

**INF450/550: Survey in ecological data collection tools & products**

Term	Class No.	Section	Units	Days & Times	Room	Mode
Spring 2026	12652	001	3	TuTh 9:35am – 10:50am	SICCS 223	In Person

**Academic Catalog Description:**

Surveys, data collection tools, and products used by ecoinformaticists, along with introductions to the organizations and professionals that build and utilize those tools and products; builds applied skills in using those tools for the purpose of conducting graduate research.

**Enrollment Requirements:**

Enrollment in a SICCS graduate program or undergraduate upper class status.

**Instructor:**

Dr. Ben Ruddell, Ph.D., P.E.

Email: [Benjamin.Ruddell@nau.edu](mailto:Benjamin.Ruddell@nau.edu)

Office Phone: 928-523-3124

Office Location: SICCS (bldg. 90), Room 323.

Office Hours: After class the instructor will usually be available for discussion in the hall or office as standing office hours. Asynchronous “lab” sessions are held via the textbook Git and via the class mailing list; please use these venues to pose questions and report problems that could benefit your classmates or be answered by them before bringing questions to the instructor. In-person and zoom meetings are available with the instructor by appointment. This format ensures that your questions can benefit other students, can be answered as quickly as possible, and that students whose schedules conflict with posted office hours are able to access the instructor.

**Required Textbook**

Katharyn Duffy, Bijan Seyednasrollah, Jordan S Read, David Failing, Chris Florian, Donal O'Leary, & Ben Ruddell. (2021, March). Environmental Informatics Using Research Infrastructures and their Data: Fall 2020 Edition (Version 2020). Zenodo. <http://doi.org/10.5281/zenodo.4576496>; also see <https://katharynduffy.github.io/Environmental-Informatics-Using-Research-Infrastructures-and-their-Data/>

**Course Website:**

All materials are posted to, and all assignments submitted to, the Google Drive Folder. In order to access the folder, you must register your email address with the course mailing list Google Group, and you must register that same email address as a Google Account, and you must log in to google drive (and/or your web browser) using that google account. You will also have a personal student assignments folder assigned to you on the google drive. [https://drive.google.com/drive/folders/1tO5x9GVZhwfrGfwPASZZo-fOk6F5n8HJ?usp=drive\\_link](https://drive.google.com/drive/folders/1tO5x9GVZhwfrGfwPASZZo-fOk6F5n8HJ?usp=drive_link)

**Course Mailing List for Questions:**

All questions regarding the assignments or other general course topics will be posted to the course mailing list which is sent to all course participants. This mailing list serves as a chat room for the course. Questions posted here will be answered by anyone in the course, and the instructor will answer them within two business days after posting if another student has not answered adequately. Private questions for the instructor should be sent directly to the instructor. Your official NAU email address has been added to the mailing list: [inf550\\_fall2026@googlegroups.com](mailto:inf550_fall2026@googlegroups.com)

**Prerequisite Skills:**

To access the numerous sources of data and open-source code for this course, students will require the following skills to be successful: Intermediate proficiency in R and/or Python; Basic bash; Basic knowledge of version control methods such as Git, and pushing, pulling, forking and cloning repositories. If you don't yet feel confident in these

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skills, pre-requisite training is available from both NAU courses as well as many fee based and free online educational resources. Students are expected to complete pre-requisite training prior to the first day of class, whether via a for-credit course, a self-study, or prior experience in programming.

### Course Purpose and Learning Outcomes

This course surveys data collection tools and products used by ecoinformaticists and provides an introduction to the organizations and professionals that build and utilize those tools and products. The course develops applied skills in the use of data science tools and products that are employed by major environmental and ecological science organizations and researchers, especially in the United States. The course is appropriate for graduate students of quantitative environmental and ecological science and engineering, especially those students who plan to pursue thesis work and/or careers in ecological informatics. The course is also appropriate for upper division undergraduates with strong software/computing skills. Upon successful completion of this course, students will be able to demonstrate the following learning outcomes:

- Identify major USA based ecological and environmental research infrastructures, their tools, and their missions.
- Summarize the function and relative advantages of major ecoinformatics tools (e.g. git, repositories, applications, API's, data standards, metadata standards, and databases).
- Apply the main toolkit and data workflow of a variety of ecoinformatics organizations to reach simple preliminary results to quantitative questions.
- Articulate with whom they (the student) might be interested in future ecoinformatics work, and explore graduate studies with those persons (if any).
- Network with one or more ecoinformatics graduate students, faculty, and/or professionals.
- Articulate a quantitative ecological or environmental data science question that is important for the graduate student's thesis work and the most appropriate ecoinformatics tools with which to address that question.
- Utilize the most appropriate quantitative ecoinformatics tools to derive simple preliminary results for the student's thesis, answering a data science question that is important for the graduate student's thesis work.
- Demonstrate comprehension of the main literature in the academic field of ecoinformatics.
- Identify and collaboratively solve with the rest of the course's students the various software problems that appear in the course training materials due to bugs, updates, and changes that occur frequently in a subject matter involving thousands of interoperating software systems spanning dozens of major organizations.

### Assessments of Course Student Learning Outcomes

There are several mechanisms by which your course grade will be determined. Coding lab assignments allow you to practice and develop the concepts and analytic skills that we discuss in lectures including programming tasks; these must be completed individually. Participation allows you to benefit from lecture, discussion, and guest conversations; your attendance is required. Quizzes will allow you feedback on the extent to which you individually have mastered the material from lectures and reading assignments. End-of-unit questions and summaries will help you iteratively consider both the data stemming from each organization, and research questions over the course of the semester that will feed into your final semester presentation. Simply providing a mostly correct solution with little or no explanation will generally get you a "C". To get an "A" or a "B" score, you'll generally have to show "above average" or "excellent" mastery, which in this course is demonstrated by clear, complete analysis; demonstrated knowledge beyond factual basics; and robust, elegant implementations. The final project presentation will build upon the end-of-unit questions and summaries that you have conducted over the semester, and will focus on pulling together data from two or more research infrastructures to answer a question of your choosing.

### Grading System

A weighted sum of assessment components is used to determine your final grade in the course:

- Attendance is a pass/fail criterion (see class policies) P/F
- Homework, Quizzes, and Assignments, equally weighted 40%
- Coding labs, equally weighted 40%

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Final Project Presentation 20% (INF450 gets an automatic 100% grade on this and is excused)  
Extra Credit Projects Requiring Contract with Instructor, up to 20%

Grades will be assigned using the weighted sum described above using this scale:  
**A** ≥ 90.0%, **B** ≥ 80.0%, **C** ≥ 70.0%, **D** ≥ 60.0%, **F** < 60.0%.

There is no “curve”. Each student’s grade is based on their own outcomes assessments and not affected by the grades of other students. Extra credit opportunities may present themselves throughout the semester and will be announced during class meetings. Attendance is required and absences will be recorded. If you are absent without prior excuse granted by the instructor, more than three times, you will be notified in writing that further absences may result in failing the class. Late assignments will not be accepted without written permission of the instructor or a classes missed memo. To avoid loss of context, any grade disputes must be brought to my attention no later than 5 business days after the assignment was returned, or the last day of regular class (not exam week), whichever is sooner. At NAU, please check LOUIE for your final grade. If you need a current tally of your grade or have other questions about a grade, please ask the instructor, in writing, via email.

In Spring of 2026 the following extra credit projects are available, for up to 20% extra credit, at the instructor’s discretion; these require a written contract:

1. Write a chapter on FAIR practices
2. Write a chapter on AI/LLM usage
3. Write a chapter on [suggest a topic, such as an additional research infrastructure]
4. Build an ecological informatics mailing list of instructors around the world who want to offer this course
5. Help the instructor manage the textbook Git for the semester by accepting and pushing changes

### Course-Specific Policies

- Computers: Students will be required to use a variety of open-source free and fair use software included in NAU’s standard software distribution and most computer labs.
- GitHub: All students will be required to sign up for a free GitHub account to push bugs on the textbook.
- Google Account: All students will be required to register their chosen email address as a Google Account.
- Electronic device usage must support learning in the class. All cell phones, PDAs, music players and other entertainment devices must be turned off (or in silent mode) during lecture and may not be used at any time. Laptops or workstations (if present) are allowed for note-taking and activities only during lectures; no non-class-related use is allowed.
- Email to the instructors and teaching assistants must be short, clear, respectful and professional, and must include an appropriate salutation, a subject line beginning with the course’s title and a descriptive topic, an explanation of the purpose of the email, and a clear request for action or a clear question. If it does not contain these features, it may not be answered effectively or in a timely fashion.
- All assignments must be submitted by 11:59pm Flagstaff Time (MST) on their due date.
- Homework and written assignments must meet formatting requirements or it will not be graded:
  - When applicable both a .Rmd file with all code, and a knitted .pdf will be required for all code-based assignments.
  - All applicable homework assignment submissions must be saved in the following format:  
LASTNAME\_COURSECODE\_HomeworkAssignment#.Rmd and  
LASTNAME\_COURSECODE\_HomeworkAssignment#.pdf
  - The top of the first page of the assignment must include your full name and NAU ID number, the class name, the homework name, and the date of submission.
  - Present results in the order deliverables are listed in the assignment spec.
  - All work must be typewritten, with the exception of maths, figures, and diagrams which could be hand-drawn or scanned if appropriate. All work must be clear and easily legible to the instructor.

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### Class Outline and Tentative Schedule

*The course topics and a tentative schedule are subject to change without notice.*

Week	Block Theme					Content	Labs & Assignments
1	NEON					Overview of the class and its content; Introduction to ecoinformatics institutions and the environmental research infrastructures concept; FAIR data	Git Version Control; Document & Publish Your Workflow: R Markdown & knitr
2		Phenolog				NEON: its people, its mission, its tools	NEON Metadata; Pulling NEON data via API and R packages; NEON Written Exercises
3						NEON Terrestrial Observation Sampling (TOS) Data	NEON Metadata; Pulling NEON data via API and R packages; Intro NEON Culmination Summary
4						USA-NPN: its people, its mission, its tools	Utilizing the rNPN package; USA-NPN Written Exercises
5						USA-NPN: Understanding Data Biases & the challenge of observational data	Working with continuous & discrete data together; USA-NPN Culmination Summary
6			Near-Surface Remote Sensing			Image processing networks and their utility; The PhenoCam Network: its people, its mission, its tools	PhenoCam API access; Pulling & plotting phenology across 2 ecosystems; Marrying Eddy Co-Variance Flux and phenology data; PhenoCam Culmination Activity
7					NEON AOP Campaign: Hyperspectral	NDVI from NEON Hyperspectral AOP; Calculating Peak Greenness Timing Across Multiple Sensors; NEON AOP Written Exercises	
8		Remote Sensing				NEON AOP: LiDAR; DEM Data	Gridded, Raster, & LiDAR Data; LiDAR and Hyperspectral Data Product Fusion; NEON AOP Culmination Activity
9					NASA EOS: its people, its mission, its tools; Distributed Archive Centers; LP DAAC	Global Ecosystems Dynamics Investigation (GEDI) Lidar Data; NASA EOS Written Exercises	

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10						LP DAAC Continued	Pulling MODIS point and area requests via the AppEEARS API; Visualize 5 years of MODIS, PhenoCam, USA-NPN, and NEON vegetation dynamics; NASA EOS Culmination Activity
11						USGS: its people, its mission, its tools; NWIS Surface Water Monitoring	NEON Ecohydrology & Aquatic Data Access; USGS NWIS Written Exercises
12						NWIS Surface Water Monitoring and NEON Ecohydrology continued	Precipitation, drought severity, elevation and stream discharge data: Understanding the 2013 Colorado Floods; EcoHydrology Culmination Activity
13						NOAA Physical Science Laboratory: its people, its mission, its tools	Pulling reanalysis climate data for NEON tower locations; Calculating offsets between tower and gridded climate metrics
14						PRISM and NARR Data	Deriving Climate-Observation Relationships; Climate Culmination Activity
15						CMIP5/6 Climate Projections: its people, its mission, its tools; BioClim	Knitting the past to the future climate: How should you do it?
16						Exam Week	Final Presentations

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*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://www9.nau.edu/policies/Client/Details/1443?whoIsLooking=Students&pertainsTo=All>*

**ARTIFICIAL INTELLIGENCE**

*Artificial intelligence (AI) technologies bring both opportunities and challenges. Ensuring honesty in academic work creates a culture of integrity and expectations of ethical behavior. The use of these technologies can depend on the instructional setting, varying by faculty member, program, course, and assignment. Please refer to course policies, any additional course-specific guidelines in the syllabus, or communicate with the instructor to understand expectations. NAU recognizes the role that these technologies will play in the current and future careers of our graduates and expects students to practice responsible and ethical use of AI technologies to assist with learning within the confines of course policies.*

**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. For additional information, see NAU's Student Code of Conduct policy at <https://nau.edu/university-policy-library/student-code-of-conduct/>.

**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*



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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. To report a concern related to possible unlawful discrimination or harassment or to request a time to meet, please use the [Report an Issue Form](#). To file a complaint, please submit the online [Complaint Form](#). EAO also assists with religious accommodations. To request a religious accommodation, please use the [Religious Accommodation Request Intake Form](#). EAO additionally provides access to lactation spaces, and please use to the [Lactation Space Request Form](#) to request use of a location. For additional information about nondiscrimination or anti-harassment, contact EAO at [EquityandAccess@nau.edu](mailto:EquityandAccess@nau.edu), or visit the EAO website at <https://nau.edu/equity-and-access>. The EAO is located in Old Main on the first floor.

**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 employees, and covered guests.

One may direct inquiries concerning the application of Title IX to either or both the university Title IX Coordinator or the U.S. Department of Education, Assistant Secretary, Office of Civil Rights. You may contact NAU's Title IX Coordinator at [titleix@nau.edu](mailto:titleix@nau.edu) or by phone at 928-523-5434. In furtherance of its Title IX obligations, NAU promptly will investigate or equitably resolve all reports of sex/gender-based discrimination, harassment, or sexual misconduct and will eliminate any hostile environment as defined by law. To submit a report, please use the [File a Report Form](#). The Office for the Resolution of Sexual Misconduct (ORSM): Title IX Institutional Compliance, Prevention & Response addresses matters that fall under the university's [Sexual Misconduct Policy](#). ORSM also facilitates reasonable modifications for pregnant or parenting individuals. Additional important information and related resources, including how to request help or confidential support following conduct covered by the Sexual Misconduct Policy, is available on the [ORSM web site](#), and you also may contact the office at [titleix@nau.edu](mailto:titleix@nau.edu). The ORSM is located in Gammage on the third floor.

**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 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://legacy.nau.edu/university-policy-library/research/>

**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

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reported to your instructor or the University's Research Integrity Officer, Scott Pryor, who can be reached at [scott.pryor@nau.edu](mailto:scott.pryor@nau.edu) or 928-523-5927. More information about misconduct in research is available at <https://legacy.nau.edu/university-policy-library/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.

Last revised August 14, 2025

**Appendix B. SICCS INITIATIVES OF INTEREST TO STUDENTS*****School of Informatics, Computing, and Cyber Systems Initiatives******SICCS Freshman/Sophomore Academic Support***

Student retention is a top priority for the Steve Sanghi College of Engineering (SCE) and the School of Informatics, Computing, and Cyber Systems (SICCS). To help you succeed, we provide a variety of academic resources, including office hours, tutoring, Peer Academic Coaching, and time management support.

If you are enrolled in a **100-level or 200-level CS-, EE-, SE-, IMG-, or CYB course**, you have access to **FREE** tutoring in Engineering Building Room 104. If you attend tutoring, you are eligible to receive a percentage of the points you missed on one early assignment or assessment in the course for which you sought tutoring. This grade adjustment is limited to one modification per course per semester and applies only to 100-level or 200-level CS-, EE-, SE-, IMG-, or CYB prefixed course.

Tutoring begins in Week 2. Schedules will be sent to faculty and students during Week 1 and posted in academic buildings. For more information, please contact Leslie Mitchell, our Academic Success Program Manager. [Leslie.Mitchell@nau.edu](mailto:Leslie.Mitchell@nau.edu)

***100% career readiness extra-credit opportunities***

SCE and SICCS are committed to preparing students for their careers. We partner with industry and offer opportunities to engage with professionals through Industry Nights and the NAU Engineering Fest. To encourage participation, students can earn extra credit in **CS-, EE-, SE-, IMG-, or CYB-prefixed courses** as follows:

Each **Industry Night** talk you attend allows you to add 2% to your final grade in one CS-, EE-, SE-, IMG-, or CYB course of your choice (in the same semester). You may apply at most 2% extra credit per course per semester from Industry Nights. Example: If you attend three Industry Nights, you may distribute the credits across courses, but no single course may receive more than 2% from Industry Night events. There are typically 4-6 Industry Night events throughout the semester and details about each event will be distributed separately through email and Canvas notifications

By attending the **NAU Engineering Fest**, you may add 3% to your final grade in one CS-, EE-, SE-, IMG-, or CYB course of your choice (in the same semester). This 3% is in addition to the 2% maximum from Industry Nights. Example: You may apply up to 5% total extra credit in one course (2% from Industry Nights + 3% from Engineering Fest). NAU Engineering FEST occurs every Fall and details about the event will be distributed through email and Canvas notifications.

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