

# Course Syllabus

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## Bio 599 and INF 599: Ecological Data Analysis

Fall 2024 - 3 units

**Instructor:** Dr. Xanthe Walker

Department of Biological Sciences, School of Informatics, Computing, and Cyber Systems (SICSS), and Center for Ecosystem Science and Society (ECOSS)

Office: Science and Health Building (SHB, Room 541)

Email: [xanthe.walker@nau.edu](mailto:xanthe.walker@nau.edu)

Phone: 928 637 5642

**Class Times:** Tues and Thurs 12:45-2:00

**Class Locations:** Science Annex, Rm 105

**Office Hours:** Monday 12:30-2:00 and Tuesday 2:00-3:30 in person or via zoom. Please email me to schedule an alternative meeting time.

**Purpose:** This course provides an overview of statistical methods commonly used to model ecological data. Such data often violates assumptions of simpler techniques, including non-independence of observations, non-normally distributed data, non-linear and non-monotonic relationships between predictors and response variables, and the presence of spatial and temporal autocorrelation. We will focus on the application of these methods with only minimal discussion of their theoretical basis. Students will be encouraged to work with their own datasets.

### Course learning outcomes:

1. Prepare you for research by reviewing the basic principles for designing good studies, gathering and organizing data, and properly analyzing those data.
2. Develop proficiency in the programming language R to manipulate, summarize, analyze, and interpret data.
3. Choose appropriate analysis techniques for a variety of data types and formats.
4. Understand regression-type analysis ranging from simple linear regression to more complex generalized linear mixed effects models, and how to apply them.

1. Create publication-ready graphics and learn what to write in a paper.

**Career Competencies and Transferrable Skills:** In this course you will learn professional skills that can support your future career. Below is a list of skills from National Association of Colleges and Employers (NACE) you will learn and practice in this class via in-class discussions, assignments, presentations, and assigned readings:

1. Critical thinking: gather and analyze information from a diverse set of sources and individuals to fully understand a problem, and accurately summarize and interpret data with an awareness of personal biases that may impact outcomes
2. Communication: exchange information, ideas, facts, and perspectives in a clear and organized manner that others can effectively understand.
3. Professionalism: Demonstrate dependability, integrity, and preparation in planning, initiating, managing, and completing projects

**Career Ready Resources:**

LinkedIn:

CEFNS Career Development

[www.linkedin.com/in/cefns-career-development-072715233](https://www.linkedin.com/in/cefns-career-development-072715233)

NAU Career Development

<https://www.linkedin.com/company/nau-career-development/>

Handshake:

<https://nau.joinhandshake.com/login>

Udemy: Online courses and career searching advice

<https://in.nau.edu/its/udemy/>

Log in with your NAU email account and search 'NAU Career Steps'

O\*net Online: Occupation exploration reports

<https://www.onetonline.org/>  [\(https://www.onetonline.org/\)](https://www.onetonline.org/)

**Assessment and Grading:** You will have frequent opportunities to demonstrate your knowledge and understanding. Each of the following categories of assignments:

1. Weekly R markdown files (20%) from in-class R workshops (LO# 2,3,5 and CC #1,3)

2. Lead a discussion of an assigned paper (10%). Each student will be required to lead a discussion. This includes a 10-minute overview of the paper and facilitating a 10-minute discussion. (LO#3,4, and CC#1,2,3)
3. Assignments (30%). There are two minor assignments described in detail below (LO# 1,2,3,4,5, and CC#1,3).
4. Final Project. This will include a project presentation (10%) and a final written report (20%). Details are described below (LO#1,2,3,4,5, and CC#1,2,3).
5. Attendance and participation (10%) (CC#1,2,3).

**Grading Scale:**

90% to 100%	<b>A</b>
80% to 89.99%	<b>B</b>
70% to 79.99%	<b>C</b>
60% to 69.99%	<b>D</b>
Below 60%	<b>F</b>

**Class Format:**

Two lectures a week. Each week will cover one broad topic. One lecture is instructor-led background information. The second lecture of the week will start with a student-led discussion of an assigned paper and end with a workshop where students will work through R code and complete exercises.

**Weekly schedule (subject to change):**

1. Introduction to course, R, Rstudio, Rmarkdown
2. Exploratory data analysis and data visualization
3. Linear regression
4. Introduction to Machine learning methods
5. Heterogeneity of Variance: General Least Squares (GLS)
6. Mixed effects models (MEM)
7. Model selection and collinearity
8. Violation of Independence; spatial and temporal autocorrelation
9. Generalized Linear Models (GLM)
10. Generalized linear mixed models (GLMMs)
11. Zero-inflated and Zero-adjusted Models (ZIP and ZAP)
12. Generalized Additive (Mixed) Models (GAMs and GAMMs)
13. Review & Project presentations

## 14. Project presentations

## 15. Project presentations

**Assignment #1: Explore, explain, and summarize your dataset (Due week 5 – 15%)**

- Explanation (10 points):
  - Explain (in a paragraph) the purpose of the study that yielded the data.
  - Explain the specific data set you are using. For example, say where the data are from, give the meaning of the variables, and so on.
  - State what parameters (magnitudes) you will estimate with these data.
  - State what hypotheses you will test with these data.
- Attributes and Values (10 points):
  - Identify the attribute type of each attribute in your dataset. If it's not clear, you may need to justify why you chose the type.
- Identify the values of the summarizing properties for the attributes, including frequency, location and spread (e.g. value ranges of the attributes, frequency of values, distributions, medians, means, variances, percentiles, etc). Note that not all of these summary statistics will make sense for all the attribute types, so use your judgment!
- Proceed through the 8 steps of data exploration we covered in class and in the Zuur reading (20 points).
- Illustrate and describe the main patterns revealed in the data (5 points).
- Include your clean R code in an appendix (5 points).
- Submit paper to me as a single pdf file via Canvas: LASTNAME.FIRSTNAME.ASSIGNMENT1.PDF

**Assignment #2: Analyze a model (Due week 12 – 15%)**

- Explanation (15 points)
  - Use the dataset you described in Assignment #1
  - Include just one response variable.
  - For the explanatory variables, include at least one categorical fixed factor, such as an experimental or observational treatment.
  - Include at least 1, and no more than 5, additional explanatory variables (random or fixed factors, blocks, covariates, etc).
  - Fit a model to the data in R. Explain in words the model you fit. This can be any type of model we have covered; lm, gls, lme.
- Model selection (15 points)
  - Address how well the statistical assumptions of your analysis were met. How did you handle violations?
  - Go through your selected process of model selection. Explain your steps. Determine your final model.

- Interpret the output (15 points).
  - To assess biological significance, explain the parameter estimates (magnitudes). What do they mean and what are your conclusions based on these parameter estimates? To assess statistical significance, explain the null hypotheses and interpret the test results.
  - State the overall conclusions reached from your analyses of biological and statistical significance.
  - Visualize the model fit to the data. Explain what the graph shows.
- Include your clean R code in an appendix (5 points).
- Submit paper to me as a single pdf file via Canvas: LASTNAME.FIRSTNAME.ASSIGNMENT2.PDF

### **Final Project (Due week 15 - presentation 10% and written 20%):**

- Develop a solid, well-thought-out statistical analysis of a dataset. Use what we have done in class or go beyond if you want. I encourage you to use one of your own datasets related to your thesis research project so that the class can help move you forward in your degree.
- Present this in class (10-15 min with 5 min questions)
- No need to show us your code, unless it is helpful to show a small part to explain what you did.
- Write this up in a scientific paper format, e.g., Intro, Methods, Results, Discussion. Explain the question, study system, etc. Walk through your logic and analytical process. Interpret what you found.
- Submit paper to me as a single pdf file via Canvas: LASTNAME.FIRSTNAME.FINALPROJECT.PDF

## **SYLLABUS POLICY STATEMENTS**

### **ACADEMIC INTEGRITY**

NAU expects every student to firmly adhere to a strong ethical code of academic integrity in all their scholarly pursuits. The primary attributes of academic integrity are honesty, trustworthiness, fairness, and responsibility. As a student, you are expected to submit original work while giving proper credit to other people's ideas or contributions. Acting with academic integrity means completing your assignments independently while truthfully acknowledging all sources of information, or collaboration with others when appropriate. When you submit your work, you are implicitly declaring that the work is your own. Academic integrity is expected not only during formal coursework, but in all your relationships or interactions that are connected to the educational enterprise. All forms of academic deceit such as plagiarism, cheating, collusion, falsification or fabrication of results or records, permitting your work to be submitted by another, or inappropriately recycling your own work from one class to another, constitute academic misconduct that may result in serious disciplinary consequences. All students and faculty members are responsible for reporting suspected instances of academic misconduct. All students are encouraged to complete NAU's online academic integrity workshop available in the E-Learning Center and should review the full Academic Integrity policy available at <https://policy.nau.edu/policy/policy.aspx?num=100601>.

### **USE OF GENERATIVE ARTIFICIAL INTELLIGENCE (AI)**

This course allows for the use of generative artificial intelligence (AI) technologies as part of the research and preparation phase of the work; for example, using these technologies to assist with research, generating ideas, and creating summaries of topics, that are then used as an input to the work students do to generate a final assignment. In this use, students should be aware of the potential limitations of using generative AI as a tool for learning and research, since information is not always reliable or accurate, and should critically evaluate the sources, methods, and outputs of generative AI systems. Any final work submitted by students that contributes toward the course grade is expected to be generated by the students themselves, working individually or in groups as directed by class assignment instructions. Submitting final work created by generative AI constitutes an academic integrity violation. If you have any questions about this policy or if you are unsure whether a particular use of generative AI is acceptable, please ask for clarification before using such technologies.

## COPYRIGHT INFRINGEMENT

All lectures and course materials, including but not limited to exams, quizzes, study outlines, and similar materials are protected by copyright. These materials may not be shared, uploaded, distributed, reproduced, or publicly displayed without the express written permission of NAU. Sharing materials on websites such as Course Hero, Chegg, or related websites is considered copyright infringement subject to United States Copyright Law and a violation of NAU Student Code of Conduct. For additional information on ABOR policies relating to course materials, please refer to ABOR Policy 6-908 A(2)(5).

## COURSE TIME COMMITMENT

Pursuant to Arizona Board of Regents guidance (ABOR Policy 2-224, Academic Credit), each unit of credit requires a minimum of 45 hours of work by students, including but not limited to, class time, preparation, homework, and studying. For example, for a 3-credit course a student should expect to work at least 8.5 hours each week in a 16-week session and a minimum of 33 hours per week for a 3-credit course in a 4-week session.

## DISRUPTIVE BEHAVIOR

Membership in NAU's academic community entails a special obligation to maintain class environments that are conducive to learning, whether instruction is taking place in the classroom, a laboratory or clinical setting, during course-related fieldwork, or online. Students have the obligation to engage in the educational process in a manner that does not interfere with normal class activities or violate the rights of others. Instructors have the authority and responsibility to address disruptive behavior that interferes with student learning, which can include the involuntary withdrawal of a student from a course with a grade of "W". For additional information, see NAU's Disruptive Behavior in an Instructional Setting policy at <https://nau.edu/university-policy-library/disruptive-behavior>.

## NONDISCRIMINATION AND ANTI-HARASSMENT

NAU prohibits discrimination and harassment based on sex, gender, gender identity, race, color, age, national origin, religion, sexual orientation, disability, veteran status and genetic information. Certain

consensual amorous or sexual relationships between faculty and students are also prohibited as set forth in the Consensual Romantic and Sexual Relationships policy. The Equity and Access Office (EAO) responds to complaints regarding discrimination and harassment that fall under NAU's Nondiscrimination and Anti-Harassment policy. EAO also assists with religious accommodations. For additional information about nondiscrimination or anti-harassment or to file a complaint, contact EAO located in Old Main (building 10), Room 113, PO Box 4083, Flagstaff, AZ 86011, or by phone at 928-523-3312 (TTY: 928-523-1006), fax at 928-523-9977, email at [equityandaccess@nau.edu](mailto:equityandaccess@nau.edu), or visit the EAO website at <https://nau.edu/equity-and-access>.

## TITLE IX

Title IX of the Education Amendments of 1972, as amended, protects individuals from discrimination based on sex in any educational program or activity operated by recipients of federal financial assistance. In accordance with Title IX, Northern Arizona University prohibits discrimination based on sex or gender in all its programs or activities. Sex discrimination includes sexual harassment, sexual assault, relationship violence, and stalking. NAU does not discriminate on the basis of sex in the education programs or activities that it operates, including in admission and employment. NAU is committed to providing an environment free from discrimination based on sex or gender and provides a number of supportive measures that assist students, faculty, and staff.

One may direct inquiries concerning the application of Title IX to either or both the Title IX Coordinator or the U.S. Department of Education, Assistant Secretary, Office of Civil Rights. You may contact the Title IX Coordinator in the Office for the Resolution of Sexual Misconduct by phone at 928-523-5434, by fax at 928-523-0640, or by email at [titleix@nau.edu](mailto:titleix@nau.edu). In furtherance of its Title IX obligations, NAU promptly will investigate or equitably resolve all reports of sex or gender-based discrimination, harassment, or sexual misconduct and will eliminate any hostile environment as defined by law. The Office for the Resolution of Sexual Misconduct (ORMS): Title IX Institutional Compliance, Prevention & Response addresses matters that fall under the university's Sexual Misconduct policy. Additional important information and related resources, including how to request immediate help or confidential support following an act of sexual violence, is available at <https://in.nau.edu/title-ix>.

## ACCESSIBILITY

Professional disability specialists are available at Disability Resources to facilitate a range of academic support services and accommodations for students with disabilities. If you have a documented disability, you can request assistance by contacting Disability Resources at 928-523-8773 (voice), 928-523-8747 (fax), or [dr@nau.edu](mailto:dr@nau.edu) (e-mail). Once eligibility has been determined, students register with Disability Resources every semester to activate their approved accommodations. Although a student may request an accommodation at any time, it is best to initiate the application process at least four weeks before a student wishes to receive an accommodation. Students may begin the accommodation process by submitting a self-identification form online at <https://nau.edu/disability-resources/student-eligibility-process> or by contacting Disability Resources. The Director of Disability Resources, Jamie Axelrod,

serves as NAU’s Americans with Disabilities Act Coordinator and Section 504 Compliance Officer. He can be reached at [jamie.axelrod@nau.edu](mailto:jamie.axelrod@nau.edu).

RESPONSIBLE CONDUCT OF RESEARCH

Students who engage in research at NAU must receive appropriate Responsible Conduct of Research (RCR) training. This instruction is designed to help ensure proper awareness and application of well-established professional norms and ethical principles related to the performance of all scientific research activities. More information regarding RCR training is available at <https://nau.edu/research/compliance/research-integrity>.

MISCONDUCT IN RESEARCH

As noted, NAU expects every student to firmly adhere to a strong code of academic integrity in all their scholarly pursuits. This includes avoiding fabrication, falsification, or plagiarism when conducting research or reporting research results. Engaging in research misconduct may result in serious disciplinary consequences. Students must also report any suspected or actual instances of research misconduct of which they become aware. Allegations of research misconduct should be reported to your instructor or the University’s Research Integrity Officer, Dr. David Faguy, who can be reached at [david.faguy@nau.edu](mailto:david.faguy@nau.edu) or 928-523-6117. More information about misconduct in research is available at <https://nau.edu/university-policy-library/misconduct-in-research>.

SENSITIVE COURSE MATERIALS

University education aims to expand student understanding and awareness. Thus, it necessarily involves engagement with a wide range of information, ideas, and creative representations. In their college studies, students can expect to encounter and to critically appraise materials that may differ from and perhaps challenge familiar understandings, ideas, and beliefs. Students are encouraged to discuss these matters with faculty.

NAU Student Resources

Additional student resources can be found here:

<https://in.nau.edu/peer-jacks/student-resources/>









[https://in.nau.edu/wp-content/uploads/sites/194/SA-2021-22-NAU-Student-Resource-Guide\\_Accessible\\_PRT-1.pdf](https://in.nau.edu/wp-content/uploads/sites/194/SA-2021-22-NAU-Student-Resource-Guide_Accessible_PRT-1.pdf)

Course Summary:

Date	Details	Due
Mon Sep 2, 2024	 <a href="#">R code - week 1</a> ( <a href="https://canvas.nau.edu/courses/30394/assignments/531634">https://canvas.nau.edu/courses/30394/assignments/531634</a> )	due by 11:59pm



Date	Details	Due
Mon Sep 9, 2024	 <b><u>R code - week 2</u></b> ( <a href="https://canvas.nau.edu/courses/30394/assignments/531639">https://canvas.nau.edu/courses/30394/assignments/531639</a> )	due by 11:59pm
Mon Sep 16, 2024	 <b><u>R code - week 3</u></b> ( <a href="https://canvas.nau.edu/courses/30394/assignments/531640">https://canvas.nau.edu/courses/30394/assignments/531640</a> )	due by 11:59pm
Mon Sep 23, 2024	 <b><u>R code - week 4</u></b> ( <a href="https://canvas.nau.edu/courses/30394/assignments/531641">https://canvas.nau.edu/courses/30394/assignments/531641</a> )	due by 11:59pm
Thu Sep 26, 2024	 <b><u>Assignmentt #1</u></b> ( <a href="https://canvas.nau.edu/courses/30394/assignments/531628">https://canvas.nau.edu/courses/30394/assignments/531628</a> )	due by 11:59pm
Mon Sep 30, 2024	 <b><u>R code - week 5</u></b> ( <a href="https://canvas.nau.edu/courses/30394/assignments/531642">https://canvas.nau.edu/courses/30394/assignments/531642</a> )	due by 11:59pm
Mon Oct 7, 2024	 <b><u>R code - week 6</u></b> ( <a href="https://canvas.nau.edu/courses/30394/assignments/531643">https://canvas.nau.edu/courses/30394/assignments/531643</a> )	due by 11:59pm
Mon Oct 14, 2024	 <b><u>R code - week 7</u></b> ( <a href="https://canvas.nau.edu/courses/30394/assignments/531644">https://canvas.nau.edu/courses/30394/assignments/531644</a> )	due by 11:59pm
Mon Oct 21, 2024	 <b><u>R code - week 8</u></b> ( <a href="https://canvas.nau.edu/courses/30394/assignments/531645">https://canvas.nau.edu/courses/30394/assignments/531645</a> )	due by 11:59pm
Mon Oct 28, 2024	 <b><u>R code - week 9</u></b> ( <a href="https://canvas.nau.edu/courses/30394/assignments/531646">https://canvas.nau.edu/courses/30394/assignments/531646</a> )	due by 11:59pm
Mon Nov 4, 2024	 <b><u>R code - week 10</u></b> ( <a href="https://canvas.nau.edu/courses/30394/assignments/531635">https://canvas.nau.edu/courses/30394/assignments/531635</a> )	due by 11:59pm
Mon Nov 11, 2024	 <b><u>R code - week 11</u></b> ( <a href="https://canvas.nau.edu/courses/30394/assignments/531636">https://canvas.nau.edu/courses/30394/assignments/531636</a> )	due by 11:59pm
Thu Nov 14, 2024	 <b><u>Assignment #2</u></b> ( <a href="https://canvas.nau.edu/courses/30394/assignments/531627">https://canvas.nau.edu/courses/30394/assignments/531627</a> )	due by 11:59pm
Mon Nov 18, 2024	 <b><u>Course Evaluation Open</u></b> ( <a href="https://canvas.nau.edu/calendar?event_id=124361&amp;include_contexts=course_30394">https://canvas.nau.edu/calendar?event_id=124361&amp;include_contexts=course_30394</a> )	12:01am
	 <b><u>Course Evaluation Open</u></b> ( <a href="https://canvas.nau.edu/calendar?event_id=124361&amp;include_contexts=course_30394">https://canvas.nau.edu/calendar?event_id=124361&amp;include_contexts=course_30394</a> )	12:01am

Date	Details	Due
	<a href="#">event_id=187172&amp;include_contexts=course_30394</a>	
Thu Nov 21, 2024	 <b>R code - week 12</b> ( <a href="https://canvas.nau.edu/courses/30394/assignments/531637">https://canvas.nau.edu/courses/30394/assignments/531637</a> )	due by 11:59pm
Thu Dec 5, 2024	 <b>Final Presentation</b> ( <a href="https://canvas.nau.edu/courses/30394/assignments/531630">https://canvas.nau.edu/courses/30394/assignments/531630</a> )	due by 11:59pm
Fri Dec 6, 2024	 <b>Final Written Project</b> ( <a href="https://canvas.nau.edu/courses/30394/assignments/531631">https://canvas.nau.edu/courses/30394/assignments/531631</a> )	due by 11:59pm
Sun Dec 8, 2024	 <b>Course Evaluation Close</b> ( <a href="https://canvas.nau.edu/calendar?event_id=124362&amp;include_contexts=course_30394">https://canvas.nau.edu/calendar?event_id=124362&amp;include_contexts=course_30394</a> )	11:59pm
	 <b>Course Evaluation Close</b> ( <a href="https://canvas.nau.edu/calendar?event_id=187173&amp;include_contexts=course_30394">https://canvas.nau.edu/calendar?event_id=187173&amp;include_contexts=course_30394</a> )	11:59pm
	 <b>Attendance</b> ( <a href="https://canvas.nau.edu/courses/30394/assignments/531629">https://canvas.nau.edu/courses/30394/assignments/531629</a> )	
	 <b>Lead Paper Discussion</b> ( <a href="https://canvas.nau.edu/courses/30394/assignments/531632">https://canvas.nau.edu/courses/30394/assignments/531632</a> )	
	 <b>Participation</b> ( <a href="https://canvas.nau.edu/courses/30394/assignments/531633">https://canvas.nau.edu/courses/30394/assignments/531633</a> )	