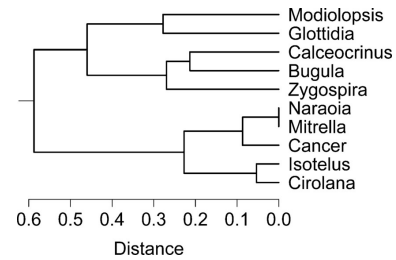


# Multivariate Data Analysis for Ecology and Environmental Science

## EVPP 651

### 3 credits

### Spring Semester, 2024



Source: Philip M. Novack-Gottshall

**INSTRUCTOR:** Diego Valderrama.  
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**CLASSROOM:** Innovation Hall, room 205.

**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. Legendre. 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](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	<u>25%</u>
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-.

**ACADEMIC INTEGRITY:** GMU students, faculty and staff are bound by the GMU Honor Code. Adherence to the GMU Honor Code is expected of all students, specifically:

*Members of the George Mason University community pledge not to cheat, plagiarize, steal, or lie in matters related to academic work.*

In all assignments and communications, plagiarism will not be tolerated. This applies equally to oral and written communications in the context of any evaluated (graded) course assignments. As stated in the Honor Code, infractions may result in invalidated credit for dishonorable work and lowered grade, including failure from the class, suspension or dismissal. Inquiries for clarification from the professor are welcome. For more information see the complete Honor Code in the university catalog.

**DISABILITY ACCOMMODATIONS:** 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 <http://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](mailto:ods@gmu.edu) | Phone: (703) 993-2474.

**DIGITAL COMMUNICATION:** Students must use their MasonLive email account to receive important University information, including communications related to this class. I will not respond to messages sent from or send messages to a non-Mason email address.

**DIVERSITY STATEMENT:** George Mason University promotes a living and learning environment for outstanding growth and productivity among its students, faculty and staff. Through its curriculum, programs, policies, procedures, services and resources, Mason strives to maintain a quality environment for work, study and personal growth. An emphasis upon diversity and inclusion throughout the campus community is essential to achieve these goals. Diversity is broadly defined to include such characteristics as, but not limited to, race, ethnicity, gender, religion, age, disability, and sexual orientation. Diversity also entails different viewpoints, philosophies, and perspectives. Attention to these aspects of diversity will help promote a culture of inclusion and belonging, and an environment where diverse opinions, backgrounds and practices have the opportunity to be voiced, heard and respected.

**NOTICE OF MANDATORY REPORTING OF SEXUAL OR INTERPERSONAL**

**MISCONDUCT:** As a faculty member, I am designated as a “Non-Confidential Employee,” and must report all disclosures of sexual assault, sexual harassment, interpersonal violence, stalking, sexual exploitation, complicity, and retaliation to Mason’s Title IX Coordinator per University Policy 1202. If you wish to speak with someone confidentially, please contact one of Mason’s confidential resources, such as Student Support and Advocacy Center (SSAC) at 703-993-3686 or Counseling and Psychological Services (CAPS) at 703-993-2380. You may also seek assistance or support measures from Mason’s Title IX Coordinator by calling 703-993-8730, or emailing [titleix@gmu.edu](mailto:titleix@gmu.edu).

**TENTATIVE CLASS SCHEDULE:** Subject to changes.

Week	Date	Topic	Textbook Chapters	
			Borcard <i>et al.</i> (2018)	Legendre & Legendre (2012)
1	Jan 22	Introduction to the course and R		
2	Jan 29	Exploratory Data Analysis	2	
3	Feb 5	Coefficients of Association	3	7
4	Feb 12	Cluster Analysis	4	8
5	Feb 19	Cluster Analysis continued (lab practice)	4	8
6	Feb 26	Exam 1		
7	Mar 4	<b>SPRING BREAK (NO CLASSES)</b>		
8	Mar 11	Principal Component Analysis (PCA) - Theory		9
9	Mar 18	Principal Component Analysis (PCA) - Practice	5	9
10	Mar 25	Exam 2 (Take Home) given out		
11	April 1	Other Ordination Techniques: Correspondence Analysis (CA) and Principal Coordinate Analysis (PCoA)	5	9
12	April 8	Other Ordination Techniques: Non-metric Multidimensional Scaling (nMDS)	5	9
13	Apr 15	Exam 3 (Take Home) given out.		
14	Apr 22	Redundancy Analysis		
15	Apr 29	PERMANOVA Exam 4 (Take Home) given out.		