# IBS 595 - Ecology

**Fall 2011 (Tue-Thur 10.00-11.15)**

## Course description

This course is aimed at providing a firm understanding of ecological theory as well as the methods to study ecological questions in scientific research. Topics include population growth, species interactions, community ecology, biodiversity, experimental design and statistical analysis.

## Course format

The class is a mix of lectures, discussion sections and computer labs, most of which will use the package R. Some of the instructors will have you carry out simulations and analyses during lectures. ***It is therefore important that you bring your laptop to class.*** Please install R on your laptop before the first class. R can be downloaded for free from http://www.r-project.org/. If you don't have a laptop, please notify Dr. de Roode before the first class – we will be able to provide you with a laptop during class hours. Alternatively, you may work with a colleague during class time.

## Course information

- Building/Room: 1562 Clifton Road ("Dental School"), room 109
- Meeting time: Tue-Thur 10.00-11.15
- Maximum enrollment: 18
- Required for PBEE students; non-PBEE students need permission from instructors

## Course objectives

1. Understand different types of single-species population growth models; students should understand the properties of these models and their application to real populations.
2. Understand major types of species interactions (competition, predation, parasitism); the student should understand simple theory that models these interactions and their application to real populations.
3. Understand the important concepts underlying spatial ecology, community ecology and island biogeography, and how to apply them to PBEE-related research.
4. Understand modern approaches to studying ecology using molecular methods.
5. Apply topics and tools learnt in this course to own research.
6. Provide a firm basis for IBS 592 – Quantitative Methods; IBS 592 will follow up on a lot of the topics discussed in IBS 595 by incorporating probability methods into ecological models.

## Course instructors (when emailing, put "IBS 595" in subject line)

Dr. Jaap de Roode (course director): jacobus.deroode@emory.edu
Dr. Chris Beck: christopher.beck@emory.edu
Dr. Berry Brosi: bbrosi@emory.edu
Dr. Nicole Gerardo: nicole.gerardo@emory.edu
Dr. Thomas Gillespie: thomas.gillespie@emory.edu

## Getting help

**Asking Questions about the Material.** The most important thing that you can do to get the most out of the class is to ask questions. Please ask questions during class. If you have a question outside of class, you can send your questions to one of the instructors. You can also make an appointment to meet with an instructor.

**Office Hours.** There are no regular office hours; to set up an appointment, email one of the instructors.

**Questions about modeling in R.** The instructors regularly use R, but they do not know all the gazillion snippets of R code that you may want to use in this course. However, there are many great books on R, and R has a great built-in help function. Moreover, Google is usually able to provide you with an answer in picoseconds, many orders of magnitude faster than your fastest instructor! Simply type in things like “addressing the sub-diagonal in a matrix in R” and you’ll be surprised at how fast you’ll find a solution.

## Course materials

### Textbooks

The course will build on a number of books as well as primary literature and lecture notes. Different instructors may have different preferences for using background literature. While textbooks are necessary for some lectures, other lectures can be followed with provided notes. Because ecological science is increasingly based on carrying out mathematical and statistical models in R, we recommend the following books (if you are not sure you want to purchase these books at this time, you can of course loan them from the library or photocopy relevant chapters from instructors or other students).

- ***A Primer of Ecology with R*; M. Henry H. Stevens, Springer.** This book provides an overview of most of the ecological models covered in this class, and includes R code.
- ***The R Book*; Michael J. Crawley, Wiley.** This book provides an amazingly complete manual on doing life sciences statistics in R, and will be a great help to anyone doing statistics as part of their graduate work.
- ***Ecological Models and Data in R;* Benjamin M. Bolker, Princeton University Press.** This is another great book on ecological modeling in R; it provides a lot of information on probability testing and stochastic simulations. This book is required material for IBS 592, so students taking this class may want to purchase the book already. For our course, it provides some useful introductory information.
- ***Modern Statistics for the Life Science;* Alan Grafen and Rosie Hails, Oxford University Press.** This book provides an amazingly helpful explanation of general linear models. Chapters of this book will be made available on the blackboard site, however, the book is well worth pursuing. The book does not come with R code, but relevant code will be provided on the blackboard site.

*See the appendix for other helpful literature.*

### Additional Readings

- Additional readings will be posted on the blackboard site “IBS595: Ecology – Fall 2011”. Go to the tab “Content”; here you will find folders for background reading (e.g. Grafen & Hails’ *Modern Statistics for the Life Science*), as well as folders for lectures (folder “Lecture materials” in folder “content”); these latter folders will contain primary literature readings as well as lecture notes if available.

- Individual instructors will notify you of what readings need to be completed ***before or after*** lectures.

**Blackboard**

- The blackboard site "IBS595: Ecology – Fall 2011" is used for providing readings, lecture notes and assignments (see folder "Assignments" in the "Content" folder). We will also use Blackboard to update your grade book after each completed assignment. Keep an eye on the announcements to find out about assignments and assigned readings.

## Assignments

Individual instructors will provide you with assignments related to the topics they teach. As a general rule, assignments are due 1 week after they are handed out to you, and are to be handed in (electronically or on paper, depending on the instructor) to the relevant instructor for grading. You should expect 1-2 assignments per week. There are no exams, and there is no cumulative final assignment. If you have trouble with an assignment, feel free to contact the instructor. He/she can guide you in assignments. However, do not expect to obtain the final answer from your instructor. You are allowed to work together on assignments. However, each student should hand in their own paper, with their own code, graphs, tables and wording.

## Grades

All assignments will be graded. The final grade is the arithmetic mean of all your grades. Note that there is no possibility for extra credit.

## Honor Code

Remember Emory's Honor Code throughout this course (http://www.college.emory.edu/current/standards/honor_code.html). Note that re-using R code from the internet, books and lecture notes, and working together on assignments, do not constitute violations of the honor code.

## Class schedule

| **Date** | **Topic** | **Instructor** |
|---|---|---|
| Thu, Aug 25 | What is ecology; and an introduction to R | De Roode/Gerardo |
| Tue, Aug 30 | Life history evolution | Beck |
| Thu, Sep 1 | Life history evolution | Beck |
| Tue, Sep 6 | Single species population dynamics | De Roode |
| Thu, Sep 8 | Single species population dynamics | De Roode |
| Tue, Sep 13 | Single species population dynamics | De Roode |
| Thu, Sep 15 | Interspecific competition | De Roode |
| Tue, Sep 20 | Interspecific competition | De Roode |
| Thu, Sep 22 | Predation | Gerardo |
| Tue, Sep 27 | Metapopulations | Brosi |
| Thu, Sep 29 | Metapopulations | Brosi |
| Tue, Oct 4 | Molecular ecology and population structure | Gerardo |

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| Thu, Oct 6 | Molecular ecology and population structure | Gerardo |
| Tue, Oct 11 | FALL BREAK: NO CLASS | - |
| Thu, Oct 13 | Parasitism: microparasite models | De Roode |
| Tue, Oct 18 | Parasitism: microparasite models | De Roode |
| Thu, Oct 20 | Parasitism: macroparasite models | De Roode |
| Tue, Oct 25 | Parasitism in a community context | Gillespie |
| Thu, Oct 27 | Parasitism in a community context | Gillespie |
| Tue, Nov 1 | Landscape ecology | Gillespie |
| Thu, Nov 3 | Landscape ecology | Gillespie |
| Tue, Nov 8 | Biodiversity: causes and measurements | Brosi |
| Thu, Nov 10 | Biodiversity: causes and measurements | Brosi |
| Tue, Nov 15 | Biodiversity: neutral theory | Beck |
| Thu, Nov 17 | Island biogeography | Gerardo |
| Tue, Nov 22 | Island biogeography | Gerardo |
| Thu, Nov 24 | THANKSGIVING: NO CLASS | - |
| Tue, Nov 29 | Ecosystem ecology: guest lecture | Lance Gunderson |
| Thu, Dec 1 | Ecosystem ecology | De Roode/Gerardo |
| Tue, Dec 6 | Wrap-up and evaluations | De Roode/Gerardo |

## Appendix: Useful resources on R and ecology

**General and population ecology**

- *Population Ecology: First Principles*; John H. Vandermeer and Deborah E. Goldberg, Princeton University Press.
- *A Primer of Ecology;* Nicholas J. Gotelli, Sinauer Associates.
- *Ecology;* Begon, Harper and Townsend, Blackwell.
- *Foundations of Ecology: Classic Papers with Commentaries;* Eds. Leslie A. Real & James H. Brown, 1991. The University of Chicago Press.

**Basic Introduction to R**

- The R Tutor
  http://www.r-tutor.com/

**R Packages for Ecological Modeling**

- **GillespieSSA**
  http://rss.acs.unt.edu/Rdoc/library/GillespieSSA/html/GillespieSSA-package.html
  GillespieSSA provides a simple to use and extensible interface to several stochastic simulation algorithms for generating simulated trajectories of finite population continuous-time model. Currently it implements Gillespie's exact stochastic simulation algorithm (Direct method) and several approximate methods (Explicit tau-leap, Binomial tau-leap, and Optimized tau-leap). The package also contains a library of template models that can be run as demo models and can easily be customized and extended. Currently the following models are included, decaying-dimerization reaction set, linear chain system, logistic growth model, Lotka predator-prey model, Rosenzweig-MacArthur predator-prey model, Kermack-McKendrick SIR model, and a metapopulation SIRS model.

- **Simecol**
  http://simecol.r-forge.r-project.org/
  The simecol package is intended to give users (students and scientists) an interactive environment to implement, distribute, simulate and document basic and advanced ecological models without the need to write long simulation programs. For this purpose, an object oriented approach is developed, which should provide a consistent but still flexible and extensible way to implement simulation models of different types, namely
    - ordinary differential equation (ODE) models,
    - non-spatial individual-based models,
    - grid-oriented individual-based models,
    - particle diffusion-type models
    - and more.

- **DEMEtics**
  http://cran.r-project.org/web/packages/DEMEtics/index.html
  This package allows one to calculate the fixation index Gst (Nei, 1973) and the differentiation index D (Jost, 2008) pairwise between or averaged over several populations. P-values, stating the significance of differentiation, and 95 percent confidence intervals can be estimated using bootstrap resampling. In the case that more

than two populations are compared pairwise, the p-values are adjusted by bonferroni correction and in several other ways due to the multiple comparison from one data set.

- **Primer**
  http://www.oga-lab.net/RGM2/packages.php?q=predpreyLV&rows=8&start=0
  Functions and data for A Primer of Ecology with R.
  Functions are primarily functions for systems of ordinary differential equations, difference equations, and eigenanalysis and projection of demographic matrices; data are for examples. Includes functions for logistic growth, competition models, predation models, metapopulation models, etc..