

BIOE 540 — Analysis of Ecological Communities

Monday 9:00-9:50 Lewis 407; Tue-Thur 9:00-10:40 Reid 303

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Course Description

This course is designed to familiarize community ecologists with the analysis of ecological community data. Such data are generated by sampling multiple species at multiple sites, e.g. plant species abundances at sample plots across a range of environments, aquatic invertebrate species (or taxa) abundances from multiple benthic samples, or bird species abundances from pre-dawn surveys across a range of vegetation structures. In each case, there are observations of multiple species and observations of multiple attributes of the environment at each sample unit. We will also cover the analysis of individual species distributions as a function of environment.

This is a practical, hands-on course emphasizing analysis and the interpretation of ecological analyses, and covers the majority of multivariate analyses in common use by community ecologists. The course is largely a lab course, and all grades are based on the quality of lab reports submitted; there are no exams. Lab reports are expected to be presented in a formal form with extensive annotated tabular and graphical output from the analyses. Submission of lab reports in PDF is required.

We will be using the R computer software to conduct all analyses. R is a public domain version of the S language, and is functionally almost identical to S-Plus. Students will be provided with a copy of the R program and all necessary material. No prior experience with R is necessary, but general familiarity with computer spreadsheets and data handling is helpful. Students are encouraged to bring their own datasets, but data will be made available to those who need it.

There will be a general lecture/literature review on Mondays, followed by a lab introduction to the software and analyses on Tuesday in lab, and hands-on analysis on Thursday. There is no text, but readings from the primary literature will be made available.

Modules

- Introduction to the R language
 - obtaining and installing R
 - S language and syntax
 - loading datasets and saving results
 - functions and packages
- Graphical/tabular examination/presentation of multivariate data
 - scatterplots and boxplots
 - multi-layer plots, colors, and glyphs
- Species and community distribution models
 - generalized linear models (GLM)
 - generalized additive models (GAM)
 - classification and regression trees (CART)
- Ordination
 - Dissimilarity and distance indices
 - Principal coordinates analysis (PCO)
 - Non-metric multidimensional scaling (NMDS)
 - Canonical correspondence analysis (CCA)
 - Distance-based Redundancy Analysis (DB-RDA)
 - Fuzzy set ordination (FSO)
- Partition analysis and discriminant analysis
 - hierarchical cluster analysis
 - non-hierarchical cluster analysis
 - Indicator species analysis
 - classification and regression trees in discriminant analysis

Materials

You will need to obtain and bring to class:

- 1) a notebook
- 2) a USB memory stick
- 3) optionally, a laptop equipped to run R

Readings

There is no text for this course. The material on the R language and the R program is available on the web, and will be available on D2L. Other readings will be made available as PDF on D2L. Statistics texts that are likely to be helpful include:

Manly, B.F.J. 2004. Multivariate statistical methods: a primer. Chapman & Hall

Venables, W.N. and B.D. Ripley. 2002. Modern applied statistics with S. Springer-Verlag

Kent, M. 2011. Vegetation description and analysis: a practical approach. CRC Press

Legendre, P. and L. Legendre. 2012. Numerical ecology. Third Edition. Elsevier.

Digby, P.G.N. and R.A. Kempton. 1987. Multivariate analysis of ecological communities. Chapman & Hall

Pielou, E.C. 1984. The interpretation of ecological data: a primer on classification and ordination. Wiley-Interscience

Work Flow

This is a demanding course, and requires continual effort. It is critical that you stay up-to-date as new material is presented every week. You must make sure that your data are loaded fully and correctly as soon as possible. You must also be sure to save all your results when you first obtain them to avoid having to repeat analyses. R makes this very easy, but it requires a little discipline on your part. Make sure you bring a USB memory stick to lab, and copy all your work onto it before you leave. You may then continue working on your own computer with the same data completely up-to-date. DO NOT assume that results left on the hard disk of computers in Reid 303 will still be there when you come back.

Lab Reports

You will be graded on the quality of your lab reports. There are no exams. You will write one or two lab reports for each module, depending on the length of that module. I will want to see extensive results, both tabular and graphical, so you will want to make sure you know how to capture and save your results in a format suitable for inclusion in your PDF lab report.

Lab reports should be written in a nearly publishable format:

- 1) abstract (question, general approach, major findings)
- 2) introduction
 - general ecological question of interest
 - review of previous results if relevant
- 3) data
 - description of data to be analyzed
- 4) methods
 - description in statistical terms of approach
 - description of software packages or functions employed
- 5) results
 - extensive presentation of annotated tabular and graphical output
- 6) interpretation
 - ecological perspective — did you learn anything about the species or communities
 - methodological perspective — how well did the analyses work to answer your question, compared to previous methods where relevant.