ESPM 111: Ecosystem Ecology
Whendee Silver/Dennis Baldocchi
Spring 2007

Syllabus

**Course description**
This course will develop the principles of ecosystems ecology, with an emphasis on their application to terrestrial ecosystems. Ecosystem ecology involves the study of energy and material flows through both the living (plants, animals, microbes) and non-living (soils, atmosphere) components of ecological systems. We will study the major element cycles (carbon, nitrogen, phosphorus) and patterns of energy flow through ecosystems, including how those fluxes and their controls differ for different ecosystems. Our goal is to develop a solid understanding of the links between ecosystem structure and function. Thus we will focus on the logical connections among ideas so that complex processes can be understood from some basic concepts.

**Course grade**
In order to provide some experience in ecosystem analysis, five problem sets are required. Assignments will include a mix of data reduction and interpretation. These problem sets along with the case studies and explorations (typically presented in Fridays' lecture) will form the topics for the discussion section. **It is imperative that you actively participate in discussion sections.** To learn ecosystem ecology, you need to practice the specific application of concepts described in lecture. Assignments are due in class on Friday, one week from the date assigned. Late assignments will be accepted the following Monday in class for a maximum of 50% credit. No late assignments will be accepted past Monday. Graded assignments will be returned to students during section.

There will be a Midterm and Final exam. Grades will be calculated as follows:

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|---|---|
| Homework assignments: | 30% |
| Midterm: | 35% |
| Final: | 35% |

**Instructor**s

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**Lecture Outline: Before Spring Break**

| Week | Date | Lecture Topic | lead | Reading |
|---|---|---|---|---|
| 1 | W Jan 17 | L1 Introduction: overview and course mechanics | WS/DDB | Chapin et al. 1996 |
| | F Jan 19 | L2 The ecosystem concept/scaling | DDB | Chapter 1; Brown et al 2002 |
| 2 | M Jan 22 | L3 History of ecosystem ecology | WS | Chapter 1 |
| | W Jan 24 | L4 Climate and Atmosphere | DDB | Chapter 2 |
| | F Jan 26 | L5 Ecosystem-Climate Interactions | DDB | Chapter 2 |
| 3 | M Jan 29 | L6 Geology and Soil Development | WS | Chapter 3 |
| | W Jan 31 | L7 Soils | WS | Chapter 3 |
| | F Feb 2 | L8 State factor analysis of ecosystems: a virtual hike through the ecological staircase | WS | |
| 4 | M Feb 5 | L9 Ecosystem Structure and Function | DDB | Chapter 4 |
| | W Feb 7 | L10 Energy | DDB | Chapter 4 |
| | F Feb 9 | L11 Water & Ecohydrology | DDB | Chapter 4 |
| 5 | M Feb 12 | L12 Soil Biology (Mary Firestone) | WS | |
| | W Feb 14 | L13 Carbon I, Principles of Carbon cycle | DDB | Chapter 6/Ch 15 |
| | F Feb 16 | L14 Carbon II, Ecophysiology of leaves | DDB | Chapter 5 |
| 6 | M Feb 19 | No Class (Holiday) | | |
| | W Feb 21 | L15 Respiration and Decomposition | WS | Chapters 7 |
| | F Feb 23 | L16 Decomposition II | WS | |
| 7 | M Feb 26 | L 17 Production and carbon balance of plant stands | DDB | Chapter 6 |
| | W Feb 28 | L18 Review for Midterm #1 | WS/DB | |
| | F Mar 2 | L19 Midterm #1 | | |
| 8 | M Mar 5 | L20 Remote Sensing of Ecosystem Ecology, on towards Global Ecology | DDB | Running et al, 2004 |
| | W Mar 7 | L21 Nutrient Cycling I | WS | Chapters 8 and 9 |
| | F Mar 9 | L22 Nutrient Cycling II | WS | Chapters 8 and 9 |
| 9 | M Mar 12 | L23 Nutrient Use Efficiency | WS | Chapter 9 |
| | W Mar 14 | L24 Nitrogen and Phosphorus | WS | Chapter 9 |
| | F Mar 16 | L25 Case study: Nutrient limitation to terrestrial ecosystems: examples from Hawaii | WS | Aber and Melillo Chapter 22 |
| 10 | M Mar 19 | L26 Nitrogen II | WS | Chapter 9 |
| | W Mar 21 | L27 Nitrogen III | WS | |
| | F Mar 23 | L28 Case Study: Nitrogen Deposition | WS | Aber, et al. 1998 |

**Lecture Outline: After spring break**

| Week | Date | Lecture topic | | Reading |
|---|---|---|---|---|
| 11 | M Mar 26 | Spring Break | | |
| | W Mar 28 | Spring Break | | |
| | F Mar 30 | Spring Break | | |
| 12 | M Apr 2 | L29 Ecosystem development during Primary and Secondary succession | DDB | Chapter 13 |
| | W Apr 4 | L30 Ecosystem Dynamics | DDB | Chapter 13 |
| | F Apr 6 | L31 Case study oak Savanna (Dennis Baldocchi) | DDB | |
| 13 | M Apr 9 | L32 Biodiversity I: Meaning and measures of biodiversity | WS | Chapter 12 |
| | W Apr 11 | L33 Biodiversity II: Consequences for ecosystem function | WS | Chapter 12 |
| | F Apr 13 | L34 Impacts of disturbance on ecosystems | WS | |
| 14 | M Apr 16 | L35 Landscape patterns in ecosystem structure and function: Resource gradients | DDB | Chapter 14 |
| | W Apr 18 | L36 Modeling as an integrative Ecosystem Tool | DDB | |
| | F Apr 20 | L37 Global biogeochemical cycles | WS | Chapter 15 |
| 15 | M Apr 23 | L38 Global climate change | DDB | IPCC 2007 Summary |
| | W Apr 25 | L39 Ecosystems and Environmental Change<br>Effects of T, $CO_2$, ppt, O on ecosystem function and vegetation dynamics, part 1 | DDB | |
| | F April 27 | L40 Ecosystems and Environmental Change<br>Shifts in ecosystem function and vegetation dynamics, part 2 | DDB | |
| 16 | M April 29 | L41 Restoration Ecology | WS | |
| | W May 2 | L42 Summary: Ecosystem sustainability and the future: Human as THE keystone species | DDB/WS | |
| | F May 4 | L43 Review for Midterm #2 | | |
| 17 | M May 7 | L44 Midterm #2 | | |

**Readings: Texts**

Chapters without authors refer to chapters in the textbook: Chapin, F. S. III, P.A. Matson, and H. A. Mooney, 2002. Principles of Terrestrial Ecosystem Ecology. Springer-Verlag, New York

Aber, J. and J. Melillo. 2001. Terrestrial Ecosystems. 2nd edition..

Brady, N.C. 1990. The Nature and Property of Soils. 10th edition. MacMillan Publishing, New York and London.

Schlesinger, W.H. 1997. Biogeochemistry. Academic Press. San Diego and London.

**Readings: Journal Articles**

Aber, J., McDowell, W., Nadelhoffer, K., Magill, A., Kamakea, M., McNulty, S., Burrie, W., Rustad, L., and Fernandez, I., 1998, Nitrogen Saturation in Temperate Forest Ecosystems. Bioscience, **48** (11): 921-934.

Barford, C. C., S. C. Wofsy, M. L. Goulden, J. W. Munger, E. H. Pyle, S. P. Urbanski, L. Hutyra, S. R. Saleska, D. Fitzjarrald, and K. Moore. 2001. Factors controlling long- and short-term sequestration of atmospheric CO2 in a mid-latitude forest. Science **294**:1688-1691.

Brown JH, Gupta VK, Li BL*, et al.* (2002) The fractal nature of nature: power laws, ecological complexity and biodiversity. *Philosophical Transactions of the Royal Society of London Series B-Biological Sciences* **357**, 619-626.

Chapin, F. S. I., M. S. Torn, and M. Tateno. 1996. Principles of ecosystem sustainability. American Naturalist **148**:1016-1037.

Clark, D. A., S. Brown, D. W. Kicklighter, J. Q. Chambers, J. R. Thomlinson, and J. Ni. 2001. Measuring net primary production in forests: Concepts and field methods. Ecological Applications **11**:356-370.

Hairston, N. G., F. E. Smith, and L. B. Slobodkin. 1960. Community structure, population control, and competition. American Naturalist **94**: 421-425.

Huston, M. A. 1997. Hidden treatments in ecological experiments: Re-evaluating the ecosystem function of biodiversity. Oecologia, Berlin **110**:449-460.

IPCC, 2007, Climate Change 2007: The Physical Science Basis, Summary for Policymakers.

Parton, W., Silver, W., Burke, I.C., Gassens, L., Harmon, M.E., Currie, W.S., King, J.Y., Adair, E.C., Brandt, L.A., Hart, S.C., and Fasth, B., 2007, Global-Scale Similarities in Nitrogen Release Patterns During Long-Term Decomposition, *Science*, **315**: 361-364.

Ryan, M. G., Phillips, N., and Bond, B.J., 2006. The Hydraulic Limitation Hypothesis Revisited, *Plant, Cell and Environment* **29**:367-381.

Running S, Nemani R, Heinsch F*, et al.,* 2004, A continuous satellite-derived measure of global terrestrial primary production. *BioScience* **54**, 547-560.

Stephenson, N. L. 1990. Climatic Control of Vegetation Distribution the Role of the Water Balance. American Naturalist **135**:649-670.

Tilman, D., and J. A. Downing. 1994. Biodiversity and stability in grasslands. Nature **367**:363-365.

**Course Website**
http://espm.berkeley.edu/classes/espm-111/