Syllabus

Course Information

Course Number: GEOL 651

Course Title: Paleoecological Community Analysis

Time: 2:20 PM - 3:35 PM

Location: Halbouty 327

Credit Hours: 3 CR

Instructor Details

Instructor	David Bapst	Christina Belanger
Office	Halbouty 169	Halbouty 265
E-Mail	dwbapst@tamu.edu	christina.belanger@tamu.edu
Online Office Hours	TuTh: 3:40-4:30 PM	Tu: 1:00-2:00 PM
	Wd: 10:00-11:00 AM	Fr: 3:30-4:30 PM

Course Description

Quantitative analysis of multivariate paleoecological community data; measurement of diversity; cluster analysis; gradient analysis by standard and canonical ordination techniques.

Course Prerequisites

A basic course in statistics or approval of instructor. (Graduate students are routinely approved.)

Special Course Designation

None.

Course Learning Outcomes

Graduate students who complete this course should be able to:

- Calculate common ecological measurements in R.

- Apply multivariate statistical techniques to their own research work.

- Intuit potential caveats and artifacts in multivariate analyses, such as ordinations and cluster analyses.

- Interpret and critically evaluate another person's analysis of multivariate data sets of ecological or environmental variables

- Identify appropriate methods for visualizing and summarizing multivariate structure.

- Use classification analyses to discriminate and test groups within datasets.

- Troubleshoot error messages and other problems with their code.

- Teach themselves an unfamiliar statistical test to apply to their own data.

- Devise novel analytical approaches when necessary, using statistical theory, simulations, etc.

Textbook and/or Resource Materials

Students need access to their own computer, on which they should have the R interpreter (install from CRAN: https://cran.r-project.org/), the integrated development environment (IDE) Rstudio (install from the Rstudio website, https://www.rstudio.com/products/rstudio/download/#download), and a spreadsheet program (such as Microsoft Excel). Both R and RStudio are available for free, and LibreOffice Calc is a free spreadsheet program.

No textbooks are required, however you may find the following volumes useful in your studies, a :

- **Borcard et al., 2011.** Numerical Ecology with R. Springer. 306 pp.

- **Crawley, M.J., 2013.** The R Book. John Wiley & Sons, West Sussex, 1051 p.

- **Hammer and Harper, 2006.** Paleontological Data Analysis. Wiley-Blackwell. 351 p.

- **Legendre and Legendre, 2012.** Numerical Ecology, 3rd edition. Elsevier. 1006 pp. *(There are many reprints of this volume - older versions are also good!)*

- **Patzkowsky and Holland, 2012.** Stratigraphic Paleobiology: Understanding the Distribution of Fossil Taxa in Time and Space. University of Chicago Press. 256 pp.

- **Sneath and Sokal, 1973.** Numerical Taxonomy: Principles and Practice of Numerical Classification. W H Freeman and Co. 588 pp.

- **Sokal and Rohlf, xxxx.** Biometry: The Principles and Practice of Statistics in Biological Research. *(Newest version is 2011. 1994 edition is also good.)*

- **Zar, 2009.** Biostatical Analyses, 5th edition. Pearson. 960 pp.

Grading Policy

Your final letter grade will be based on the final percentage grade for the course:

A	90-100%
B	80-89%
C	70-79%
D	60-69%
F	Less than 60%

Your final percentage for the course will be based on:

Project Paper	40%
Preliminary Drafts & Data Set	15%
In Class Presentations	10%
Homework Assignments	20%

Grades in this class will be based on a series of individual homework assignments, a final project, and in-class presentations.

Term Project, Drafts and Final Project Paper This class requires a project-based term paper, with students proposing a project focused on research question of their own selection from within the earth and environmental sciences. Students are required to locate and obtain an appropriate dataset – perhaps from a publicly-available source, such as supplemental material for an article, or collected as part of their own research, or supplied by their advisor. **Datasets must have a minimum of 10 samples and more than one variable measured for each sample, so that reasonable questions concerning multivariate data structure can be addressed.** Addressing these research questions will require applying various

analyses from throughout the course, and possibly beyond the covered course material.

During Week 3, students must submit a **Project Proposal**, where they briefly describe one or more potential research projects they might persue, and where they would get the data necessary, and the questions that would be addressed.

Drafts of the term paper are due at four points during the semester:

1. The first draft due, the **Introduction and Data Draft**, is expected to contain (at a minimum) the introduction, and a partial Methods section that describes the context and background of the data: where, when, and *how* was the data collected, and also describing any necessary treatments required to further analyze the data.

2. The second draft, the **Methods Draft** is expected to build off the former draft, but also describe the analytical approaches the student will apply in the Methods section.

3. The third draft due should be a relatively complete **Full Draft**, adding results, discussion and any necessary figures or tables. We will review this and give you feedback.

4. The fourth is the **Final Draft**, which will be the basis for your final grade for the term paper.

Each of the three interim drafts **should have** proper in-text citations and formatted references, include a file containing the current data set used for the project, regardless of whether it has been modified since the original data submission.

Expected Structure for the Term Paper   The length of your final paper will depends on how much you have to say to build an efficient, compelling investigation of your question. This final paper should be formatted like a scholarly manuscript, covering the methods, and results of their project. A complete paper draft will have the following required sections:

- **Abstract (REQUIRED)** - A concise, 1 paragraph summary of your study (e.g. questions, data, methods, results).

- **Introduction (REQUIRED)** - Provide scientific context for your research question and background a reader would need to understand your study system and the importance of answering your research question. State your questions clearly and introduce how you will investigate them.

- **Methods (REQUIRED)** - A complete description of the data and analyses you use, with justifications for why you chose those specific methods. Include references that support your decisions.

- **Results (REQUIRED)** - A report of the results of your analyses, including reporting all necessary statistical values, and necessary supporting figures and tables. Interpretation of results should be minimized.

- **Discussion (REQUIRED)** - An interpretation of your results in the context of the hypothesis you set out to test with reference to the published results of other workers. Address any analytical challenges, alternative interpretations, related your findings to the work of others, implications of your results to the field, and suggestions for future work that could improve your ability to answer your research questions.

- **Conclusions (OPTIONAL)** - A concise summary of the "take-home" results, interpretations, and implications of your research. Similar to the abstract, but does not restate the study's setup.

- **References (REQUIRED)** - Choose a consistent journal format. If uncertain which to use, use Paleobiology style, as it the instructor's favorite.

- **Data Appendix (REQUIRED)** - A file or table that contains all data you used for your paper. You must submit a data appendix with the draft of your Introduction and Methods draft, but you should update this appendix as you revise or add to your data over the course.

Project Presentations In week 3, students will take turns introducing the rest of the class to the data and questions they are planning on addressing in the term project. This presentation does not require slides or graphics (although you can use them if you want), and should be less than 5 minutes in duration.

Similarly, in week 12, students will again present to the class their project, covering again the questions motivating the research, the nature of the dataset, and which methods they are planning to apply, or have already applied, to the dataset. Students should particularly focus on any difficulties they've encountered, or confusion they have about which methods to apply. Again, slides or graphics are not necessary, and the presentation should be kept brief, preferably under 5-8 minutes.

In the last week of the course, students will be asked to prepare a more detailed presentation as an endcap to the research project for the semester. Slides, figures and any other graphic aids are recommended. Students are expect to re-introduce the rest of the class to the motivation behind their analyses, the data they used, the methods they applied and why they chose those methods, and what the results can tell us about in the context of the system. (Depending on the class size, time constraints and public health emergencies, the instructor may poll the student on whether live presentations are preferred over recorded presentations.)

For all the above presentations, students in the audience will actively participate by posing questions (for the live presentations), as well as providing written feedback about each other's presentations, which will be passsed in an anonymized form to the presenter. Giving peer feedback, particularly on the final presentation, is a component of the Project Presentation grade.

Late Work Policy

Late work is discouraged, but will be accepted with a penalty relative to how late the submission is, depending on the assignment and reason given for the late submission. Work submitted late due to an excused absence is not considered late work, and is exempt from the late work policy.

Course Schedule

			Lecture Topic	Assignments
Week 1	Tu	Jan 18	Course Introductions	
	Th	Jan 20	Research Questions & Multivariate Data Set Structure	TP: Research Questions
Week 2	Tu	Jan 25	Programming with R in RStudio	Install R before Class!
	Th	Jan 27	Loading Data Sets & Manipulating Tables in R	PL: Loading Data
Week 3	Tu	Feb 1	Data Transformations & Cleaning Data in R	T P: Proposal; PL: Transformations
	Th	Feb 3	Typical Univariate Statistics: Parametric & Non-Parametric Tests	PL: Univariate
Week 4	Tu	Feb 8	Measuring Correlations & Fitting a Regression	PL: Correlations & Regressions
	Th	Feb 10	Multiple & Logistic Regression in R	TP: Introduction and Data
Week 5	Tu	Feb 15	Model Selection & Step-Wise Methods with the Akaike Information Criterion	PL: Regression Models
	Th	Feb 17	Yardsticks for Ecology: Diversity, Evenness & Richness	PL: Ecological Metrics
Week 6	Tu	Feb 22	Community Ecology Metrics in R; Rarefaction and Collector's Curves	PL: Rarefaction
	Th	Feb 24	Dissimilarity Metrics & Their Uses (ANOSIM, PERMANOVA)	PL: Dissimilarity Matrices
Week 7	Tu	Mar 1	Cluster Analyses: Visualizing Dissimilarity	PL: Cluster Analysis
	Th	Mar 3	Cluster Analyses in R	DR 1: Cluster Analysis (begin)
Week 8	Tu	Mar 8	Understanding Principal Component Analysis (PCA) for Metric Data	DR1: Cluster Analysis (due)
	Th	Mar 10	Performing and Interpreting a PCA	TP: Methods Draft; PL: PCA
Spring Break	Tu	Mar 15	**Spring Break**	
	Th	Mar 17	**Spring Break**	
Week 9	Tu	Mar 22	PCO/MDS & NMDS in R	PL: PCO & NMDS
	Th	Mar 24	Do an Ordination with your Data in Class	DR2: Ordinations (begin)
Week 10	Tu	Mar 29	Detrended Correspondence Analysis (DCA) for Community Ecology in R	PL: CA & DCA
	Th	Mar 31	Direct Gradient Analysis in R (CCA, RDA)	DR2: Ordinations (due)
Week 11	Tu	Apr 5	**Term Project Progress Presentations**	
	Th	Apr 7	**Term Project Progress Presentations**	

			Lecture Topic	Assignments
Week 12	Tu	Apr 12	Classification with Ordinations (LDA, CVA, DFA)	TP: Full Draft
	Th	Apr 14	More Classification with Ordinations	PL: DFA
Week 13	Tu	Apr 19	CART: Classification & Regression Tree Analysis	
	Th	Apr 21	CART & Random Forest in R	PL: CART
Week 14	Tu	Apr 26	**Final Project Presentations 1**	
	Th	Apr 28	**Final Project Presentations 2**	

Optional Course Information Items

- **Technology Support** – A great deal of this course involves using the programming language R on a computer. If you have technology issues with installing or running this software, please feel free to email the instructors so they can help you troubleshoot. A quicker and generally effective method is to take whatever message or warning that you've received, and try searching for solutions online using a search engine. For issues with University infrastructure, like the campus wifi or Canvas, you should contact TAMU IT Help Desk Central via email, virtual chat, phone, etc.

- **Student Resources** – A variety of student resources focused on health and safety are available to you should you need them, listed at the ECCB program's Student Resources page.

University Policies

Attendance Policy

The university views class attendance and participation as an individual student responsibility. Students are expected to attend class and to complete all assignments.

Please refer to Student Rule 7 in its entirety for information about excused absences, including definitions, and related documentation and timelines.

Makeup Work Policy

Students will be excused from attending class on the day of a graded activity or when attendance contributes to a student's grade, for the reasons stated in Student Rule 7, or other reason deemed appropriate by the instructor.

Please refer to Student Rule 7 in its entirety for information about makeup work, including definitions, and related documentation and timelines.

"Absences related to Title IX of the Education Amendments of 1972 may necessitate a period of more than 30 days for make-up work, and the timeframe for make-up work should be agreed upon by the student and instructor" (Student Rule 7, Section 7.4.1).

"The instructor is under no obligation to provide an opportunity for the student to make up work missed because of an unexcused absence" (Student Rule 7, Section 7.4.2).

Students who request an excused absence are expected to uphold the Aggie Honor Code and Student Conduct Code. (See Student Rule 24.)

Academic Integrity Statement and Policy

> ***"An Aggie does not lie, cheat or steal, or tolerate those who do."***

"Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one's work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case" (Section 20.1.2.3, Student Rule 20).

You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at aggiehonor.tamu.edu.

Americans with Disabilities Act (ADA) Policy

Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact the Disability Resources office on your campus (resources listed below) Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

Disability Resources is located in the Student Services Building or at (979) 845-1637 or visit disability.tamu.edu.

Title IX and Statement on Limits to Confidentiality

Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit gender-based discrimination and sexual harassment, including sexual assault, sexual exploitation, domestic violence, dating violence, and stalking.

With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see University Rule 08.01.01.M1):

- The incident is reasonably believed to be discrimination or harassment.
- The incident is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University.

Mandatory Reporters must file a report regardless of how the information comes to their attention – including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, you will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University's goal is to make sure you are aware of the range of options available to you and to ensure access to the resources you need.

Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with Counseling and Psychological Services (CAPS).

Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the University's Title IX webpage.

Statement on Mental Health and Wellness

Texas A&M University recognizes that mental health and wellness are critical factors that influence a student's academic success and overall wellbeing. Students are encouraged to engage in healthy self-care by utilizing available resources and services on campus. Students who need someone to talk to can contact Counseling & Psychological Services (CAPS) or call the TAMU Helpline (979-845-2700) from 4:00 p.m. to 8:00 a.m. weekdays and 24 hours on weekends. 24-hour emergency help is also available through the National Suicide Prevention Hotline (800-273-8255) or at suicidepreventionlifeline.org.

College and Department Policies

College and departmental units may establish their own policies and minimum syllabus requirements. As long as these policies and requirements do not contradict the university level requirements, colleges and departments can add them in this section.