NREM 691: Forest Nutrition and Biogeochemistry

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Academic preparation: an ecology course and a soils course.

Lecture Readings: (books on reserve at Sinclair Library)

Fisher RF and Binkley D. 2000. Ecology and Management of Forest Soils. Wiley & Sons, New York.

Schlesinger WH. 1997. Biogeochemistry: an Analysis of Global Change. Academic Press, San Diego, CA.

Vitousek PM. 2004. Nutrient Cycling and Limitation: Hawaii as a Model System. Princeton University Press, Princeton, NJ.

These are background readings for the lectures. They are not required but may be helpful if you are not familiar with the concepts being covered in class that week. Other background readings will be available either electronically or placed in the course binder in Sherman 201. Electronic copies will be posted at the Laulima website for this course (http://laulima.hawaii.edu).

Journal articles and other publications for the discussion session are required readings, as you will be graded on your write-up and participation in the discussion. A copy of readings will be available either electronically or placed in the course binder in Sherman 201.

Objectives:
1) Learn the basics of biogeochemistry and cycling of nutrients that commonly limit forest production, using Hawaii as a model system.
2) Understand forest nutrient limitations, plant responses, and effects on cycling processes.
3) Evaluate the effects of fertilization and nitrogen fixation on forest nutrition, biogeochemistry, and other ecosystem processes.

Class Format: Two 50-minute lectures and one 50-minute discussion section each week.

Assignments:	% of Grade
Article Reviews	25
Discussion/Group Participation	25
Mid-term exam (March 06, 2009)	25
Final Project	25

Article reviews are due in class at the beginning of the Friday class discussion session. 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.

The mid-term exam will cover lecture and discussion material from Weeks 1-8. A study guide will be provided.

Instructions for the final project are described below.

Article Reviews

When writing an article review or leading the discussion, address the following questions.

1. What are the authors' purpose and objectives for the study or article? What hypothesis are they testing, argument are they defending, or principle are they outlining? What background information has led them to this point?

2. What methods do 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 Sessions

We will discuss a couple of scientific articles covering novel research or reviewing important research related to that week's class topic. One student will be tasked with leading the class discussion of each article, based on the questions listed 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. I will lead the discussion session during the first week to provide a model for subsequent weeks.

Final Project

The final project will be a grant proposal to a major federal agency such as the EPA, USDA, NSF, NASA, etc. You may choose a program for graduate student proposals or for Ph.D. principal investigators. The topic of the proposal must be within some field of terrestrial biogeochemistry. Please check with me before deciding on your topic and the specific program.

You must follow the format of the program guidelines, including a budget and detailed budget justification, and all of the following, if required: *curriculum vitae*, current and pending support, and conflict of interest. If the program uses electronic forms rather than form-fillable Word or PDF documents, create your own simplified forms that includes the same information. Unless you plan to work with vertebrate animals, highly radioactive elements, or organisms with recombinant DNA, don't bother filling out certification forms. Also include a copy of the request for proposals and/or proposal guidelines from the program.

The proposal will be due during finals week. I will have examples of funded (and not funded) proposals available. I will also hand out a guide to successful proposal writing.

During the last week of class, you will give a 15-minute presentation to the class, summarizing your topic. You may use whatever presentation media you like: overheads, handouts, Powerpoint slides, etc.

Due Dates:

February 20, 2009	Project title and abstract
March 20, 2009	Outline of research approach
April 24, 2009	Draft proposal
May 13, 2009	Final proposal

Class Topics (by week)

Basics of Biogeochemistry

1. Systems Ecology: How to Think Like a Biogeochemist.
2. Origin of Soil Minerals and Weathering Reactions.
3. Soil Development and Biogeochemical Processes.
4. Nutrient Inputs to Terrestrial Ecosystems.
5. Nutrient Outputs from Terrestrial Ecosystems.

Forest Nutrient Cycling

6. Forest Nutrition and Nutrient Limitations.
7. Nutrient Use Efficiency: Adapting to Nutrient Limitations.
8. Integration of Energy, Carbon and Nutrient Cycles.
   Mid-Term Exam.
9. Nitrogen Cycling I: A Global Perspective.
10. Nitrogen Cycling II: Biogeochemistry at the Ecosystem Level.
11. Spring Break. No Class.
12. Phosphorus Cycling I: Inorganic and Organic Cycling Pathways
13. Phosphorus Cycling II: Plant Access and Uptake Mechanisms

Management Strategies to Enhance and Sustain Forest Nutrition

14. Fertilization I. Forms of Fertilizer, Application Methods, and Expected Responses.
15. Fertilization II. Effects on Ecosystem Processes.
16. Nitrogen Fixation. Effects on Forest Nutrition and Biogeochemistry.
17. Forest Harvesting: Effects on Nutrition and Biogeochemistry.
18. Finals Week: Presentations of Final Projects