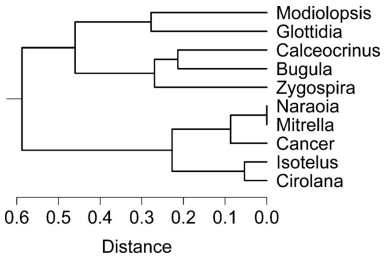
Multivariate Data Analysis for Ecology and Environmental Science

EVPP 651

3 credits

Spring Semester, 2025



Source: Philip M. Novack-Gottshall

INSTRUCTOR: Diego Valderrama.
3033 David King Hall
Tel: 703-993-1029
Email: dvalder@gmu.edu

CLASSROOM: Krug Hall, room 19.

CLASS MEETINGS: Mondays, 7:20 PM to 10:00 PM.

OFFICE HOURS: By appointment.

COURSE DESCRIPTION AND GOALS:

This course provides graduate students in ecology and environmental science with tools needed to analyze multivariate datasets. These datasets often arise from field studies of biological communities and suites of environmental factors like water quality. Similar tools are needed in biosystematics and molecular biology and these students should also find the course helpful.

This course assumes a basic knowledge of ecology and statistics. Students will learn the basic techniques for data exploration and preparation and specific techniques of classification and ordination as well as gaining practice in interpretation and presentation of results of these analyses. A hands-on approach will be taken with students working and conducting a thorough analysis of ecological datasets. After completion of the course, students will be competent to conduct multivariate analyses of their own data and to critically evaluate research papers utilizing a range of multivariate analyses.

COURSE CONTENT AND INSTRUCTIONAL METHODS:

The subject matter of this course is delivered in the form of lectures and practice problem sets. The class will meet weekly for 2 h 40 minutes in a computer classroom. On some dates lab time will be devoted to working on exams.

The course is divided into three sections: i) Intro and Cluster Analysis; ii) Principal Component Analysis; and iii) Other Ordination techniques. In each section we will learn the theory behind the analytical approach and work problems to facilitate hands-on learning of each approach.

Textbooks:

Legendre, P. and L. Legendre. 2012. *Numerical Ecology, Third English Edition*. Elsevier, Amsterdam (No need to purchase).

Borcard, D., F. Gillet and P. Legende. 2018. *Numerical Ecology with R, Second Edition.* Springer International Publishing, Cham, Switzerland. Companion book to L&L (2012). Available online through the George Mason University Libraries website.

- Please download the 'Script, Functions and Data' folder at http://www.numericalecology.com/numecolR/

Software: R, freely available at The R Project for Statistical Computing (https://www.r-project.org/; please make sure you have updated to at least version 4.1.3). RStudio (https://www.rstudio.com/) is strongly recommended as script manager. For general resources on learning and using R, feel free to check out the Mason Libraries' InfoGuide at https://infoguides.gmu.edu/learn_r

Exams: There will be four exams during the course, with most content assigned as take-home. If you have any questions while working on the exam, contact the instructor by e-mail.

COURSE GRADING: Weighting of the activities undertaken in class will be as follows:

Exam 1	30%
Exam 2	20%
Exam 3	25%
Exam 4	25%
TOTAL	100%

Your final score in the course will be calculated based on the percentage grade earned on each of the course activities listed above, multiplied by the weighting listed for each activity. Letter grades will be assigned based on your final course score as follows:

- A+ = 97 - 100%
- A = 93 – 96.99%
- A- = 90 – 92.99%
- B+ = 87 – 89.99%
- B = 83 – 86.99%
- B- = 80 – 82.99%
- C = 70 – 79.99%
- F = 0 – 69.99%

PLEASE NOTE THAT I DO NOT ROUND UP. FOR EXAMPLE, AN 89.99 IS A B+ AND IT WILL NOT BE ROUNDED UP TO AN A-.

TENTATIVE CLASS SCHEDULE: Subject to changes.

Week	Date	Topic	Textbook Chapters	
			Borcard *et al.* (2018)	**Legendre & Legendre (2012)**
1	Jan 27	Introduction to the course and R		
2	Feb 3	Exploratory Data Analysis	2	
3	Feb 10	Coefficients of Association	3	7
4	Feb 17	Cluster Analysis	4	8
5	Feb 24	Cluster Analysis continued (lab practice)	4	8
6	March 3	Exam 1		
7	Mar 10	**SPRING BREAK (NO CLASSES)**		
8	Mar 17	Principal Component Analysis (PCA) - Theory		9
9	Mar 24	Principal Component Analysis (PCA) - Practice	5	9
10	Mar 31	Exam 2 (Take Home) given out		
11	April 7	Other Ordination Techniques: Correspondence Analysis (CA) and Principal Coordinate Analysis (PCoA)	5	9
12	April 14	Other Ordination Techniques: Non-metric Multidimensional Scaling (nMDS)	5	9
13	Apr 21	Exam 3 (Take Home) given out.		
14	Apr 28	Redundancy Analysis		
15	May 5	PERMANOVA Exam 4 (Take Home) given out.		

Common Policies Affecting All Courses at George Mason University

Updated August 2024

These four policies affect students in all courses at George Mason University. This Course Policy Addendum must be made available to students in all courses (see Catalog Policy AP.2.5).

Additional policies affecting this course, and additional resources or guidance regarding these policies, may be provided to students by the instructor.

Academic Standards

Academic Standards exist to promote authentic scholarship, support the institution's goal of maintaining high standards of academic excellence, and encourage continued ethical behavior of faculty and students to cultivate an educational community which values integrity and produces graduates who carry this commitment forward into professional practice.

As members of the George Mason University community, we are committed to fostering an environment of trust, respect, and scholarly excellence. Our academic standards are the foundation of this commitment, guiding our behavior and interactions within this academic community. The practices for implementing these standards adapt to modern practices, disciplinary contexts, and technological advancements. Our standards are embodied in our courses, policies, and scholarship, and are upheld in the following principles:

- **Honesty:** Providing accurate information in all academic endeavors, including communications, assignments, and examinations.
- **Acknowledgement:** Giving proper credit for all contributions to one's work. This involves the use of accurate citations and references for any ideas, words, or materials created by others in the style appropriate to the discipline. It also includes acknowledging shared authorship in group projects, co-authored pieces, and project reports.
- **Uniqueness of Work:** Ensuring that all submitted work is the result of one's own effort and is original, including free from self-plagiarism. This principle extends to written assignments, code, presentations, exams, and all other forms of academic work.

Violations of these standards—including but not limited to plagiarism, fabrication, and cheating—are taken seriously and will be addressed in accordance with university policies. The process for reporting, investigating, and adjudicating violations is outlined in the university's procedures. Consequences of violations may include academic sanctions, disciplinary actions, and other measures necessary to uphold the integrity of our academic community.

The principles outlined in these academic standards reflect our collective commitment to upholding the highest standards of honesty, acknowledgement, and uniqueness of work. By adhering to these principles, we ensure the continued excellence and integrity of George Mason University's academic community.

Student responsibility: Students are responsible for understanding how these general expectations regarding academic standards apply to each course, assignment, or exam they participate in; students should ask their instructor for clarification on any aspect that is not clear to them.

Accommodations for Students with Disabilities

Disability Services at George Mason University is committed to upholding the letter and spirit of the laws that ensure equal treatment of people with disabilities. Under the administration of University Life, Disability Services implements and coordinates reasonable accommodations and disability-related services that afford equal access to university programs and activities. Students can begin the registration process with Disability Services at any time during their enrollment at George Mason University. If you are seeking accommodations, please visit https://ds.gmu.edu/ for detailed information about the Disability Services registration process. Disability Services is located in Student Union Building I (SUB I), Suite 2500. Email: ods@gmu.edu. Phone: (703) 993-2474.

Student responsibility: Students are responsible for registering with Disability Services and communicating about their approved accommodations with their instructor *in advance* of any relevant class meeting, assignment, or exam.

FERPA and Use of GMU Email Addresses for Course Communication

The Family Educational Rights and Privacy Act (FERPA) governs the disclosure of education records for eligible students and is an essential aspect of any course. **Students must use their GMU email account** to receive important University information, including communications related to this class. Instructors will not respond to messages sent from or send messages regarding course content to a non-GMU email address.

Student responsibility: Students are responsible for checking their GMU email regularly for course-related information, and/or ensuring that GMU email messages are forwarded to an account they do check.

Title IX Resources and Required Reporting

As a part of George Mason University's commitment to providing a safe and non-discriminatory learning, living, and working environment for all members of the University community, the University does not discriminate on the basis of sex or gender in any of its education or employment programs and activities. Accordingly, **all non-confidential employees, including your faculty member, have a legal requirement to report to the Title IX Coordinator, all relevant details obtained directly or indirectly about any incident of Prohibited Conduct** (such as sexual harassment, sexual assault, gender-based stalking, dating/domestic violence). Upon notifying the Title IX Coordinator of possible Prohibited Conduct, the Title IX Coordinator will assess the report and determine if outreach is required. If outreach is required, the individual the report is about (the "Complainant") will receive a communication, likely in the form of an email, offering that person the option to meet with a representative of the Title IX office.

For more information about non-confidential employees, resources, and Prohibited Conduct, please see University Policy 1202: Sexual and Gender-Based Misconduct and Other Forms of Interpersonal Violence. Questions regarding Title IX can be directed to the Title IX Coordinator via email to TitleIX@gmu.edu, by phone at 703-993-8730, or in person on the Fairfax campus in Aquia 373.

Student opportunity: If you prefer to speak to someone ***confidentially***, please contact one of Mason's confidential employees in Student Support and Advocacy (SSAC), Counseling and Psychological Services (CAPS), Student Health Services (SHS), and/or the Office of the University Ombudsperson.