Experimental Design for Environmental Scientists

EVPP 991-002
Lecture Wednesdays 7:20 – 9:10pm
Innovation Hall 211

Instructor

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Goals of this Course

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.

Textbook

Recommended Texts:

I will be drawing on examples and materials from several sources. You are not required to have these, but you will either find them useful in this course or in future endeavors.

Underwood, A.J. 1997. *Experiments in Ecology*. Cambridge University Press. 524 pp.

Townend, John. 2002. *Practical Statistics for Environmental and Biological Scientists*. John Wiley and Sons, Ltd. 276 pp.

Ruxton, G.D. and Colegrave, N. 2016. *Experimental Design for the Life Sciences*. Oxford University Press, USA. 224 pp.

Skalisko, JR. 1992. *Techniques in Wildlife Investigations: Designs and Analysis of Capture Data*. Academic Press. 254 pp.

Karban, R., Huntzinger, M., Pearse I.S. 2014. *How to do Ecology: A concise handbook*. Princeton University Press. 200 pp.

Grading and Assignments

The final grade you earn in this course will be based on your performance in homeworks (20%), discussions (30%) and presentations (50%). Final grades will be assigned using the university-wide system for grading graduate courses:

A	(94 - 100 %)	B-	(80 - 82.99 %)
A-	(90 - 93.99 %)	C	(70 - 79.99 %)
B+	(87 - 89.99 %)	F	(< 70 %)
B	(83 - 86.99 %)		

Student-led Presentation and Discussion (50% of grade): This assignment will allow you to explore a specific area in experimental design that you find interesting and share the results of your background and library research with your colleagues. Each student will prepare two 30-45 minute powerpoint lecture on a subject, detailing key vocabulary words and providing theoretical framework. After, each student will lead a 30-45 minute discussion of two relevant papers published within the last 10 years. Discussions will focus on the experimental design used in each manuscript.

Peer review is an essential component of modern science. To this end, students will fill out a brief evaluation for each of their colleague's talks. The evaluation form will ask students to briefly address overall performance as well as organization, clarity, and slide "aesthetics."

Discussion and Homework (50% of grade): Every student is expected to come to class prepared to discuss each paper. Students should be able to: 1) identify the question(s) being addressed; 2) describe the approaches used to address the question; 3) summarize the data presenting in figures and tables; 4) assess the significance and/or validity of the authors' conclusions; and where appropriate, 5) propose follow-on experiments. To stimulate discussion in class, students will prepare and submit 2 questions related to each manuscript chosen for discussion.

In order to help you 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?

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. Summarize what was really great about the paper and what was really bad.

Other excellent resources for how to read a scientific paper/article:
http://www.virology.ws/2012/04/06/how-to-read-a-scientific-paper/
http://www.youtube.com/watch?v=gytqXl-hr8M
http://twp.duke.edu/uploads/media_items/scientificarticlereview.original.pdf

Possible discussion topics:

- Single factor experiments,
- Multifactor experiments,
- Randomized complete block designs,
- Repeated Measures experiments,
- Nested experiments,
- Split-plot designs,
- Factorial designs,
- Latin Square designs,
- Experiments with covariation,
- Long-term experiments or studies,
- Observational vs experimental studies
- Matched Sampling in observational studies
- Tabular designs
- Proportional designs
- Biodiversity Ecosystem Functioning (BEF) experiments,
- Before-After-Control-Impact (BACI) designs,
- Environmental Impact designs,
- Meta-analyses,
- Spatial autocorrelation,
- Additive – Replacement design,
- Monoculture vs Polyculture,
- Importance of scale in designs,
- Random, stratified, systematic, ranked set, composite, and adaptive cluster sampling

Practical Matters

Please Be prepared for class and Do not be late to class (classes will start on time).

Students must use their gmu.edu 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.

Cell phones and other communicative devices are not to be used during class. Please keep them stowed away and out of sight. Laptops or tablets may be permitted for the purpose of taking notes only, but you must submit a request in writing to do so. Engaging in activities not related to the course (e.g., gaming, email, chat, etc.) will result in a significant deduction in your participation grade.

Regarding electronic devices (such as laptops, cell phones, etc.), please be respectful of your peers and your instructor and do not engage in activities that are unrelated to class. Such disruptions show a lack of professionalism and may affect your participation grade.

Late assignments will be penalized at least 10% for each 24-hour interval that they are late. Assignments > 1 week late will not be accepted unless you have medical or other valid *documented* reasons for the delay. In certain cases, students will be allowed to take the exam at a unique time - this will usually be held in my office **before** the scheduled class exam. The only valid reasons for missing an assignment deadline or an examination are those accepted by the University (see http://catalog.gmu.edu/content.php?catoid=5&navoid=104) and include death in the immediate family and major illness of the student.

Current COVID-19 Policies: 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 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, Red, or Blue 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 will always be welcome in the classroom.

Basic Course Technology Requirement: Activities and assignments in this course will regularly use the Blackboard learning system, available at https://mymason.gmu.edu. Students are required to have regular, reliable access to a computer with an updated operating system (recommended: Windows 10 or Mac OSX 10.13 or higher) and a stable broadband Internet connection (cable modem, DSL, satellite broadband, etc., with a consistent 1.5 Mbps [megabits per second] download speed or higher.

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 she/her for myself and you may address me as "Dr. Fowler" in email and verbally.

Academic Integrity: It is expected that students adhere to the George Mason University Honor Code as it relates to integrity regarding coursework and grades. The Honor Code reads as follows: "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 forth this: Student members of the George Mason University community pledge not to cheat, plagiarize, steal and/or lie in matters related to academic work." More information about the Honor Code, including definitions of cheating, lying, and plagiarism, can be found at the Office of Academic Integrity website at http://oai.gmu.edu. Students should read these statements and understand their implications and how they apply to this course. Any violation of the code of academic integrity will result in a severe penalty assessed on the final grade. This penalty will range from a **minimum** of a full letter grade reduction to an F for the course. All academic integrity violations will be reported to the Chair of the Department of Environmental Science and Policy, the Dean of the College of Science, and the Director of the Academic Integrity Board.

Any assignment turned in for a grade in this course must reflect your work and your work only.

All course materials posted to Blackboard or other course site are private to this class; by federal law, any materials that identify specific students (via their name, voice, or image) must not be shared with anyone not enrolled in this class.

Student Disabilities: If you are a student with a disability and you need academic accommodations, please see me and contact Disability Services at 703.993.2474 or ods.gmu.edu. All academic accommodations must be arranged through that office at the beginning of the semester.

Wk	Date	Lecture topic
1	25 Aug	Class introduction and overview Introduction to Experimental Design – Dr. Fowler
2	8 Sept	Regression Designs – Dr. Fowler
3	15 Sept	Power and Sample Size Estimation
4	22 Sept	Pseudoreplication
5	26 Sept	Randomized Block Design
6	6 Oct	Single factor Experiments
7	13 Oct	Multiple factor Experiments
8	20 Oct	Nested Designs
9	27 Oct	Repeated Measures Experiments
10	3 Nov	Before After Control Impact Designs
11	10 Nov	Topical
12	17 Nov	Topical
13	21 Nov	**No class - Thanksgiving**
14	28 Nov	**No class**
15	5 Dec	**No class**

No FINAL EXAM

Presenter's Name_____ Presenter's Topic_____

Standards	5 - 4 Exemplary	3 - 2 Satisfactory	1-0 Unacceptable	Score	Weight	Total Score
Organization	Has a clear opening statement that catches audience's interest; maintains focus throughout; summarizes main points	Has opening statement relevant to topic and gives outline of speech; mostly organized; provides adequate "road map" for the listener	Has no opening statement or has an irrelevant statement; gives listener no focus or outline of the presentation		X 4	
Content	Demonstrates substance and depth; is comprehensive; shows mastery of material; clearly explains data	Covers topic; uses appropriate sources; is objective; explains data confusingly	Does not give adequate coverage of topic; lacks sources; minimal data explanations		X 4	
Quality of conclusion	Delivers a conclusion that is well documented and persuasive	Summarizes presentation's main points; draws conclusions based upon these points	Has missing or poor conclusion; is not tied to analysis; does not summarize points that support the conclusion		X 3	
Delivery	Has natural delivery; modulates voice; is articulate; projects enthusiasm, interest, and confidence; uses body language effectively	Has appropriate pace; has no distracting mannerisms; is easily understood	Is often hard to understand; has voice that is too soft or too loud; has a pace that is too quick or too slow; demonstrates one or more distracting mannerisms		X 2	
Use of media	Uses slides effortlessly to enhance presentation; has an effective presentation even without media; does not read notes	Looks at slides to keep on track; uses an appropriate number of slides; may glance at written notes	Relies heavily on slides and notes; makes little eye contact; uses slides with too much text		X 1	
Editing	Scientific names are italicized and correctly capitalized; spelling is correct; color choices are helpful; images are correctly sized; slides are pleasing to look at	Some editing mistakes	Many editing mistakes		X 1	
Response to Questions	Demonstrates full knowledge of topic; explains and elaborates on all questions	Shows ease in answering questions but does not elaborate	Demonstrates little grasp of information; has undeveloped or unclear answers to questions		X 2	
Discussion	Encourages audience interaction; calls peers by name; poses thought provoking questions	Has a couple of questions for discussion; does not actively engage peers	Hardly any discussion; comes unprepared to lead discussion on topic		X 3	

Grand Total _____/100

Notes: