

## EVPP 991 – 004: Experimental Design for Environmental Scientists

**Meeting Time:** Wednesday 4:30 – 6:20 pm

**Location:** Innovation Hall 317

**Instructors:** **Dr. T. Reid Nelson**, [tnelso3@gmu.edu](mailto:tnelso3@gmu.edu)  
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**Course Web Site:** Go to <http://mymason.gmu.edu>, log in with your email name and your GMU email password, select Blackboard, and then select Diversity of Fishes EVPP-536 (Fall 2021). All information will be in this location.

### Course Description and Goals:

This course will cover the basic experimental design knowledge necessary for a graduate student to design and execute a research project. The course aims to have students learn how to think about their study system and research question of interest in a systematic way in order to design an efficient sampling and experimental research program. We will emphasize thinking about whole biological systems, causality, and the limits of inference that can be drawn from observational versus experimental studies. The course will build through a series of topics, selected each semester by the class. We will begin by thinking about the basics of how we sample populations and how we describe those samples. We will move on to the fundamentals of hypothesis testing as a jumping off point for more complex levels of experimental design. Beyond becoming familiar with experimental design, this course will build and improve your critical thinking and reading skills and ensure that you are comfortable thoroughly digesting scientific literature. Furthermore, this course will improve your communication skills through presentations and in class discussions.

### Student-led Presentation and Discussion (50% of grade):

Given that our course is a seminar, the majority of the course will be student led presentations and discussions on experimental design and examples/readings from the primary literature. You will explore a specific experimental design (approved by me) that you find interesting and ideally pertinent to your research. You will research this topic providing the results of your background research and a synopsis of 2 scientific papers (published within the last 10 years) with the class, focusing on their design and analysis. You will prepare one 30 – 45 minute PowerPoint lecture explaining the experimental design topic, detailing key vocabulary words, what situations you would use the design for, providing theoretical examples and what statistical tests could be used. You will need to explain how these statistical test(s) operate at a conceptual level as well as their assumptions. You will end your presentation with a synopsis of you chosen papers, focusing on their design and analysis. In this part of the presentation be sure to highlight their hypotheses and research questions, designs to test these questions (sample size, factors, treatments, replication, controls, etc.), their statistical analysis, results and interpretation.

After your presentation, you will lead a discussion (~30 minutes) of your two chosen papers published within the last 10 years. Discussions will focus on the experimental design used in each manuscript, ensuring that their design (sample size, treatments, replication, controls, etc.) was appropriate to answer the stated research objectives and that their results and interpretations were supported by their analyses and design. In many instances, conclusions are made beyond what is supported by a study, or people decide on a favorite hypothesis to explain the phenomena they observe. I encourage everyone to read with a critical mindset and continually ask themselves if the authors statements are supported by their study or if the are speculative. Speculation is fine in a scientific paper as long as it is clear that is what is occurring.

Peer review is an essential component of modern science. To this end, you all and myself will fill out a brief evaluation for each of their colleague’s talks. The evaluation form will ask you to briefly address overall performance as well as organization, clarity, and slide “aesthetics.” Your grade for your presentation and discussion will be based on these forms with an average taken among all forms.

Your peers will be responsible for coming to class prepared to discuss the current weeks design and assigned scientific literature. To this end, for each week you are not presenting, you are required to upload 2 questions/topic to a blackboard discussion page prior to the start of class and be prepared to ask these questions in class. Furthermore, you are expected to fully participate in class discussions, given that we each have unique insight that we can all learn from.

**Potential Topics and Presentation Schedule**

<b>Week</b>	<b>Date</b>	<b>Topic</b>	<b>Presenter</b>
1	1/26	Introduction to Class, Overview, and Experimental Design	Dr. T. Reid Nelson
2	2/2	Environmental Sampling Schemes	
3	2/9	Power Analysis and Sample Size Estimation	
4	2/16	Psuedoreplication	
5	2/23	Linear Regression Designs	
6	3/2	Single Factor Design (ANOVA & Non-Parametric alternatives)	
7	3/9	Nested Designs	
8	3/16	Spring Recess (no class)	
9	3/23	Multiple Factor Designs (Full factorial analysis)	
10	3/30	Randomized Block Designs	
11	4/6	Repeated Measures	
12	4/13	Before After Control Impact (BACI) Designs	
13	4/21	Multivariate Community Analysis	
14	4/27	Generalized Linear Models & Mixed Models (GLM & GLMM)	
15	5/4	Meta-Analyses	

**Other Potential Topics**

- Long-term Datasets
- Interview Designs
- Observational Studies
- Analysis of Covariance (ANCOVA)
- Fixed vs. Random Effects
- Principal Component and Correspondence Analysis
- Non-linear Regression

Segmented Regression  
Split-Plot Designs  
Generalized Additive Models (GAM)  
Problems of Scale in Ecology  
Other designs you are interested in, please let me know!

**To help digest each scientific paper, follow the points below:**

Identify the point of the paper. What was the authors' question? What general principles or big ideas are the authors' addressing? Did you find yourself asking questions that the introduction did not address?

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Identify the point of the paper. What was the authors' question? What general principles or big ideas are the authors' addressing? Did you find yourself asking questions that the introduction did not address?

Briefly summarize each figure. The authors chose these figures because they tell the story of the data and usually build on one another. It might be useful to identify what question(s) each figure is addressing. Summarize the main conclusion of the figure and point out any criticisms you might have.

What figures were the most important?

Identify the methods/techniques used for this experiment. A flow chart might be a useful way to imagine this.

Were the authors able to support their hypothesis? Why or why not? Why are the conclusions important (i.e., why should we care?)?

While the paper is still fresh in your mind, jot down two points you would like to discuss about the paper itself – questions about their models or predictions, how the data were interpreted, or what was confusing (this is what you need to turn in prior to class). Summarize what was really great about the paper and what was really bad.

**Additional Resources for how to read a scientific paper:**

<https://www.science.org/content/article/how-seriously-read-scientific-paper>  
<https://www.elsevier.com/connect/infographic-how-to-read-a-scientific-paper>  
<http://www.virology.ws/2012/04/06/how-to-read-a-scientific-paper/>  
<https://www.youtube.com/watch?v=Fm6pdg3uAPA>

**Grading:** Your Presentation and Discussion will constitute 50% of your final grade, with the remaining 50% coming from your prepared questions for class (20%) and participation in our weekly discussion (30%). This course will be graded on the university wide graduate scale (see below) and there will be no final exam or research paper due in this course.

Assignment	Percentage	Grade	Score
Presentation & Discussion Lead	50 %	A+	97 - 100
Class Preparation	20 %	A	93 - 96
Discussion Participation	30 %	A-	90 - 92
		B+	87 - 89
		B	83 - 86
		B-	80 - 82
		C	70 - 79
		F	< 70

**While there is no required text, the below texts will be useful in your discussion preparation.**

Underwood, A. J. 1997. Experiments in ecology: their logical design and interpretation using analysis of variance. Cambridge University Press.

Quinn, G. P. (Gerald P., and M. J. Keough. 2002. Experimental design and data analysis for biologists. Cambridge University Press, Cambridge, U.K.

Karban, R., M. Huntzinger, and I. S. Pearse. 2014. How to Do Ecology A Concise Handbook Second Edition. Princeton University Press.

\*\*\*YOU CAN ACCESS How to Do Ecology FOR FREE THROUGH THE GMU LIBRARY\*\*\*

Once logged in with your account, search the title, and then select online resources. Click on the JSTOR link to download all sections of the book for free!

**Honor Code:** Mason is an Honor Code university; please see the Office for Academic Integrity for a full description of the code and the honor committee process (see below for the student pledge). In this course the honor code applies as follows, when you are responsible for a task, you will perform that task. When you rely on someone else's work in presentations or papers, you will give proper citation to that work.

*Student Pledge:* To promote a stronger sense of mutual responsibility, respect, trust, and fairness among all members of the George Mason University Community and with the desire for greater academic and personal achievement, we, the student members of the university community, have set for this Honor Code: Student Members of the George Mason University community pledge not to cheat, plagiarize, steal, or lie in matters related to academic work.

**Gender identity and pronoun use:** If you wish, please share your name and gender pronouns with me and how best to address you in class and via email. I use he/him/his for myself and you may address me as Reid or Dr. Nelson in email and verbally.

**Safe Return to Campus Statement:** First of all, I want to address that these are new and uncertain times for everyone. Over the course of the pandemic, I have dealt with my own anxiety and stress management issues and strongly encourage everyone to practice good self-care and try to consciously maintain a healthy mental state. For anyone that is feeling anxious or overwhelmed by the return to campus, the state of the world in general, or any other issues, please reach out to the Counseling and Psychological Services (CAPS) center and seek help as needed <https://caps.gmu.edu/covid19/>. Speaking from personal experience, talking to someone and getting strategies to maintain good mental health can be paramount to our well-being, happiness, and intellectual pursuits.

All students taking courses with a face-to-face component are required to follow the university's public health and safety precautions and procedures outlined on the university Safe Return to Campus webpage (<https://www2.gmu.edu/safe-return-campus>). Similarly, all students in face-to-face and hybrid courses must also complete the Mason COVID Health Check daily, seven days a week. The COVID Health Check system uses a color code system and students will receive either a Green, Yellow, or Red email response. Only students who receive a "green" notification are permitted to attend courses with a face-to-face component. If you suspect that you are sick or have been directed to self-isolate, please quarantine or get testing. Faculty are allowed to ask you to show them that you have received a Green email and are thereby permitted to be in class. Students are required to follow Mason's current policy about facemask-wearing. As of August 11, 2021, all community members are required to wear a facemask in all indoor settings, including classrooms. An appropriate facemask must cover your nose and mouth at all times in our classroom. If this policy changes, you will be informed; however, students who prefer to wear masks either temporarily or consistently will always be welcome in the classroom.

**Absenteeism Policy:** I believe that being in the classroom is a valuable experience where a free exchange of ideas and healthy academic debate can flourish. In person presentations and discussions are also paramount to the learning process and building a sense of community. Therefore, I hope that everyone can make plans to be in class as frequently as possible. We live in uncertain times and unforeseen personal issues may arise. If these occur please contact me as soon as possible and we will work together to accommodate absences as needed.

**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.

**Sexual Harassment, Sexual Misconduct, and Interpersonal Violence:** George Mason University is committed to providing a learning, living and working environment that is free from discrimination and a campus that is free of sexual misconduct and other acts of interpersonal violence in order to promote community well-being and student success. We encourage students and employees who believe that they have been sexually harassed, sexually assaulted or subjected to sexual or interpersonal misconduct to seek assistance and support. University Policy 1202: Sexual Harassment and Misconduct speaks to the specifics of Mason's process, the resources, and the options available to students and employees.

**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). Unforeseen personal issues may arise and if these occur please contact me as soon as possible and we will work together to accommodate absences as needed.