Quantitative Methods for Environment and Natural Resources Syllabus

ENR 8780 Spring 2022

Course Information

Course times and location: Tuesday and Thursday 2:20 – 3:40 PM, Laboratory: TBD
(typically Friday morning via zoom, alternative is Monday morning)

- **Credit hours:** 3
- **Mode of delivery:** In-person

Instructor

- **Name:** Robert J. Gates
- **Email:** gates.77@osu.edu
- **Office location:** 383C Kottman Hall
- **Office hours:** By appointment
- **Preferred means of communication:**
  - My preferred method of communication for questions is **email.**
  - My class-wide communications will be sent through the Email or Announcements tool in CarmenCanvas. Please check your [notification preferences](go.osu.edu/canvas-notifications) (go.osu.edu/canvas-notifications) to be sure you receive these messages.

- Lecture/lab zoom link (when needed):
  https://osu.zoom.us/j/93218498253?pwd=MW9OS0JLc2ZYL1A0bDRac3JnVkFhUT09

- Office hours and zoom link:
  https://osu.zoom.us/j/93546381885?pwd=VGZoKzViL00xSG5hME1uUEQxcXROZz09

Course Prerequisites

Stat 5302 (530) or equiv, and Grad standing; or permission of instructor. Not open to students with credit for ENR 822.

Course Description

Environmental and Natural Resources (ENR) scientists are often faced with analyzing complex data sets collected from ecological communities, agro-ecosystems, or designed experiments conducted in the laboratory and the field. Natural Resource and Environmental scientists use a variety of statistical analyses to model these relationships, regardless of whether studies are descriptive, mensurative, or experimental. These data seldom satisfy assumptions of common statistical tests that are covered in more foundational statistics courses. The advent of open-source statistical analysis software such as R has made a wide variety of statistical applications that are better suited to the questions, study designs, and data structures or distributions that researchers encounter compared to more conventional analysis methods.

As a result, ENR scientists have a wealth of statistical methods and paradigmatic approaches to make inferences from their data, but it is often difficult to determine which method or paradigm will produce the most clear and robust results. This course begins with applying univariate analyses including multivariable ANOVA and nonlinear regression models, then moves on to mixed effects, generalized linear, generalized additive, and generalized estimating equation models during the first half of the course. The second half of the course covers multivariate methods that extend statistical analyses and models to data sets with more than one dependent variable. Students work though this progression of statistical methods applying each in turn to their own data or data sets provided to gain knowledge and experience with the analytical methods that are available for application to data from their own graduate research program. The course culminates with a professional paper that students develop with a specific application to one or more research questions of interest to them. The course throughout stresses evaluating and meeting assumptions to properly fit models, and careful interpretation with clear presentation of results.

Learning Outcomes

- gain working knowledge of advanced univariate and multivariate methods that are used to analyze environment and natural resources data;

- apply advanced statistical analyses to answer research questions that emanate from environmental, natural resources, and related disciplines, or interpret and critique analyses and results of peers;

- learn and practice proper and efficient presentation of statistical analyses in oral and written formats/venues, including theses/dissertations, and peer-reviewed manuscripts.

How This Course Works

Mode of delivery: This course is delivered primarily in-person. We have required lecture sessions each week on Tuesdays and Thursdays from 2:20 to 3:40 pm in KH245. Informal consultation/recitation sessions will be offered via zoom on Friday or Monday each week (TBD) The remainder of your work will be on your own using R/RStudio with resources made available in Carmen each week.

Pace of online activities: This course is divided into **weekly modules** that are released ahead of class on Tuesday. Students are expected to keep pace with bi-weekly assignments but may schedule their efforts freely within each module.

Credit hours and work expectations: This is a 3 credit-hour course. According to Ohio State bylaws on instruction (go.osu.edu/credit hours), students should expect around 3 hours per week of time spent on direct instruction (instructor content and Carmen activities, for example) in addition to 6 hours of homework (reading and assignment preparation, for example) to receive a grade of C average.

Attendance and participation requirements: Regular participation is one of the highest predictors of success. With that in mind, I have the following expectations for everyone's participation:

- **Zoom meetings and office hours**: I will post recordings of synchronous sessions for those who cannot attend, and for your later reference. Attendance of the laboratory/consultation sessions on Friday or Monday are optional but highly encouraged. I will also schedule at least 2-3 individual zoom check-in sessions to go over homework assignments as they are graded during the semester and to discuss your final term project paper.

- **Participating in-person (preferred) or via zoom (when necessary) class sessions:** You are expected to log in to the course in Carmen each week. During most weeks you will probably log in many times. Please notify me if you have a situation that might cause you to miss class in person or via zoom.

Required Materials and/or Technologies

- Bring laptop computer to class lectures if you find that useful as we go. I anticipate that you will.

- Download and install/update R for mac or PC at https://www.r-project.org/

- Download and install/update RStudio IDE for mac or PC at https://www.rstudio.com/products/rstudio/download/

- A data set to work on throughout the semester. Preferably a data set from your graduate research project, advisor or lab mates. Data set optimally includes multiple variables that can be construed as dependent responses or independent predictors in

as statistical model. A mixture of both categorial and continuous variables on the dependent and independent sides is ideal.

Recommended/Optional Materials and/or Technologies

- Reference or required readings will be posted each week on Carmen/Canvas

- R vignettes, tutorials, and R scripts will be posted each week on Carmen/Canvas

Required Equipment

- **Computer:** current Mac (MacOS) or PC (Windows 10) with high-speed internet connection

- **Webcam:** built-in or external webcam, fully installed and tested

- **Microphone:** built-in laptop or tablet mic or external microphone

- **Other:** a mobile device (smartphone or tablet) to use for BuckeyePass authentication

If you do not have access to the technology you need to succeed in this class, review options for technology and internet access at go.osu.edu/student-tech-access.

Required Software

Microsoft Office 365: All Ohio State students are now eligible for free Microsoft Office 365. Visit the installing Office 365 (go.osu.edu/office365help) help article for full instructions.

CarmenCanvas Access

You will need to use BuckeyePass (buckeyepass.osu.edu) multi-factor authentication to access your courses in Carmen. To ensure that you are able to connect to Carmen at all times, it is recommended that you do each of the following:

- Register multiple devices in case something happens to your primary device. Visit the BuckeyePass - Adding a Device (go.osu.edu/add-device) help article for step-by-step instructions.

- Request passcodes to keep as a backup authentication option. When you see the Duo login screen on your computer, click **Enter a Passcode** and then click the **Text me new codes** button that appears. This will text you ten passcodes good for 365 days that can each be used once.

- Install the Duo Mobile application (go.osu.edu/install-duo) on all of your registered devices for the ability to generate one-time codes in the event that you lose cell, data, or Wi-Fi service.

If none of these options will meet the needs of your situation, you can contact the IT Service Desk at 614-688-4357 (HELP) and IT support staff will work out a solution with you.

Technology Skills Needed for This Course

- Basic computer and web-browsing skills
- Basic statistical programming skills
- Navigating CarmenCanvas (go.osu.edu/canvasstudent)
- CarmenZoom virtual meetings (go.osu.edu/zoom-meetings)
- The zoom link for this course (lecture and lab) is: https://osu.zoom.us/j/7273487084?pwd=UnA2bEZaQ3psZENyd3VZdlh3MW5RZz09
- Office Hours zoom link: https://osu.zoom.us/j/93546381885?pwd=VGZoKzViL00xSG5hME1uUEQxcXROZz09

Technology Support

For help with your password, university email, CarmenCanvas, or any other technology issues, questions or requests, contact the IT Service Desk, which offers 24-hour support, seven days a week.

- **Self Service and Chat**: go.osu.edu/it
- **Phone:** 614-688-4357 (HELP)
- **E mail:** servicedesk@osu.edu

How Your Grade is Calculated

Assignment Category	Points
Personal data set summary and submission (properly formatted for statistical analysis)	30 points (10%)
Recording of personal data (TBA)	30 points (10%)
Topical bi-weekly homework assignments (n=6)	15 points each, 90 pts. total (30%)
Written term paper	100 points (34%)
Class participation (in-person attendance, virtual OK when necessary, 2 consultations, discussion postings, timely submission of work.	50 points (16%)

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Descriptions of Major Course Assignments

Personal Data Set Summary

Description: Your personal data set ideally includes a mixture of variable types (continuous, integer, ordinal, categorical), some of which can be construed as dependent and independent. You will use R/RStudio to prepare a summary of your data set, including but not limited to the numbers, types, and nature (dependent/independent) of the variables, sample size(s), and distributional properties. Upon completion, you will record and post (on Carmen) a 10-min zoom presentation during which you will identify the questions/problems, hypotheses/predictions you expect to explore with your data. You will also describe (briefly) the general field/lab methods and sampling design (e.g., blocking or nesting factors, repeated measures, fixed vs. random variables, etc.) that generated your data set. The summary and link to your recording will be posted to a discussion board on Carmen. You will be given a more specific set of directions for this assignment during the first week of class.

Bi-weekly Homework Assignments

Description: We will be covering ~6 general topical areas of statistical analysis every 2-3 weeks during the semester. You will be expected to apply some form of these analyses to your personal data set, essentially trying to answer questions or model effects of interest with your data set if it is possible to do so. The goal of the course is to give you practical knowledge and familiarity with these methods so that you can understand and critically evaluate their application in the scientific literature or apply them in your own work. Your objective is to "try out" various statistical methods on your data set. By the end of the semester, you will identify and apply the statistical method(s) or model(s) that you deem most suitable to your question/problem and to test your hypotheses/predictions. You will be given a more specific set of directions for these assignments in class.

Written Term Paper

Description: You will prepare a final term paper for the course following the writing and technical style for a journal or other peer-reviewed outlet in your field of study. This can be a draft manuscript that you intend to submit with or without co-authors for publication, a thesis or book chapter, or other manuscript that conveys technical information that emanates from the statistical method(s) or model(s) that are best suited to your data and study goals and objectives. I view clear technical writing and properly supported presentation and interpretation of results to be the endpoint of statistical analyses. We will stress the importance of clear and correct explanation of statistical methods and presentation of analyses. Consequently, the term papers need to follow accepted scientific writing style and formatting for the outlet where you expect to publish.

Class Participation

Description: Class participation scores are based on your engaged attendance of in-person lectures (alternatively via zoom with notification for approved reasons), timely completion of

assignments, and 2 scheduled consultations or check-ins (zoom or in person). You are also expected to post and comment on assignments to the discussion board on Carmen.

Late Assignments

Please refer to Carmen for due dates. Due dates are set to help you stay on pace and to allow timely feedback that will help you complete subsequent assignments. I will not normally deduct points for assignments that are <1 week late but falling behind on assignments will affect your participation score. Please contact me if circumstances prevent you from completing and submitting assignments more than one week late.

Instructor Feedback and Response Time

[Example: I am providing the following list to give you an idea of my intended availability throughout the course. Remember that you can call 614-688-4357 (HELP) at any time if you have a technical problem.

- **Preferred contact method:** If you have a question, please contact me first through my Ohio State email address. I will reply to emails within **24-48 hours on days when class is in session at the university**.

- **Class announcements:** I will send all important class-wide messages through the Announcements tool or by email from CarmenCanvas. Please check your notification preferences (go.osu.edu/canvas-notifications) to ensure you receive these messages.

- **Discussion board:** I will check and reply to messages in the discussion boards at least once by the end of each week.

- **Grading and feedback:** For assignments submitted by the due date, I will try to provide feedback and grades within **seven days**. Assignments submitted after the due date may have reduced feedback, and grades may take longer to be posted.

Grading Scale

93–100: A
90–92.9: A-
87–89.9: B+
83–86.9: B
80–82.9: B-
77–79.9: C+
73–76.9: C
70–72.9: C-
67–69.9: D+
60–66.9: D
Below 60: E

Other Course Policies

Discussion and Communication Guidelines

Statistical analyses and modeling and using R/RStudio are greatly facilitated by engaging with user communities, including your instructor, classmates, and colleagues, as well as on-line communities including but not limited to:

Github (https://github.com/)
R-bloggers (https://www.r-bloggers.com)
R-project blog (https://developer.r-project.org/Blog/public/)
R-sig-ecology (https://stat.ethz.ch/mailman/listinfo/r-sig-ecology)
RStudio blog (https://www.rstudio.com/blog/)
StackOverflow (https://stackoverflow.com/questions/tagged/r)
tidyverse (https://www.tidyverse.org)

- **Writing style**: While there is no need to post discussions as if you were writing a research paper, you should remember to use good grammar, spelling, and punctuation. A more conversational tone is fine for discussion posts to Carmen. Clear and organized expression with technical oral and written communication styles are expected for other assignments.

- **Tone and civility**: Let's maintain a supportive learning community where each of us feels secure and we interact amicably while supporting and learning from each other. There is no such thing as a dumb question and thoughtful constructive feedback and critical thinking are valued.

- **Backing up your work**: Be sure to save and back-up your data sets and work in R/RStudio. There can be some conflicts between RStudio and OneDrive. Let me know if you experience such problems.

- **Synchronous sessions**: During our Zoom sessions I ask that you use your real name and a clear photo of your face in your Carmen profile. You may turn your camera off if you choose when you join full-group lecture time via zoom. If we use breakout rooms or other small-group discussions during lecture or laboratory sessions, having cameras and mics on as often as possible will help you get the most out of those activities. You are always welcome to use the free, Ohio State-themed virtual backgrounds (go.osu.edu/zoom-backgrounds). Remember that Zoom and the Zoom chat are our classroom space where respectful interactions are expected.

Academic Integrity Policy

See Descriptions of Major Course Assignments for specific guidelines about collaboration and academic integrity in the context of this online class.

Ohio State's Academic Integrity Policy

Academic integrity is essential to maintaining an environment that fosters excellence in teaching, research, and other educational and scholarly activities. Thus, The Ohio State University and the Committee on Academic Misconduct (COAM) expect that all students have read and understand the university's Code of Student Conduct (studentconduct.osu.edu), and that all students will complete all academic and scholarly assignments with fairness and honesty. Students must recognize that failure to follow the rules and guidelines established in the university's *Code of Student Conduct* and this syllabus may constitute "Academic Misconduct."

The Ohio State University's *Code of Student Conduct* (Section 3335-23-04) defines academic misconduct as: "Any activity that tends to compromise the academic integrity of the university or subvert the educational process." Examples of academic misconduct include (but are not limited to) plagiarism, collusion (unauthorized collaboration), copying the work of another student, and possession of unauthorized materials during an examination. Ignorance of the university's *Code of Student Conduct* is never considered an excuse for academic misconduct, so I recommend that you review the *Code of Student Conduct* and, specifically, the sections dealing with academic misconduct.

If I suspect that a student has committed academic misconduct in this course, I am obligated by university rules to report my suspicions to the Committee on Academic Misconduct. If COAM determines that you have violated the university's Code of Student Conduct (i.e., committed academic misconduct), the sanctions for the misconduct could include a failing grade in this course and suspension or dismissal from the university.
If you have any questions about the above policy or what constitutes academic misconduct in this course, please contact me.

Other sources of information on academic misconduct (integrity) to which you can refer include:

- Committee on Academic Misconduct (go.osu.edu/coam)
- Ten Suggestions for Preserving Academic Integrity (go.osu.edu/ten-suggestions)
- Eight Cardinal Rules of Academic Integrity (go.osu.edu/cardinal-rules)

Copyright for Instructional Materials

The materials used in connection with this course may be subject to copyright protection and are only for the use of students officially enrolled in the course for the educational purposes associated with the course. Copyright law must be considered before copying, retaining, or disseminating materials outside of the course.

Creating an Environment Free from Harassment, Discrimination, and Sexual Misconduct

The Ohio State University is committed to building and maintaining a community to reflect diversity and to improve opportunities for all. All Buckeyes have the right to be free from harassment, discrimination, and sexual misconduct. Ohio State does not discriminate on the basis of age, ancestry, color, disability, ethnicity, gender, gender identity or expression, genetic information, HIV/AIDS status, military status, national origin, pregnancy (childbirth, false pregnancy, termination of pregnancy, or recovery therefrom), race, religion, sex, sexual orientation, or protected veteran status, or any other bases under the law, in its activities, academic programs, admission, and employment. Members of the university community also have the right to be free from all forms of sexual misconduct: sexual harassment, sexual assault, relationship violence, stalking, and sexual exploitation.

To report harassment, discrimination, sexual misconduct, or retaliation and/or seek confidential and non-confidential resources and supportive measures, contact the Office of Institutional Equity:

1. Online reporting form at equity.osu.edu,
2. Call 614-247-5838 or TTY 614-688-8605,
3. Or email equity@osu.edu

The university is committed to stopping sexual misconduct, preventing its recurrence, eliminating any hostile environment, and remedying its discriminatory effects. All university employees have reporting responsibilities to the Office of Institutional Equity to ensure the university can take appropriate action:

- All university employees, except those exempted by legal privilege of confidentiality or expressly identified as a confidential reporter, have an obligation to report incidents of sexual assault immediately.

- The following employees have an obligation to report all other forms of sexual misconduct as soon as practicable but at most within five workdays of becoming aware of such information: 1. Any human resource professional (HRP); 2. Anyone who supervises faculty, staff, students, or volunteers; 3. Chair/director; and 4. Faculty member.

Your Mental Health

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. No matter where you are engaged in distance learning, The Ohio State University's Student Life Counseling and Consultation Service (CCS) is here to support you. If you find

yourself feeling isolated, anxious or overwhelmed, on-demand mental health resources (go.osu.edu/ccsondemand) are available. You can reach an on-call counselor when CCS is closed at 614- 292-5766. **24-hour emergency help** is available through the National Suicide Prevention Lifeline website (suicidepreventionlifeline.org) or by calling 1-800-273-8255(TALK). The Ohio State Wellness app (go.osu.edu/wellnessapp) is also a great resource.

Requesting Accommodations

The university strives to make all learning experiences as accessible as possible. If you anticipate or experience academic barriers based on your disability including mental health, chronic or temporary medical conditions, please let me know immediately so that we can privately discuss options. To establish reasonable accommodations, I may request that you register with Student Life Disability Services (SLDS). After registration, make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion. In light of the current pandemic, students seeking to request COVID-related accommodations may do so through the university's request process, managed by Student Life Disability Services.

Disability Services Contact Information

- Phone: 614-292-3307

- Website: slds.osu.edu

- Email: slds@osu.edu

- In person: Baker Hall 098, 113 W. 12th Avenue

Accessibility of Course Technology

This online course requires use of CarmenCanvas (Ohio State's learning management system) and other online communication and multimedia tools. If you need additional services to use these technologies, please request accommodations as early as possible.
- CarmenCanvas accessibility (go.osu.edu/canvas-accessibility)
- Streaming audio and video
- CarmenZoom accessibility (go.osu.edu/zoom-accessibility)

Course Schedule

Refer to the CarmenCanvas course for up-to-date due dates.

Week	Work	Topics, Readings, Assignments, Due Dates
1		***Course Introduction –*** paradigms and philosophies of statistics
2	Home-work 1	***Statistical Paradigms –*** multivariate data sets, statistical assumptions, getting to know your data.
3	Personal data set	***General Linear Models I –*** analysis of variance, variable coding and contrasts, random effects
4	Home-work 2	***General Linear Models II –*** ANCOVA and multiple regression, mixed effects, and diagnostics
5	Data set summary	***Advanced Regression Techniques I –*** non-linear regression, smoothing and regression splines, quantile regression, and weighted least squares
6	Home-work 3	***Advanced Regression Techniques II –*** nonlinear regression a*nd generalized additive models*
7		***Generalized Linear Models I –*** maximum likelihood estimation, fitting GLMs, and diagnostics
8	Home-work 4	***Generalized Linear Models II –*** binomial and count regression, multi-model inference, generalized linear mixed models
9		***Generalized Linear Models III –*** zero-truncated and zero-inflated models, generalized estimating equations, and generalized additive models ***Introduction to Multivariate Methods –*** elementary matrix algebra, distance and similarity measures, assumptions and diagnostics
10		***Ordination and Classification I, Linear Models –*** principal components and factor analysis, structural equation modeling
11	Home-work 5	***Ordination and Classification II, Linear Models –*** multivariate ANOVA and discriminant analysis, canonical correlation analysis
12		***Ordination and Classification III, Community Analysis and Description –*** Diversity and indicator analysis, cluster analysis, multiple response permutation procedures, classification and regression trees
13		***Ordination and Classification IV, Unimodal Indirect Ordination –*** Bray-Curtis, Correspondence analysis, detrended correspondence analysis, non-metric multidimensional scaling
14	Home-work 6	***Ordination and Classification V, Unimodal Direct Ordination –*** canonical correspondence analysis, redundancy analysis, co-correspondence analysis
15		***Special Topics, Course Overview, and Reporting Statistical Analyses***