Ecosystem Science & Sustainability
BES 551 - 3 credits
Spring 2018

Instructor:
Dr. Austin Humphries
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Office Hours by appointment only

Meeting Time and Location:
Tuesday and Thursday, 12:30 - 1:45pm in CBLS room 252

Catalog Description:
Fundamental principles of systems modeling, linking natural and human infrastructure, processes, ecosystem dynamics with focus on global change; creating innovative methods to frame the complexity of designing more sustainable systems.

Course Narrative:
Problems are often addressed by utilizing easy and comfortable approaches to obtain simple solutions. However, such approaches are often far from effective in dealing with complex, dynamic, and diverse problems in ecosystems that are undergoing rapid change. The goal of this course is to move the focus from elements of a problem to *recognizing patterns and interrelationships (i.e. feedbacks)*, and learning how to design and communicate a more effective, efficient, and creative system solution(s).

Course Objective:
Ecosystem science is an evolving discipline that focuses on interactions and transactions within and between biological and ecological systems, as well as social and economic systems, and is especially concerned with the way the functioning of ecosystems can and are influenced by humans. The purpose of this course is to engage in the scientific basis, conceptual framework, principles, and approaches of ecosystem science by applying general systems theory to ecology and real-world problem solving. This approach considers external influences such as economics that usually fall outside the bounds of ecology and uses energy as a common currency. We will use case studies from coupled human-natural systems around the world to focus on issues of sustainability.

Learning Outcomes:
By the end of the course, you will be able to:
(1) identify and describe major environmental and social components that underpin sustainability,
(2) explain the principles of systems ecology and the theoretical background,
(3) build causal diagrams and system models to understand interactions and feedbacks, and
(4) apply modeling frameworks to a case study of your choice and design appropriate solution(s).

Teaching and Learning Approach:
I believe the purpose of higher education is not to demonstrate my expertise to you as students, but rather help you build your own expertise. To do that effectively, I let go of authority, of the concept that

I am the exclusive purveyor of content you need and cannot get without my tutelage. In other words, I have to give up power. Therefore, I think of “my class” in the sense of being a steward rather than sole proprietor. This doesn’t mean that I abandon every scintilla of lecture or that I will scrap the structure of the course. But it does mean that I have made the choice to quit “continuous exposition by the teacher” in favor of much more interaction, discussion, and collaboration.

This course is designed to foster interdisciplinary, integrative, and systems thinking for viewing and solving problems in ecosystems. Classes are open-ended, student-driven, and often involve group-based learning and discussion. From you as a graduate student, the course requires enthusiasm for grappling with complex interactions that span spatial and temporal scales. Furthermore, it requires initiative and a willingness and ability work in groups and discuss material openly. Many students enjoy these challenges but some do not. If you want to be told what to do at all times, are uncomfortable engaging with problems that do not have a right or wrong answer, or dislike group work, then this course may not be for you. As a student in this course, you should expect to invest a considerable amount of time outside of class with reading assignments as well as with the project.

Course Requirements and Grading:
This course is based on discussion and synthesis of material. Two take-home, essay-based exams will be administered during the semester, and grading will be based on these (25% each), class participation and homework (25%), and the group project (25%). For the project, if you work in a group you will receive an individual grade based on your contribution as viewed by group participants (12.5%), as well as a group grade (12.5%), to form a composite individual score. You are expected to read assigned material and be prepared for active participation in class.

Grade scale: A, 93-100; A-, 90-92; B+, 87-89; B, 83-86; B-, 80-82; C+, 77-79; C, 73-76; C-, 70-72; D+, 67-69; D, 63-66; F, 62 or below.

Term Project:
The project provides a framework and tools for analyzing and understanding coupled human-natural systems using case studies. After completing this project, you will be able to use the systems modeling framework and apply it to other scenarios, making it a transferable skill. I find this approach is especially good when developing and leading a team that needs to focus on a large problem. Using a specific case study of your choosing, you will: (1) introduce the case study giving background and context to the system, (2) produce a white paper and detailed sub-system model of the case study with all components, (3) combine sub-system models to create a synthesized general systems model of the case study, (4) identify and describe input/output interactions and leverage points in the master model by graphically representing flow dynamics, (5) add an input or change an existing input to reflect a hypothesized aspect of global change (e.g., increases in carbon dioxide, warming temperatures, sea level rise, climate change, invasive species, storm frequency and magnitude, globalization), and (6) provide a potential solution(s) derived from the systems model with explicit acknowledgement of trade-offs and interactions within the model.

Sakai:
The Sakai site for this course will contain the syllabus, all presentations given in class, homework assignments, readings, and any other course materials. Any announcements for the course will also be

posted on the site, so please be sure that you check your associated email. It is your responsibility to check Sakai before emailing me about assignments.

COURSE POLICIES

Late assignments: Late work will be accepted and read but for each calendar day they are late, your grade will be reduced by 10%. Electronic submissions will not be accepted.

Email: Email messages will be responded to within 48 hours of being received (not including weekend hours). When relevant, student questions about similar topics/concerns may be answered in one group email (e.g., on Sakai). Questions about course material may also be addressed in class, rather than through an email, though in this case the student who sent the email will be notified as such.

Attendance: Attendance is mandatory. You are allowed only 2 absences during the semester. Please arrive to class on time. If you arrive to class more than 10 minutes late, you will be marked absent for that meeting. Missing class will negatively affect your grade and if you miss more than 2 classes, you will receive a zero for any homework or assignments that were due the day you were absent and receive negative marks for participation (because you weren't there to participate!).

Technology: Out of respect for fellow classmates, cell phone use *will not be allowed* during class. I request, therefore, that you turn off/silent mode your cell phones (or, *if* you are expecting an important call, set them to vibrate for the duration of section) and place them out of view – this means in your bag and *off your desk*. Laptop computers will only be allowed by special permission or when we are using them for modeling – bring them to class with you. Notes must be taken by hand unless you are unable to take notes. If you are determined to work on a laptop in class, you should meet with me to discuss proper computer usage. Proper usage includes closing all non-course related pages and tabs, viewing only the course readings/lecture slides.

Discussion: Throughout the course of the semester we will be addressing a variety of issues which people will have diverse opinions on. It is critical that we respect one another's thoughts, and address comments and ideas we may differ with and not the person that holds them. No demeaning or threatening language will be tolerated. Any student who feels uncomfortable in class should contact me outside of class to discuss the issue and to find an adequate resolution.

Religious Holidays: It is the policy of the University of Rhode Island to accord students, on an individual basis, the opportunity to observe their traditional religious holidays. Students desiring to observe a holiday of special importance must provide written (email) notification to the instructor.

Readings (in the order they appear during semester):

Steffen, W., Persson, Å., Deutsch, L., Zalasiewicz, J., Williams, M., Richardson, K., ... & Molina, M. (2011). The Anthropocene: From Global Change to Planetary Stewardship. *Ambio*, *40*(7), 739-761.

Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., ... & Folke, C. (2015). Planetary Boundaries: Guiding Human Development on a Changing Planet. *Science*, *347*(6223), 1259855.

Collins, S. L., Carpenter, S. R., Swinton, S. M., Orenstein, D. E., Childers, D. L., Gragson, T. L., ... & Knapp, A. K. (2011). An integrated conceptual framework for long-term social–ecological research. *Frontiers in Ecology and the Environment*, *9*(6), 351-357.

Steneck, R. S., Hughes, T. P., Cinner, J. E., Adger, W. N., Arnold, S. N., Berkes, F., ... & Olsson, P. (2011). Creation of a Gilded Trap by the High Economic Value of the Maine Lobster Fishery. *Conservation Biology*, *25*(5), 904-912.

Odum, H. T. (1994). *Ecological and General Systems: An Introduction to Systems Ecology*. Univ. Press of Colorado.

Odum, H. T. (1973). Energy, ecology, and economics. *Ambio*, 220-227.

Odum, H. T., Odum, E. P. (2000) The Energetic Basis for Valuation of Ecosystem Services. *Ecosystems*, 3:21-23.

Kirkwood, C.W. (1998). System Dynamics Methods: A Quick Introduction. Creative Commons License. http://www.public.asu.edu/~kirkwood/sysdyn/SDIntro/ch-1.pdf

Dr. Seuss. (1971). *The Lorax*. Random House Children's Books.

Schedule and Assignments:

Theme	Date	Class topic	Reading / Assignment
Sustainability Concepts	23-Jan	No class	NA
	25-Jan	No class	NA
	30-Jan	No class	NA
	1-Feb	The Anthropocene	Steffen et al. 2011
	6-Feb	Planetary boundary concepts	Steffen et al. 2015
	8-Feb	Social-ecological systems	Collins et al. 2010
	13-Feb	Project – introduction	Project overview
	15-Feb	Resilience and social traps	Steneck et al. 2011
	20-Feb	Project – background	Project Task #1
	22-Feb	Project – sub-system model	Take-home Exam #1 given
Systems Modeling	27-Feb	Intro to systems ecology	Project Task #2
	1-Mar	Energetics concepts	Odum 1994; Take-home Exam #1 DUE
	6-Mar	No class	NA
	8-Mar	Energetics modeling	Odum 1973
	20-Mar	Guest lecture – Dr. Dan Campbell	Odum & Odum 2000; Campbell 2008, 2014
	22-Mar	Causal loop modeling	Kirkwood 1998
	27-Mar	No class	NA
	29-Mar	Systems modeling application	Dr. Seuss 1971
	3-Apr	Project – peer-review	Project Task #3; Take-home Exam #2 given
Application to Problem	5-Apr	Project – mental modeler	Project Task #4
	10-Apr	Project – model dynamics	Take-home Exam #2 DUE
	12-Apr	Project work – stressor	Finish in-class Model Dynamics exercise
	17-Apr	Project work – solution	Project Task #5
	19-Apr	Project work – finish	Project Task #6
	24-Apr	Project presentations	PowerPoint presentation
	26-Apr	Project presentations	PowerPoint presentation