

## **Simulation Analysis of Forest Ecosystems** (3 credits)

**FOR 6156**

**Lectures and Discussion:** MWF 8:30-9:20 AM in MAEB room 234

**Instructor:** Wendell Cropper wcropper@ufl.edu  
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214 Newins Ziegler Hall

**Office Hours:** After class or by appointment. See me for help with programming, homework and projects. Email questions and programs.

### **Course Description**

This course is designed to explore the conceptual basis, evaluation, implementation, testing, and analysis of forest and tree simulation models. Each student will develop and present a modeling project based on their research or other approved topics.

**Course is Designed For:** Graduate Students

**Prerequisites:** Undergraduate course(s) in ecology, plant physiology. Ability to use Algebra.

### **Course Resources:**

#### **Books (recommended) :**

Modeling Biological Systems. Principles and Applications.  
J. W. Haefner. 1996. Chapman and Hall, NY. 473 pp.

Python programming books:

Learning Python. Mark Lutz, David Ascher. 1999. O'Reilly and Associates, Inc. 366 pp. OR

How to Think Like a Computer Scientist. Learning with Python. 2002.  
A.Downey, et. Al. Green Tea Press. Wellesley, Mass. (pdf)

<http://www.freenetpages.co.uk/hp/alan.gauld/>

**Python Programs:** example programs provided that illustrate each topic

## **Web Resources:**

<http://www.python.org/> (free download of Python for windows, mac, and Unix); Tutorials

[http://en.wikibooks.org/wiki/NonProgrammer%27s\\_Tutorial\\_for\\_Python/Contents](http://en.wikibooks.org/wiki/NonProgrammer%27s_Tutorial_for_Python/Contents)

<http://sourceforge.net/projects/numpy> (free download of Numerical Python)

<http://matplotlib.sourceforge.net/> (free download of Matplotlib)

<http://www.cse.csiro.au/poptools/index.htm> (Excel plug in)

## **Lecture and Discussion Topics:**

### **Introduction to Modeling.**

What is a model?  
How are models made?  
Testing and Evaluation of models.

Haefner Chapt 1 - 3.

Jorgensen, S.E. 2008. Overview of the model types available for development of ecological models. *Ecol. Model.* 215:3-9.

Caswell, H. 1988. Theory and models in ecology: A different perspective. *Ecological Modelling* 43:33-44.

### **Introduction to Python programming.**

complete Python tutorial.  
turn in first problem set program.

### **Introduction to Matrix Algebra and Matrix Models**

Tree Population modeling  
Forest succession modeling  
Landscape Transition (Markov) modeling

Pinard, M. 1993. *Biotropica* 25(1):2-14

Anderson, P.J. and F.E. Putz 2002. *For. Ecol. Manage.* 170:271-283.

Cropper, W.P. and D. DiResta. 1999. *Ecol. Modelling* 118:1-15.

Cropper, W.P. and E.L. Loudermilk. 2006. *Ecol. Model.* 198:487-494.

Dalva, M., et al. 1999. *Ecology* 80(8):2635-2650

Acevedo, M.F. et al. 1995. *Ecological Applications* 5(4):1040-1055

Lytle, D.A. and D.M. Merritt 2004. *Ecology* 85:2493-2503.

Holm et al. 2008. *Biotropica* 40:550-558.

Haefner Chapter 13

### **Some useful functions.**

Haefner Chapter 4

## **Introduction to Numerical Integration.**

integration error  
Introduction to Stella and Berkeley Madonna  
simulation packages.  
Introduction to Excel spreadsheet for simulation.  
Nutrient cycling models  
Energy flow models  
Population dynamics models

Anderson, R.M. et al. 1981. Nature 289:765-771  
Ferguson et al. 2003. Nature 425:681-685  
Madden, L.V. et al. 2002. BioScience 52:65-74  
Earn, D.J.D. 2000. Science 287:667-670.  
Hastings, A. 1993. Annu. Rev. Ecol. Syst. 24:1-33  
Harwell et al. 1981. Ecological Modelling 12:105-131

Haefner Chapter 6

## **Disease Modeling.**

Differential equation models  
Spatial models  
Cellular Automata  
Network models  
Agent-based (IBM) Models

Ferguson et al. 2006. Nature 442:452

## **Chaos.**

Logistic Map (Difference Equation)  
Lorenz Chaos (Differential equations)  
Matrix population models (Density-Dependent)

Becks et al. 2005. Nature 435:1226-1229  
May 1974. Science 186:645-647.  
Haefner Chapter 17

## **Gap Phase Individual-Based Succession Models.**

Examples: Jabowa, Linkages

Haefner p. 338  
Post, W.M. and J.Pastor. 1996. Climatic Change 34:253-261  
Wyckoff, P.H. and J.S. Clark. 2002. Journal of Ecology 90:604-615.  
Liu, J. and Ashton. 1995. Forest Ecology and Management 73:157-175.

## **Landscape Modeling.**

Higgins, S.I., et al. 2000. *Ecological Applications* 10:1833-1848  
Fitz, H.C. et al. 1996. *Ecological Modelling* 88:263-295  
Loudermilk, and Cropper. 2007. *Can. J. For. Res.* 37:2080-2089  
Loudermilk, et al. 2011. *Ecological Modelling* 222:2733-2750  
Shoemaker and Cropper. 2010. *Journal of Forestry Research* 21:171-176  
Haefner Chapter 15, 16, and 18

## **Modeling Plant Competition.**

Competition and coexistence - the effects of resource transport and supply rates.

Huston M.A., DeAngelis D.L. 1994. *Amer. Nat.* 144 (6): 954-977.  
Loreau, M. 1998. *Proc. Natl. Acad. Sci.* 95:5632-5636.

Haefner Chapter 14

## **Modeling Soil Nitrogen Dynamics and Decomposition.**

Nitrification  
Denitrification  
Mineralization  
Uptake

Muller, C. *Modelling Soil-Biosphere Interactions.*  
CABI Publishing. Chapt. 2  
Gholz et al. 1985. *For. Sci.* 31:463-478.  
Kruys et al. 2002. *Ecol. Applications* 12:773-781.  
Comerford et al. 2006. *Can. J. Soil Sci.* 86:665-673.  
Allison and Martiny. 2008. *PNAS* 105:11512-11519.

## **Biological Inspired Modeling: Neural Nets and Genetic Algorithms**

Cropper and Anderson 2004. *Ecol. Modelling* 177:119-127  
Cropper and Comerford 2005. *Ecol. Modelling* 185:271-281  
Cropper et al. 2011. *Ecological Informatics*  
Lek and Guegan. 1999. *Ecol. Modelling* 120:65-73.

Haefner Chapters 19 and 20

## **Modeling Tree Physiology.**

assimilation  
respiration  
transpiration  
estimation of parameters

van den Berg, M. et al. 2002. Ecol. Mod. 148:233-250.  
Chen, J.M. et al. 1999. Ecol. Mod. 124:99-119.  
Friend, A.D. 2001. Global Ecol. Biog. 10:603-619.  
Wang, Y.-P. et al. 1998. Global Change Biology 4:797-807  
Wang, YP and Jarvis. 1990. Ag. For. Met. 51:257-280.  
Cropper, W.P. and Gholz. 1993. Ecol. Mod. 66:231-249  
Cropper, W.P. 2000. For. Ecol. Man. 126:201-212.

### **Course Requirements:**

Although collaboration is an important part of science, learning modeling techniques is best done individually. No collaboration (except with the instructor) is expected for the weekly problem sets or modeling project.

Problem sets (25%)

Presentation and leading discussion of published forest modeling paper (25%)

Modeling project and oral presentation. A written report describing objectives, significance, model structure, and results and discussion is due on the last day of class. (50%)

Participation is required; discussions of topics, homework, assigned papers and projects are an essential part of this course.

### **Grading Scale:**

93% - 100% A  
90% - 92.9% A-  
86% - 89.9% B+  
83% - 85.9% B  
80% - 82.9% B-  
76% - 79.9% C+  
73% - 75.9% C  
70% - 72.9% C-  
60% - 69% D  
Below 60% E

UF grading policies:

<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

## **Course Policies**

Students are expected to attend class, engage in discussion, and submit assignments on time. Problem sets may be revised after initial grading without penalty. A new due date will be assigned for revised problem sets. A 10% late penalty will be assessed for work turned in or presented after the due date. Students must complete a written report of the modeling project, as well as an in class presentation to receive credit for the project. You must receive an A on the project to receive an A for the course.

## **University of Florida Policies**

### **Academic Honesty**

As a result of completing the registration form at the University of Florida, every student has signed the following statement: "I understand that the University of Florida expects its students to be honest in their academic work. I agree to this commitment to academic honesty and understand that my failure to comply with this commitment may result in disciplinary action up to and including expulsion from the University."

### **UF Counseling Services**

Resources are available on campus for students having personal problems or lacking clear career and academic goals with interfere with their academic performance. These resources include:

University Counseling Center, 301 Peabody Hall, 392-1575 (personal and career counseling); Student Mental Health, Student Health Care Center, 392-1171 (personal counseling); Center for Sexual Assault /Abuse Recovery and Education (CARE), Student Health Care Center, 392-1161 ext. 4231 (counseling related to sexual assault and abuse); Career Resource Center, Reitz Union, 392-1601 (career development assistance and counseling).

### **Software Use**

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual

violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate.

### **Accommodations for Students With Disabilities**

Students requesting classroom accommodation must first register with the Dean of students Office. The Dean of Students Office will provide documentation to the student who must then provide this documentation to the instructor when requesting accommodation.