Course Syllabus - Ecological resilience and ecosystem management (ENV 823)

3 Credits – Spring 2013
Class meetings: M W 10:05-11:20AM
Classroom: LSRC A109
Course website: sakai.duke.edu

Instructor: Dr. Jim Heffernan
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Course objectives:

Why do some ecosystems respond smoothly to changes in environmental drivers, while others change suddenly? When and why are some changes irreversible? This course will provide an introduction to concepts of ecological resilience and its application to the management of ecological systems, and is intended for both PhD and MEM students. The course does not require formal mathematical training, but students are expected to engage the models used in this field.

By the end of the class, students should:

-understand key concepts of ecosystem dynamics – equilibria, chaos and oscillations; positive and negative feedbacks; critical transitions, meta-stability, and other non-linear dynamics;
- know the major physical, biological, and social feedbacks that govern ecosystem behavior, and their importance in different ecosystems
- be familiar with modeling and empirical approaches to assess resilience of ecosystems
- be able to apply systems thinking to novel situations as a guide to effective environmental decision-making

Course materials:

- Required Text: Scheffer, M. Critical Transitions in Nature and Society. 2009. Princeton University Press, Princeton, NJ.
- Readings from the primary literature (see lecture schedule) will be distributed via Sakai.

Course Structure:

This course consists of lectures, discussion, and a group research project. Lectures will address fundamental theory, case studies, and empirical approaches used to understand the resilience of basic ideas, observations, and approaches to understanding the ecology of flowing water systems. Semi-weekly discussions during lecture will provide students with opportunities to reflect on, critique, and synthesize material presented in lecture; most discussions will focus on the application of important concepts to detection and management of non-linear behaviors in ecosystems. My expectation is that students will arrive in class having read assigned chapters and papers, so that lecture can focus on particularly difficult or significant concepts. Short papers based on the assigned primary literature will be the major form of assessment of student learning.

Group projects will focus on synthesis of existing studies of ecological resilience and multiple states, and may be quantitative or qualitative. For example, what proportion of studies that nominally address ecological resilience actually test for the existence of multiple states? How often do various feedbacks (trophic, biogeochemical, etc.) result in multiple states? The schedule for development and execution of these projects encourages incremental progress and provides numerous opportunities for feedback from the instructor and fellow students.

Class Schedule

Week	Section	Date	Topic	Readings	Assignment
1	Theoretical and empirical foundations	9-Jan	L: Course introduction		
2		14-Jan	L: Thresholds,regime shifts, and alternative stable states	Ch. 1, 2; Scheffer et al. 2001;	
		16-Jan	**D: Resilience**	Gunderson 2000; Carpenter 1998; Suding et al. 2008;	
3		21-Jan	No Class – MLK Day		
		23-Jan	L: The Quantitative Tool Box	Ch. 3, 4; May 1973; Holling 1977	Synthesis 1 due (10 pts)
4		28-Jan	**D: Testing for alternative states**	Scheffer and Carpenter 2003; Schroder et al. 2005;	
		30-Jan	**D: Are alternative states "real"?**	Ch. 6; Beisner et al. 2003; Groffman et al. 2006	
5	Case Studies: Ecosystems and Feedbacks	4-Feb	L: Biotic and Abiotic Feedbacks	Ch. 5; Van de Koppel et al. 2001; Silliman et al. 2006	
		6-Feb	**D: Shallow lakes and biogeochemical feedbacks**	Scheffer 1993; Ch. 7; TBD	Synthesis 2 due (15 pts)
6		11-Feb	**D: Coral reefs and trophic feedbacks**	Bruno et al.; Mumby et al. 2007;Ch. 10	
		13-Feb	**D: Fisheries and the Allee affect**	Ch. 10; Myers et al. 1997; Worm et al 2009	Group project draft proposals due (10 points)
7		18-Feb	**D: Savannahs and fire feedbacks**	Ch. 11; Staver et al. 2011;TBD	
		20-Feb	*Group Project Proposal Presentations* (10 pts)		
8		25-Feb	L: Connectivity, Spatial Feedbacks and Pattern Formation	Mumby and Hastings 2008; Rietkirk and van de Koppel 2008	
		27-Feb	**D:Desertification and hydrologic feedbacks**	Noy-Meier 1973; Rietkirk et al. 2004; D'Odorico	Synthesis 3 due (15 pts)
9		4-Mar	**D: Wetlands and geomorphic feedbacks**	Larsen et al. 2011; Eppinga et al. 2010	
		6-Mar	**D: Evolution and ecosystem self-organization**	Ch. 9; Corenblit et al. 2009; Holling 1988	Full proposals due (20 points)
		11-Mar	No Class - Spring Break		
		13-Mar			
10		18-Mar	**D: A general theory of alternative states?**	Didham et al. 2005; 2007; Wang et al. 2006	
	Managing for resilience	20-Mar	L: Detecting and predicting thresholds and regime shifts	Ch. 14, 15; Thrush et al. 2009	
11		25-Mar	**D: Adaptive Management**	Ch. 17; Walters and Holling 1990; Pahl-Wostl 2008;	Synthesis 4 due (15 pts)
		27-Mar	**D: Optimization and Resilience**	Holling and Mephe 1996; Peterson et al. 2003	
12		1-Apr	**D: Leading indicators of regime shift**	Contamin and Ellison 2009; Carpenter et al.; Dakos et al. 2010	Project update due (10 points)
	Resilience of socio-ecological systems	3-Apr	**D: Thresholds in global environmental change**	Ch.8; Lenton et al. 2008; Rockstrom et al. 2009; Hirota et al. 2011	
13		8-Apr	L: Resilience of socio-ecological systems	Ch. 12; Turner et al. 2003; Holling 2001	Synthesis 5 due (15 pts)
		10-Apr	**D: Resilience of Institutions**	Anderies et al. 2007; Ostrom 2012	
14		15-Apr	**D: Sea level rise and coastal resilience**	Craig 2010; Kirwan et al. XXXX; TBD	
		17-Apr	**D: Resilience and Sustainability**	Ch. 16; May et al. 2008; Dietze et al. 2003	Final Paper Due (30 pts)
Finals		1-May	*Project Presentations* (20 pts) **(9-12 AM)**		Synthesis 6 due (20 pts)

Grades

The grade you earn is based on accumulation of points from writing assignments, lab reports, and class participation as follows:

- Short papers (6 assignments [10-20 points each]): 100 pts
- Group projects (draft and final proposals, presentations, and papers): 100 pts total
- Class discussion participation and lead: 50 pts

Grades are assigned based on standard 100 pt scale:
A – 90-100% (225-250 pts)
B – 80-90% (200-225 pts)
C – 80-90% (175-200 pts)
D – 60-70% (150-175 pts)
F – 0-60% (0-150 pts)

Expectations (mine and yours)

I expect students to attend class, to be prepared, and to participate actively in discussions. Respectful treatment of peers, the TA, and myself is expected at all times. Use of cell phones and other mobile devices for any use other than those necessary for class is disruptive and not tolerated. Assignments should be turned in on time and neatly prepared. I expect students to ask for help when they are struggling with material, and to raise questions in time to obtain appropriate assistance. Honesty and integrity of all submitted work, as outlined in the Duke Honor Code, is expected at all times.

You can and should expect me to prepare interesting and informative lectures and discussions. I will be available during my posted office hours, and am happy to make appointments at other times as necessary. I can be reached electronically by email and via the class website. You should expect me to respond (at least by acknowledging your question) within 24 hours; full responses to more complicated questions may take a bit longer. My intent is to treat you all as colleagues – we are all learning together – and to make this class worthwhile and fun. Hold me to both.