii. **New Courses Required for Proposed Degree Program**. Provide course prefix, number, title, and credit hours and description for any new courses required for this degree program.

One of the strengths of the proposed degree program in ELS is a broad training encompassing a wide range of perspectives about concepts of the 'environment'. In particular faculty from SESE, SoLS and SHESC, SoGS and the Fulton School of Engineering provide a natural macro perspective that provides the big picture about the sources and sinks of nutrients, water, energy for organisms and a more long term perspective about the relationship between humans and the environment. By contrast,
organismal and subcellular perspectives of faculty in SoLS, Engineering and Chemistry/Biochemistry provide complementary understanding of effects of environmental variation on organisms, and the plastic and evolutionary responses of organisms to short- and long-term environmental change. The breadth of perspectives on the 'environment' is the single strongest selling point of the program. This is the theme of several required courses within the new degree program which we outline below.

ELS 501. Environmental Life Sciences; 3 cr.

This is a course intended to introduce graduate students to a range of fields related to the ELS program. The course will typically be co-instructed, but likely by different faculty teams each year. The mode of instruction will combine overview lectures and active discussion of current literature in the fields of inquiry. The course will culminate in synthetic collaborative research proposals on topics that foster trans-disciplinary approaches to environmental life science questions. We will cover core areas of the environmental life sciences in relation to grand challenges for the field; for the first semester, the theme will be global climate change. Another major goal of the course is to introduce the students to the varied ELS faculty. During the first meetings of most weeks, an ELS faculty member will give a lecture on a topic, and provide one relevant paper for the students to read and discuss. During subsequent meetings that week, we will discuss several assigned relevant papers. In general, there will be a review paper and 1-2 experimental papers assigned each week.

Student paper: Students will write a synthetic collaborative research proposal on topics that foster trans-disciplinary approaches to environmental life science questions, and will present this research proposal orally to the class.

Specific topics: For our first semester, with the theme of global climate change, the following topics will be covered:
- Evidence for and mechanisms of anthropogenic climate change
- Water and air pollution
- Historical changes in Earth's climate
- Evolutionary vs. plastic responses to climate change
- Microbial responses to climate change
- Biogeochemical responses to climate change
- Autotroph responses to climate change
- Animal responses to climate change
- Responses of soils to climate change
- Response of terrestrial food webs to climate change
- Responses of aquatic food webs to climate change
- Hydrological responses to climate change
- Wetlands responses to climate change
- Human responses to climate change

Grading based on Midterm and Final Exams, Take-home essays, Synthetic research proposal: Discussion contributions, Oral presentation
Course objective:

This course follows ELS 501: Environmental Life Sciences, which is taught in the fall semester. ELS 502 provides the students with opportunities to develop field skills relevant to current questions in environmental life science and to carry out a wide range of observations and measurements in natural systems.

This 4 credit course is taught during the spring semester, and is co-instructed by faculty teams. ELS 502 consists of an on-campus introductory session during weeks 1-4 aimed at formulating the research questions to be covered during the field portions of the class, and introduction to the participating laboratories and analytical facilities. The field and laboratory component (weeks 5-10) will then consist of 3 weekend field trips and one field camp during spring break (6 days) to be held at a field station, for example the ITESIS (Instituto Tecnológico y de Estudios Superiores de Monterrey) campus at Guaymas, Sonora, Mexico on the Gulf of California (Sea of Cortez). The research environments span various locations in the Sonoran desert, including riparian ecosystems and hot springs, and coastal ecosystems.

The students will analyze samples and data after each field portion in laboratories of the participating faculty. During Weeks 11-14, students will focus on data analysis and writing, interspersed by weekly seminar meetings for discussion of their progress. The research portion will culminate in a national meeting style presentation of their data in an open meeting format. This format of multiple field trips will allow the students to critically examine research questions and methods of data collection and analysis after each field portion and hone their skills in both the field as well as in the laboratory. Grading will be based on participation, the oral presentation and research paper.

Research questions to be covered will vary with the faculty teams who teach the course, as well as the field locations. Specific topics include geomorphology of desert habitats, ecology and ecophysiological adaptations of life in the desert; ecology and microbial element and organic matter transformations in microbial soil crusts; biogeochemistry of hot springs; nitrogen cycle in riparian ecosystems; nutrient supply, primary production and carbon flux in a coastal ecosystem; biosedimentary structures and ancient marine microbial systems as models of first ecosystems on Earth.
ARIZONA STATE UNIVERSITY
PROPOSAL TO ESTABLISH A NEW GRADUATE DEGREE

This template is to be used only by programs that have received specific written approval from the Provost's office to proceed with internal proposal development and review. A separate proposal must be submitted for each individual new degree program.

DEGREE PROGRAM

College/School(s) offering this degree: CLAS/FoE

Unit(s) within college/school responsible for program:

If this is for an official joint degree program, list all units and colleges/schools that will be involved in offering the degree program and providing the necessary resources:

School of Life Sciences, School of Earth and Space Exploration, Department of Chemistry and Biochemistry, School of Human Evolution and Social Change, School of Sustainability, Department of Mathematics and Statistics, School of Geographical Sciences and Department of Civil and Environmental Engineering, Fulton School of Engineering.

Proposed Degree Name: Environmental Life Sciences

Master's Degree Type: N/A

Doctoral Degree Type: PhD-Doctor of Philosophy

If Degree Type is Other, provide proposed degree type:

and proposed abbreviation:

Proposed title of major: Environmental Life Sciences

Is a program fee required? Yes ☐ No ☑

Requested effective term: Select term and year: Fall 2009
(The first semester and year for which students may begin applying to the program.)

PROPOSAL CONTACT INFORMATION
(Person to contact regarding this proposal)

Name: Susanne Neuer
Title: Asst. Professor
Phone: 7-7254
email: Susanne.neuer@asu.edu

CIP Code:
(to be determined by the Office of the Executive Vice President and the Provost of the University)

COVER SHEET
Memorandum of Understanding
for the new interdisciplinary degree program
“Environmental Life Sciences”

1. Description of Graduate Program

Environmental Life Sciences (ELS) is a graduate degree program that will provide Ph.D. level training in several complementary fields focused on interactions between organisms (plant, animal or microbe) and their environment. ELS will provide trans-disciplinary training that includes aspects of geosciences, chemistry/biochemistry, environmental engineering, sustainability, social sciences, and mathematics. As such, the program will be administered by a formal Program Committee comprised of a steering committee of faculty within the School of Life Sciences, the School of Earth and Space Exploration, the Department of Mathematics and Statistics, the School of Human Evolution and Social Change, the School of Sustainability, the School of Geographical Sciences and the Fulton School of Engineering. We encourage collaboration among graduate students and faculty in these different units that fosters integration of concepts of environmental variation in conditions, fluxes of materials and nutrient cycles across scales ranging the organism to the globe. Our overall goal is to provide a unique Ph.D. degree program that produces students with a broad appreciation of environment-organism questions in the context of natural and anthropogenic environmental change.

2. Terms of Understanding

The directors/chairs of the participating units agree

1) to allow faculties in their units who are participating members of ELS to mentor graduate students in the ELS PhD degree program, after those students have passed the admissions criteria of their unit.

2) to provide the same access to graduate student support to a student pursuing a degree in ELS under the primary mentorship of faculty from their participating unit as provided to other students from that unit.

3) to recognize teaching and training efforts by their faculty who teach or co-teach courses which are part of the ELS course curriculum. Those courses will then be cross-listed in the units of the faculty members co-teaching the course.

Robert E. Page, Jr.
Founding Director and Foundation Professor
School of Life Sciences
Arizona State University
P.O. Box 874501
Tempe, AZ 85287-4501
Phone: 480-965-1288
Fax: 480-965-6899
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Kip Hodges  
Director, School of Earth and Space Exploration
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Sander Van Der Leeuw
Professor and Director
School of Human Evolution and Social Change
College of Liberal Arts and Sciences
Arizona State University
PO Box 872402
Tempe, AZ 85287-2402
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Acknowledged and Agreed August 21, 2008:

William T. Petuskey, Chair
Department of Chemistry and Biochemistry
Memorandum of Understanding
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Approved

Wayne Raskind, Director
Dept. of Math + Statistics
August 22, 2008

Subject: Memorandum of Understanding for the new interdisciplinary degree program "Environmental Life Sciences"

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Sincerely,

[Signature]

Paul Westerhoff, Ph.D., PE
Professor and Chair
Department of Civil and Environmental Engineering
-----Original Message-----
From: Luc Anselin [mailto:Luc.Anselin@asu.edu]
Sent: Tuesday, August 12, 2008 3:42 PM
To: Susanne Neuer
Cc: Anthony Brazel
Subject: Interdisciplinary ELS Program

Dear Susanne:
Tony brought this program to my attention. We would be happy to collaborate
on this and participate with a formal MOU. You may not know that Janet Franklin is joining our school next fall with a joint appointment in SOLS.
She would be perfect for this program.
I'm sure others in the School would be interested as well.
Best,
L.

Luc Anselin
Foundation Professor of Geographical Sciences
Director, School of Geographical Sciences
Director, GeoDa Center for Geospatial Analysis and Computation
Arizona State University
From: Charles Redman  
Sent: Friday, July 11, 2008 12:24 PM  
To: Susanne Neuer; Katherine Spielmann  
Subject: RE: interdisciplinary ELS degree program

Susanne:
We at SOS would be happy to help you in the planning of the ELS program. I remain amazed by the continuing growth of new programs at ASU (including my own). Coordination is essential to reduce wasted effort and missed opportunities. I have copied Kate Spielmann on this email to see if she is able to represent us in this working group.

Chuck

Charles L. Redman  
Director, School of Sustainability  
Virginia M. Ullman Professor, Natural History and the Environment  
PO Box 875502, Tempe, AZ 85287-5502  
Phone: (480) 727-6963, Fax: (480) 965-8087  
http://schoolor/sustainability.asu.edu  
http://sustainability.asu.edu