Advanced Ecology Syllabus: Fundamentals of Ecological Modelling

Bio 534 & Bio 534L

Stuart R. Borrett

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Course Description

Scientists investigate the dynamics of complex systems with quantitative models, employing them to synthesize knowledge, to explain observations, and to forecast future system behavior. In this course, we introduce the basic principles of ecological modeling including model conceptualization, construction, analysis, use and abuse. Students will develop knowledge and skill through a sequence of laboratories that culminate with the design, implementation, and evaluation of their own process-based simulation model. At the completion of the course, successful students will be able (1) to use modeling knowledge to construct simulation models, and (2) to comprehend and evaluate models presented in the literature.

Course Time and Location

Part	Days	Time	Location
Class Meetings:	Tuesday – Thursday	12:30–1:45 pm	Friday Hall 1044
Laboratory:	Thursday	2:00–4:50 pm	Friday Hall 1044

Contact Information

Stuart R. Borrett

Office:	Friday Hall 1057
Office Phone:	910.962.2411
Email*:	borretts@uncw.edu
Office Hours:	Tuesday, 2:00 pm – 4:30 pm, or by appointment

* I will respond to email as soon as possible, but please allow 24 hours for a response. If you require a faster response you may call my office phone.

Texts and Readings

We will read material from a variety of sources including textbooks and primary literature. The required text is N. Gotelli's (2008) **A Primer of Ecology** (4^{th} ed), Sinauer, MA, which should be avilable in the bookstore. Other assigned readings will be available as PDFs from the course website which can be found at http://people.uncw.edu/borretts/teaching.html. I will also post lecture notes and laboratory assignments on the website.

In addition to the assigned readings, I recommend the following texts for further exploration.

Ecological Modeling

Haefner, J.W., 2005. Modeling Biological Systems: Principles and Applications. (2nd ed.). Springer. [**MBS**]

Jørgensen, S.E. and Bendoricchio, G., 2001. Fundamentals of Ecological Modelling. (3rd ed.). Elsevier, Amsterdam. [**FEM**]

Ellner, S.P. and Guckenheimer J. 2006. Dynamic Models in Biology. Princeton University Press, NJ. [**DMB**]

Gurney, W.S.C. and Nisbet, R.M., 1998. Ecological Dynamics. Oxford University Press, NY.

Kot, M., 2001. Elements of Mathematical Ecology. Cambridge University Press, Cambridge, U.K..

Hilborn, R. and Mangel, M., 1997. The Ecological Detective: Confronting Models with Data. Princeton University Press, Princeton, N.J.

Ford, E.D., 2000. Scientific Method for Ecological Research. Cambridge University Press, Cambridge; New York. (see especially chapter 12)

Kingsland, S.E., 1995. Modeling Nature: Episodes in the History of Population Ecology. The University of Chicago Press, Chicago, Il.

Programming with R

Dalgaard, P. 2002. Introductory Statistics with R. Springer, New York, NY.

Maindonald, J. and Braun, J. 2007. Data Analysis and Graphics Using R: An Example-Based Approach. (2nd ed.) Cambridge University Press, Cambridge.

Venables, W.N., Smith, D.M., and the R Development Core Team. 2004. An Introduction to R. Network Theory Ltd., Bristol, U.K..

Course Goals

Through your experiences in Bio534 you will have the opportunity to:

- Construct and use process–based simulation models to evaluate ecological hypotheses;
- Understand the fundamental concepts in ecological modeling and their application;
- Interpret and analyze primary literature that uses models;
- Communicate modeling results to a scientific audience; and
- Become more effective, self-assessing, and self-directed learners.

What are your personal goals for Bio534?

- What do you want to know and be able to do by the end of this course?
- Do you feel prepared to achieve these goals?
- How will you attempt to achieve these goals?

Faculty Goals

My goals for this course are best stated by Ebert–May and Tsao (2007) as follows:

- As a facilitator I will encourage and create a learning environment in which all students are actively engaged in the process of scientific thought and reasoning.

- I will guide your development toward higher-order thinking and reasoning skills so you can successfully explore and demonstrate achievement of each of the goals above.

Schedule and Assignments

The initial schedule and assignments for lecture and laboratory are listed in Tables 1 and Table 2, respectively. This is an initial plan that I expect we will adapt as the course progresses. However, I will work not to shift the dates of the exams or assignment due dates unless absolutely necessary and we all agree.

The course is designed so that we cover the core concepts. Then, the latter part of the course is comprised of mini-lectures on advanced topics (topics to be determined as a class) and reading, discussing, and evaluating primary literature.

About the Course

In class meetings there will be lectures, readings, story-telling, student presentations, discussions, problem–solving, and more. I expect you to work cooperatively in our meetings as well as study together outside of class. Together, we will uncover much about ecology and ecological modeling. I will strive to make the class as active and cooperative as possible.

You are expected to read assignments ahead of the class meeting scheduled to address that topic. In class, we will often discuss only parts of a chapter or advanced topics that build upon the reading. Thus, we may not review all of the reading in class, but you remain responsible for this material for quizzes and exams. If you don't read prior to class and laboratory you should not be surprised if you become lost during the discussions and activities. You are expected to accept responsibility for your own learning.

Assessment

Ecological modeling requires active engagement and inquiry to learn. Therefore, material in class meetings is integrated with the laboratory exercises. The laboratories build in complexity allowing you to develop your skills with programming, mathematics, and ecological modeling.

Lecture work will be assessed following the scheme in Table 3. Please notice that the course grade is dominated by two short quizzes (together worth 30%) that will cover the concepts and theory we discuss in the first part of the class and a final research project in which you will design and implement a simulation model to address an ecological topic of your choice (60%).

Laboratory will be assessed using the scheme in Table 4. The laboratory exercises will culminate in a brief summary of the activities. I encourage you to work in small teams to complete the laboratories, but everyone will write their own summaries, as this will allow me to assess your individual work and written communication skills. Also, a quarter of your laboratory grade is based on the oral presentation of your course project.

Table 1: Lecture Schedule

MTG#	Month	Day	Major Topic	Class Meeting	Reading	Items Due
1	Aug.	21	Introduction	Introduction		
2		26		Models and Science	Jackson et al. 2000	
3		28		Model Type & Use	selected papers	
4	Sept.	2		System Conceptualization	FEM Ch4	
5		4	Empirical Models	Simple Linear Regression	TBD	Conceptualization Homework
6		9	Process Models I	Single State Variable Models: Bathtubs and Populations	Gotelli Ch1	
7		11		Population Regulation: Intraspecific competition	Gotelli Ch2	
8		16		Structured Population Models	Gotelli Ch3	
9		18		Catch-up & **Quiz 1**		
10		23	Process Models II	Competition (interspcific)	Gotelli Ch5	
11		25		Predation	Gotelli Ch6	
12		30		Reading Discussion	Fussman et al. 2000: Shertzer et al. 2002	
13	Oct.	2		Modifying control functions and Wiegert's correction factor		
		7			*Fall Break*	
14		9		Project Topic Selection Presentations		Project T1: Topic Selection
15		14	Process Models III	Three State Variable Models: Putting it all together		
16		16	Models and Data	Environmental Forcing, Parameterization, and Calibration	CH9: DMB	
17		21	Model Evaluation	Model Evaluation	Oreskes 1994; Ginzburg 2003	
18		23		Model Analysis	Reckhow (1994)	
19		28		Catch-up & **Quiz 2**		Project T2: Proposals
20		30	Advanced Topics	PD1		
21	Nov.	4	and Paper Discussions	AT1: Ecosystem Network Analysis I	Fath (1998)	
22		6		AT1: Ecosystem Network Analysis II		
23		11		AT2: Inductive Process Modeling		
24		13		AT/PD		
25		18		AT/PD		
26		20		AT/PD		
27		25		AT/PD		
		27			*Thanksgiving*	
28	Dec.	2		Course Summary		Project T3: Final Report
29		11	11:30-5 pm	Final Exam		Project T4: Presentation

Table 2: Laboratory Schedule

MTG#	Month	Day	Laboratory Topic	Reading	Item Due
1	Aug.	21	Lab 1: Getting Started with R	DMB Lab Manual	
		26			Lab 1 Summary
2		28	Lab 2: Math Warm Up	Mangle 2006 (Ch1)	
	Sept.	2			Lab 2 Summary
3		4	Lab 3: Simulation Techniques, Errors and Chaos	MBS-Ch6; Otto & Day, pp 110-128	
		9			
4		11	. . .continued		
		16			Lab 3 Summary
5		18	Lab 4: Single State Variable Models		
		23			
6		25	. . .continued		
		30		Lab 4 Summary	
7	Oct.	2	Lab 5: Two State Variable Models		
		7			
8		9	. . .continued		
		14			Lab 5 Summary
9		16	Lab 6: Confronting Models with Data		
		21			Lab 6 Summary
10		23	Lab 7: Three state variable models		
		28			
11		30	. . .continued		
	Nov.	4			Lab 7 Summary
12		6	Field Trip: System conceptualization		
		11			
13		13	Work on Final Projects		
		18			
14		20	Work on Final Projects		
		25			
		27			
11:30-5	Dec.	11	Project Task 4: Final Presentation		Project T4: Presentation

Table 3: Lecture Assessment

Activity	**Course Weight (%)**
Participation and Homework	10
Quiz I	15
Quiz II	15
Final Project	
Task I: Topic Selection	5
Task II: Proposal	15
Task III: Final Report	40
total	100

Table 4: Laboratory Assessment

	Laboratory	**Weight (%)**
1	Introduction to R	5
2	Math Warm Up	5
3	Simulation Techniques, Erros, and Chaos	10
4	Single State Variable Models	15
5	Two State Variable Models	20
6	Confronting Models with Data	5
7	Three State Variable Models	25
8	Final Project Presentations	15
	total	100