GE375 – Introduction to Quantitative Environmental Modeling
Fall Semester 2013
Lecture – MWF 9:00-10:00 (CAS 228)
Lab – Monday 1:30-3:30 (CAS 327)

Professor: Dana Bauer
STO 445
617-353-7555
bauer@bu.edu

Office Hours: Mondays 10:00 – 11:00
Wednesdays 1:00 – 2:00
4:00 – 5:00
or by appointment

Teaching Fellow: Hollie Emery
CAS B47F
hemery@bu.edu

Office Hours: TBA

Course Description:
Models are simple representations of the real world, which can be used to convey information, generate and test hypotheses, and make predictions about what will happen in the future. This course introduces students to the art and science of modeling environmental systems. Students will learn the basic steps of modeling: problem definition, model development, evaluation, and application. Models will typically involve describing natural and social systems with mathematical approximations of their behavior. Lectures will help students learn how to translate “word problems” into model components. Labs will provide students with hands-on experience in the design and construction of working models using computerized spreadsheets (Microsoft Excel). Applications will be drawn from a range of environmental issues including climate change, air and water pollution, biodiversity, and natural resource management.

Prerequisite: Basic Probability and Statistics (CASMA115 or CASMA213 or equivalent)
Recommended: Introduction to Environmental Science (CASGE100 or equivalent)
Calculus I (CASMA121 or CASMA123 or equivalent)

Course Objectives:
After taking this course, you should feel comfortable creating computer models to answer a variety of real world problems, from the simple to the fairly complex. You should be proficient in developing research questions, creating hypotheses, collecting and arranging data, and designing models to test your hypotheses. You should be able to test the accuracy of your models, perform sensitivity and uncertainty analyses, and present your results. You should also be comfortable critiquing models developed by others.

Required Readings:
There is no text for this course. All required readings will be handed out in class or made available on the course webpage.
Course Website:
This syllabus, readings, lecture slides, lab and in-class assignments, and other course information will be posted on the Blackboard Learn website for this course (available from Student Central).

Grading:

<table>
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<tr>
<th>Component</th>
<th>Percentage</th>
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<tr>
<td>Lab/In-Class Assignments</td>
<td>50%</td>
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<tr>
<td>Midterm Exam</td>
<td>15%</td>
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<tr>
<td>Annotated Bibliography</td>
<td>5%</td>
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<tr>
<td>Computer Model</td>
<td>10%</td>
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<tr>
<td>Project Report</td>
<td>10%</td>
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<tr>
<td>Project Presentation</td>
<td>5%</td>
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<tr>
<td>Participation</td>
<td>5%</td>
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Lab/In-Class Assignments:
The best way to learn environmental modeling is to build models. The first major component of this course entails a series of modeling exercises. There are two types of exercises. The first type are in-class “pen and paper” modeling exercises that help you learn how to convert word problems into mathematical models. The second are computer-based lab exercises that involve construction of an entire model. These will be introduced in class on Monday and then worked on in lab Monday afternoon. Plan to spend additional time outside of lab to complete the lab exercises. You may discuss assignments with other students, but you must build your own model and turn in your own written report. Please follow the Lab Report Guidelines posted on the course webpage. Lab reports are due at the beginning of lab the following Monday. I strongly encourage you to work on your models early in the week, so that you may ask Hollie or me questions prior to the weekend. You will lose 5% for each day a lab report is late.

Midterm Exam:
There will be a two-part midterm exam on Monday, November 25. The in-class (9:00-10:00) portion of the exam will cover the basic concepts of quantitative environmental modeling. The computer-lab (1:30-3:30) portion of the exam will test basic practical modeling skills. This date will not change and there will be no make-up exam.

Research Project:
The second major component of this course is an individual research project, in which you will investigate an environmental research question of particular interest to you. The steps involved in a research project include: 1) developing a research question, 2) conducting a literature review, 3) building an Excel-based model to analyze your question, 4) calibrating and running your model, 5) conducting appropriate sensitivity analysis, and 6) analyzing your results. You will turn in a write-up of your model along with your Excel spreadsheet. A one-page proposal describing your research topic and one or more preliminary questions is due in class on Wednesday, September 25. An annotated bibliography of at least 10 references and revised research question is due in class on Wednesday, October 16. Your final computer model and project report are due on Tuesday, December 17, by 12:00pm.
Presentation:
Each student will give a short (approximately 8-minute) presentation of their research project during the final week of the semester. Your presentation should include: 1) a description of the environmental problem, 2) your specific research question, 3) the details of your model, and 4) a discussion of your key results (or anticipated results).

Class Participation:
Classes will consist of lectures, discussions of assigned readings, and group modeling exercises. Everyone is expected to read all the assigned readings prior to class and participate in class discussions and group exercises, including asking and answering questions. Attendance will count in your class participation grade. **Missing another student’s final presentation will automatically lower your final score by half a letter grade.**

Environmental Modeling Sources:
The following journals may assist you in finding ideas for your research project.

* Ecological Applications
* Ecological Modeling
* Environmental Modeling and Assessment
* Environmental Modelling and Software
* Global Change Biology
* Natural Resource Modeling
* Water Resources Research

Other environmental journals or news outlets
Sample literature reviews can be found in the *Annual Review of Environment and Resources*.

Computer Lab:
**Student Access:** Students registered for GE375 can gain access to the computer lab/classroom (CAS 327) with their BU Student ID card. The hours of operation are 8:00am to 10:00pm. A sign on the door indicates when the room is being used for classes, labs, and other events. Registered students also have access to the lab across the hall (CAS 330).

**Lab Printer:** There is a printer available for your use in our lab room (CAS 327). Each student will start out with $10.00 on account, which provides 100 pages (10 cents per page) of printing as part of the course. You may add money (in full dollar increments) to your account in the CAS Computer Services Group office (next door in CAS 331).

**Machine and Server Access:** Each of you will need to link your BU account to the CAS Active Directory in order to be able to access the classroom server and log onto the machines. Go to the webpage [www.bu.edu/computing/accounts/ad/cas](http://www.bu.edu/computing/accounts/ad/cas) and enter your BU login name and password. This only needs to be done once for your time at BU. Each of you will have your own folder on the class server `\casfsa.bu.edu\Class_Folders\Classes_327\ge_375\Students`. Instructions for accessing the class server from outside the classroom can be found at [cashelp.bu.edu/fileserver](http://cashelp.bu.edu/fileserver).
The Educational Resource Center:  
Center for Student Services (100 Bay State Road): This center provides academic assistance to undergraduates as well as graduate students. Helpful resources include a Writing Center, where doctoral-level Writing Fellows help students through all phases of the writing process, Peer Tutoring in many undergraduate courses, and Workshops on topics such as time management, study skills, and test-taking.

Academic Honesty:  
Cheating on exams, plagiarism, misrepresentation or falsification of data, knowingly allowing another student to represent your work as his or her own, altering or destroying another student’s work, and submitting the same work in more than one course without the consent of the instructors are all forms of academic misconduct and will not be tolerated. See the Academic Conduct Code at http://www.bu.edu/academics/policies/academic-conduct-code/ for more details.

Incomplete Grades:  
Grades of incomplete (“I”) are given only when specific work has not been completed and when the student and instructor have conferred and the instructor has assigned a date within the next 12 months for the work to be completed. The “I” grade automatically becomes a permanent F when the work is not completed within the 12-month period. This is CAS policy. My policy is to not give incomplete grades except under extraordinary circumstances.
Supplemental Readings:


**Course Outline:** This is a tentative schedule. We will try to stick to this schedule, but we will also move at the pace of the class. Changes will be announced in class.

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<tr>
<th>DATE</th>
<th>LECTURE TOPIC AND READINGS</th>
<th>LAB TOPIC</th>
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<tbody>
<tr>
<td>W 9/4</td>
<td>Course Overview</td>
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<tr>
<td>F 9/6</td>
<td>Introduction to Modeling</td>
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| M 9/9 – F 9/13 | Steps in Model Development  
Ford 1999 (Chapter 15)  
Jakeman et al. 2006 | LAB 1  
Graphing in Excel    |
| M 9/16 | Review of Basic Statistics  
Townend 2002 (Chapters 7 and 8) | LAB 2  
Soil Carbon I             |
| W 9/18 | Statistical Models  
Townend 2002 (Chapters 9 and 10) |                           |
| F/9/20 | Statistical Model Selection  
Owen-Smith 2007 (Chapter 15) |                           |
| M 9/23 | Evaluating Statistical Models  
Smith and Smith 2007 (Chapter 3) | LAB 3  
Soil Carbon II             |
| W 9/25 | Developing a Research Question  
NOTE: Project Topic/Research Question due today |                           |
| F 9/27 | Intro to Simulation Models – Stocks and Flows |                           |
| M/ 9/30 | Population Growth Models  
Owen-Smith 2007 (Chapter 3) | LAB 4  
Dragonflies and Frogs          |
| W 10/2 | Spatial Simulation Models – Part 1  
Hadlock 1998 (Pages 55-85) |                           |
| F 10/4 | Using Data Tables  
NOTE: Class meets in CAS 327 today | LAB 5A  
Pollution Diffusion I            |
| M 10/7 | Spatial Simulation Models – Part 2  
Hadlock 1998 (Pages 86-95) | LAB 5B  
Pollution Diffusion II          |
<p>| W 10/9 | Identifying Key Model Components |                           |</p>
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<tbody>
<tr>
<td>F 10/11</td>
<td>Practicing the Steps of Model Development</td>
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<tr>
<td>T 10/15 and W 10/16</td>
<td>Project Start-Up</td>
<td>NO LAB</td>
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<td><em>NOTE: Tuesday is running Monday’s schedule</em></td>
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<td><em>NOTE: Revised research question and annotated bibliographies due Wednesday</em></td>
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<td>F 10/18</td>
<td>Stochastic Models Starfield and Bleloch 1986 (Chapter 3)</td>
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<td>M 10/21</td>
<td>Monte Carlo Simulations and Sensitivity Analysis</td>
<td>Lab 6 Elephants and Geese</td>
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<td>W 10/23</td>
<td>Introduction to Optimization Models</td>
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<td>F 10/25</td>
<td>Linear Programming Starfield et al. 1994 (Chapter 7)</td>
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<td>M 10/28</td>
<td>Analyzing Multiple Scenarios Starfield and Bleloch 1986 (Chapter 7)</td>
<td>LAB 7 Wildlife Management</td>
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<td>W 10/30</td>
<td>Practicing the Steps of Model Development</td>
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<td>F 11/1</td>
<td>Feedback Mechanisms &amp; Causal Loop Diagrams Ford 1999 (Chapter 7)</td>
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<td>W 11/6</td>
<td>Dynamic Equilibrium and Phase Diagrams Hoagstrom 2008</td>
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<td>F 11/8</td>
<td>Solving Differential Equations with Numerical Approximation Methods</td>
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<td>M 11/11</td>
<td>Application of Predator-Prey Model Brander and Taylor 1998</td>
<td>LAB 9 Easter Island</td>
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<tr>
<td>W 11/13</td>
<td>Critiquing Models Reuveny and Decker 2000</td>
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<td>LAB TOPIC</td>
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| F 11/15    | Model Validation, and Sensitivity Analysis  
         | Hamby 1994  
         | Rykiel 1996  |                                            |
| M 11/18    | Bringing it all together in one final lab  
         | NRC 1987  
         | Ford 1999 (Chapter 4)  | LAB 10  
         | Mono Lake  |
| W 11/20    | Model Complexity  
         | Chapman 1994  
         | Jakeman and Hornberger 1993  
         | Jakeman and Hornberger 1994  |                                            |
| F 11/22    | Exam Review                                                                              |                                |
| M 11/25    | MIDTERM EXAM – Lecture Portion                                                           | MIDTERM EXAM – Lab Portion     |
| W 11/27 and F 11/29 | NOTE: No Class – Thanksgiving Recess  |                                |
| M 12/2     | Presentation Tips and Techniques                                                         | OPEN LAB – WORK ON PROJECTS    |
| W 12/4     | Real World Models – Evaluating the Ten Steps  
         | Robson et al. 2008  
         | Welsh 2008  |                                            |
| F 12/6     | Real World Models  
         | Guest Lecture – TBA  |                                            |
| M 12/9 and W 12/11 | STUDENT PRESENTATIONS and COURSE WRAP-UP  | STUDENT PRESENTATIONS          |
| T 12/17    | Final Projects Due 12:00pm                                                               |                                |