# Quantitative Thinking in the Life Sciences. Fall 2013

CRN 94796, PSS 381, Graduate Special Topics
Mondays & Wednesday 10:00 – 11:15
Lafayette Hall L202
3 Credits
Office Hours: by appointment

**Instructor:**
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**Required Texts:**
Text: *Choosing and Using Statistics: A Biologist's Guide* by Calvin Dytham

**Supplemental material:**
N.T. Hobbs, 2012. *A Modeler's Primer on R*. Colorado State University, Fort Collins, CO. This primer is available on my website under the Courses/QuantitativeThinking link.

Venables, B. and D. M. Smith (1990) *An Introduction to R* which was based an original set of notes describing the S and S-Plus environments written in 1990–2 by Bill Venables and David M. Smith when at the University of Adelaide. The R team made a number of small changes to reflect differences between the R and S programs, and expanded some of the material in their Introduction. This introduction can be found at: http://cran.r-project.org/doc/manuals/R-intro.html

**Overview:**
The goal of this course is to build a quantitative foundation to help develop tools to think about and analyze your specific project in the life sciences. We will focus on learning fundamental principles to assure a solid background that will help in sampling design and analysis, as well as provide the building blocks for further quantitative study. This course will concentrate on thinking about your project, the questions driving your system, and the data that will be needed to answer your scientific questions. Additionally, you will learn techniques for using models to gain insight from your data.

**Target Audience:**
Early process graduate students

**Objectives**:

1. Learn to think about the questions that are driving your research

2. Determine what kind of data will best inform your project's questions

3. Develop an understanding of data, data collection, and ways of describing data

4. Learn the basics of probability, distributions, and variation

5. Develop an understanding of the fundamental principles used to gain insight from data

6. Learn methods for estimating model parameters, estimating associated uncertainties, and for evaluating alternative models based on data.

7. Provide grounding needed for effective collaboration with mathematicians and statisticians

8. Give students the quantitative confidence needed to use mathematical and statistical models in their research and to build a foundation for future quantitative study

**Prerequisites:** There are no prerequisites for this class; I will review key background concepts as part of the lectures.

**Content and teaching approach**:
We will study principles and methods for understanding data and building models to help us gain insight into ecological and environmental processes. Students will be taught to use the open-source computing language R, which has become the scientific standard. R can be difficult to learn and a fundamental goal of this course is to make that challenge manageable even for students with no programming background. Weekly laboratory sessions will challenge students to learn how to use statistical tools, build models and assimilate them with data. Because of the structure of the class, it is imperative that students keep up with laboratory work, with each exercise building off previous exercises over the course.

**Grading:**
75% percent of your grade will be based on assignments and lab write-ups, each worth 50 points / week required to complete. So, if I allocate 2 weeks to a lab topic it is worth 100 points, etc.

10% percent of your grade will be based on collaboration and participation.

15% of your grade will be based on the final project.

Lab work will require programming in R as well as some processing (e.g., Microsoft Word). Each lab write-up will be turned in as a single electronic copy of the write-up that includes text and figures communicating your results. Write-ups will be posted to Blackboard.

Grading of assignments, lab write-ups and the class project will be based on the following:

1. Quality of approach to problem: Did you use a logical, thoughtful process for solving the problem?

2. Quality of presentation: Did you present your findings in a literate document? Did you clearly communicate how you solved the problem, showing mathematical steps or a computer algorithm? Was your document attractive and well organized? Was your code well annotated?

3. Quality of technique: Did you demonstrate mastery of the appropriate methods? Your lab reports should describe model results and discuss them as appropriate. Include figures and/or tables, embedded in the text, not appended at the end. All figures must have captions. All tables must have headings. Provide an appendix documenting your code.

**Things you need:**
A large amount of computer programming will be necessary to successfully complete the course, so students will need easy access to workstations running R (or with administrative access to download R), which is free, open-source software and Microsoft Excel. We will learn how to load R and R packages in the lab. It will be very helpful if you have your own laptop. You should always bring it to class if possible. Ideally, students will start the class with a conceptual idea of their proposed project ecosystem or an ecosystem of interest (e.g., studying insects in hops, site-specific yield zones in corn, or Ethiopian wolf population dynamics).

**Class notes:**
Weekly notes and details will be available on our course Blackboard site.
Notes will be available at 4 pm the day before the class. Updates may occur after the initial posting of notes but the final weekly class note version will be online on Tuesdays 4:00 pm.

Occurrences