Justification for New Course: NREM 636-Terrestrial Biogeochemistry

- **What is the objective and purpose of the new course?**

This course is designed to provide graduate students and outstanding undergraduates the opportunity to advance their basic understanding of plant-soil-nutrient relationships within a biogeochemical perspective, focusing on terrestrial forests and grasslands ecosystems in the tropics. This course will integrate information from the earth and biological sciences and apply it within an ecological perspective to help students relate the structure and function of terrestrial ecosystems within larger spatial and temporal frameworks. Students will understand the major components of the biogeochemical cycles of various nutrient elements, of organic C, and how C and nutrient cycles interact. They will also explore and evaluate mechanistic models of biogeochemistry. The knowledge and skills students acquire will improve their ability to evaluate, research, and manage forests and grasslands at different scales of time and space.

- **How will the content be organized?**

See the enclosed syllabus for course content and organization.

- **What other courses at UHM closely parallel the proposed course and in what way will the latter make a distinct contribution?**

There are several courses that are important prerequisites or that complement this course. TPSS 450-Nutrient Management of Soils and Plants, and CEE 424-Applied Hydrology provide important basic understanding of nutrient and water flows within and through terrestrial ecosystems. Other courses, such as NREM 610: Soil Formation and Classification, TPSS 610: Nutrition of Tropical Crops, TPSS 640: Advanced Soil Chemistry, and TPSS 650: Soil Plant Nutrient Relations cover similar topics as NREM 636. However, this partial overlap is common among the soils courses themselves, e.g. most of the courses listed above all cover in varying degrees soil nutrient availability and plant nutrition. The focus of each course is what is distinct. Students in NREM and the natural sciences need a course which allows them to explore and evaluate biogeochemical properties and processes outside of annual cropping or intensively-managed agricultural systems. NREM 636 will focus upon the natural biogeochemical dynamics of forest and grassland systems and also explore how various changes in land cover, land use, and management may affect ecosystem- and larger-scale processes. Finally, many students outside of the soil sciences may not have the time or interest to enroll in all of the courses listed above. NREM 636 gives them the opportunity to understand the issues in each of these disciplines that is relevant to natural systems and how these issues impact land use and management. Thus, although similar topics will be covered in NREM 636 as in other courses, the focus and scope of this course will be distinct from and complementary to them.

- **Where or how does the proposed course fit into the current and future curriculum?**

The NREM undergraduate and graduate curricula require and offer instruction in soils, water science, forestry, and conservation. This course is complements instruction in these areas. It could be taken by exceptional undergraduates and graduate students with an interest in the
nutrition, productivity, development, and management of natural terrestrial ecosystems. It is useful for developing guidelines for the sustainable production of pasture, wood products, or non-timber forest products. It can also help resource professionals minimize nutrient leaching, runoff, and water pollution by understanding the direct processes associated with nutrient cycles and the larger spatial and temporal contexts within which ecosystems are embedded. All these topics are relevant to NREM, and this course will provide a scientific framework for relating these diverse topics together.

• Why is the number of credits and level justified? Explain the prerequisites and the absence thereof.

The prerequisites for this course include NREM 203 or equivalent and TPSS 304 or equivalent and BOT 351 or equivalent. These prerequisites are necessary to ensure that students have a solid foundation in soil science and ecology. Higher-level UH courses or analogous courses from other universities will be considered as equivalents to the prerequisites.

The course is designed to be 3 credits. There will be two 50-minute lectures and one 50-minute discussion section.

The broad scope and topical approach of the proposed course may make it seem to be more appropriate as an undergraduate-level course. However, the course is designed to be taught at a graduate level, appropriate for master's students and well-prepared senior undergraduate students. Other courses, such as NREM 680: Forest Ecosystem Analysis and BOT 644: Ethnoecological Methods, are also broad topical courses offered mainly for master's level students that provide in-depth analysis at a graduate level. NREM 636 is patterned after these courses. Each week, students will be given readings from the primary scientific literature or books and other serials that are essentially compilations of the latest in scientific understanding. Students will be required to discuss these readings in class and make critical presentations of them. Although the class topics as listed in the syllabus can be taught at a basic level, the assumption will be that students have achieved this basic understanding. A deeper analysis of these topics, again relying upon primary scientific literature, will be the focus of the lectures and class discussions. Biogeochemistry is itself a broad and interesting field that cannot be fully covered in a single course. However, it is possible to provide graduate-level instruction in this topic as long as students have the appropriate background and interest.

• How will the course assist students to achieve the critical skills and competencies expected of CTAHR graduates?

This course will help students achieve several critical skills and competencies. Students will be given a diversity of assignments from critical reviews of scientific literature to data manipulation and evaluation to the use and evaluation of mechanistic simulation models. They will also be expected to lead and participate in weekly discussions of scientific literature, building their oral communication and critical thinking skills. The simulation modeling will help students build problem-solving skills and work together effectively in small groups. The class discussion will emphasize interpersonal interactions by challenging students to provide feedback, constructive criticism, and objective evaluations of other student’s presentations within a positive, respectful atmosphere. All this will require the building or strengthening of the personal characteristics
necessary to complete these various assignments and participate in small group work and class-
wide discussions.

- **How will students be evaluated?**

Students will be evaluated by the instructor on all their assignments, usually through written
feedback on their written and oral assignments. There will be two semester exams to check the
progress of student learning, and a final project that will allow the students to bring together all
the concepts and information during the semester into a comprehensive study and presentation.
Students will also be given the responsibility of evaluating each other during the weekly class
discussion, providing feedback and thereby learning more about not only how to give an
effective presentation but also how to evaluate scientific information.

- **What are the minimum qualifications for teaching this course? Is a qualified instructor
now available?**

The minimum qualifications for an instructor is someone with a Ph.D. in an ecological science
with a background in biogeochemistry. It is also important that the instructor have a record of
scientific research and publication in order to help students begin their journey toward becoming
effective scientists and managers. Such an instructor is now available. Dr. Travis Idol, assistant
professor in NREM, has the necessary minimum qualifications. The instructor's background
includes one or two graduate level courses in the following areas:

- Soil Genesis and Classification
- Soil Microbiology
- Forest Ecology
- Soil Physics
- Forest Soils
- Soil Chemistry
- Plant Nutrition

The instructor's research specialization is ecosystem nutrient cycling. He has experience working
in a variety of ecosystems from tropical dry and wet forests to temperate Mediterranean and
mesic forests. He has also given professional presentations on forest hydrology and the effects of
forest management on various ecosystem- and watershed-scale processes. The only obvious
weakness is that his background and research has not included studies of landscape- or larger-
scale processes which are relevant to terrestrial biogeochemistry. A curriculum vitae for Dr. Idol
is enclosed.

- **How will the course be financed, assuming no further cutbacks?**

Dr. Idol is already a faculty member in NREM. The course will require no out-of-the-ordinary
expenses for instruction. Thus, normal departmental allocations for instruction should be
sufficient to meet the financial needs of the course.

- **Has the course been offered before? Is there a demand for it?**

This course has not been offered before. Demand for this course comes mostly from the desire of
various faculty members in earth, plant, soil, and ecological sciences to have an integrative
cross-disciplinary course available for their students so they can effectively interact with
professionals in related disciplines about topics of mutual concern. A set of email
 correspondence with some of these faculty members is enclosed. Because this course has not
been offered before, it is difficult if not impossible to discern student interest. Although some
students may be aware of the field of biogeochemistry, many are likely not. Demand for this course will likely come, therefore, through the efforts of interested faculty in advising their students to enroll in the course.

It is possible that this course could be offered as a special topics course in order to evaluate the level of student interest. However, there is no official notification or advertisement of such courses. The course catalog does not list course titles for special topics course. This is a significant impediment to providing a realistic gauge of student interest. Given the desire of the instructor to offer this course regularly on an alternate year basis, it seemed prudent to propose it as a part of the regular curriculum rather than offer it initially just as a special topics course.

- **Is the course cross-listed with another department?**

  This course is not cross-listed with another department.
NREM 686: Terrestrial Biogeochemistry

Instructor: Travis Idol Contact Info: Sherman Lab 125
956-7508

Class Times: MW 1:30-2:20
Lab Time: 2 hrs, determined by class
Class Location:

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Pre-requisites: undergraduate ecology course, e.g., BIOL 265, BOT 351, 453/454 or equivalent and
undergraduate soils course, e.g., TPSS 304 or equivalent

Texts: Articles and book chapters assigned and copied as handouts;

Objective: To understand the major components and processes of terrestrial biogeochemistry, with
an emphasis on internal nutrient cycling, relationships of biogeochemistry to ecosystem
structure and function, and responses to changes in vegetation and climate.

Class Format: Two lectures and one discussion section.

Assignments: % of Grade
Weekly Article Reviews 20
Discussion Group Participation 20
Two In-Class exams 40
Final Project 20

Weekly article reviews are due in class on the Monday following the class discussion. For each article
reviewed, a pair of students will be assigned to lead the discussion, roughly following a set format
(described below). Discussion leaders will receive a participation grade based on the quality of their
facilitation of the discussion. Other students will be graded on their participation in the discussion.
Exam 1 will cover lecture and discussion material from Weeks 1-5; Exam 2 will cover Weeks 6-10. Exam
questions will require short essay answers. A study guide for each exam will be provided.
Instructions for the final project are described below.

Class Topics (by week)
1. Systems Ecology: how to think like a biogeochemist
2. Mineral Weathering and Soil Development
3. Atmospheric Nutrient Inputs: N-fixation, acid rain, and global dust movement
5. Nitrogen Cycling I: inputs, outputs, and internal cycling
6. Nitrogen Cycling II: relationship to organic matter dynamics (Exam 1)
7. Phosphorus Cycling I: inorganic fractions and soil development
8. Phosphorus Cycling II: organic fractions and P cycling
9. Modeling Biogeochemical Cycles I. the development of CENTURY, Biome-BGC, and TEM
10. Modeling Biogeochemical Cycles II: comparative analysis and applications to tropical environments
11. Comparative Biogeochemistry I: tropical vs. temperate ecosystems (Exam 2)
12. Comparative Biogeochemistry II: forests vs. grasslands
13. Watershed-Scale Biogeochemistry: the Hubbard Brook Experimental Forest
14. Global Climate Change: productivity, C sequestration, and biogeochemistry
15. Biodiversity: effects on biogeochemistry
16. Presentations of Final Projects
Article Reviews
When preparing to lead the discussion for a specific article or write an article review, keep in mind the following questions.

1. What are the authors’ main points in the article? What hypothesis are they testing, argument they are defending, or principle they are outlining? What background information has led them to this point?

2. What methods to the authors use to carry out their experiment? If a review article, what kinds of data or studies do they use to build their case? Are these appropriate and sufficient for their purpose?

3. What are the major findings of the study? Are they interpreted or discussed correctly and fairly?

4. What are the major conclusions of the study? Were the authors' initial hypotheses or arguments confirmed, refuted, altered in any way? Do their conclusions follow from the results? Do the authors suggest conducting the study differently or carrying out follow up research?

Discussion Sections
We will discuss a major scientific article covering novel research or reviewing important research related to that week’s class topic. One pair of students will be tasked with leading the class discussion of the article, based on the questions in the article review above. Discussion leaders will not be required to give their own answers to the questions but rather to ask questions of the other students in order to solicit their thoughts and evaluations. The discussion leaders should use student response as a way to guide the discussion toward what they think are the relevant and important issues. Thus, students should have read and attempted to understand the articles in order to meaningfully participate in the discussion. The discussion leaders must be prepared additionally to anticipate student response and therefore guide the discussion.

Final Project
The final project will be a paper and a presentation on a topic covered in class. You should select one or more of the topics covered in class as the basis for your project, but your specific topic should reach beyond the lectures and class discussion. You paper should include: a well-reasoned description/review of the topic, it’s importance to biogeochemistry, and how it intersects with other biogeochemical topics covered (or not covered) in class.
You should concentrate your sources on primary scientific literature. Review papers and technical book chapters are acceptable, especially as background material. Often, these papers contain a wealth of primary literature citations you can use for the rest of your project. Internet citations are not acceptable unless they are linked to specific peer-reviewed publications or official government reports. Use standard scientific journal formatting for your references list and for citations within the text. Please include your name on the cover page and number the pages of your write-up.
For the presentation, prepare a 15 minute summary of your topic, covering the major issues outlined above. You may use whatever presentation media you like: overheads, handouts, Powerpoint slides, etc. The final presentations will be given during the final week of class. The final paper or model write-up is not due until finals week.