Course Information: This course is a flipped-delivery, 4-credit, upper-division undergraduate/graduate course in the analysis of environmental data. It deals with scientific uncertainty and experimental design and is well suited to students doing or aiming to do research in the Earth, environmental, hydrological, and biological sciences.

Prerequisites: C or higher in STAT 2050, STAT 2070, or MATH 2200; junior standing or higher; and at least one upper-division course in the natural sciences or a related field.

Meeting Times:	Lectures	Recorded and posted on *WyoCourses* before discussion		
	Discussion	Tuesday & Thursday	8:00–9:15 am	via Zoom
	Lab	Friday	1:20–4:30 pm	via Zoom

Instructor Information:

Instructor: Dr. Cliff Riebe, Professor
Contact: criebe@uwyo.edu
Office: via Zoom
Office hours: T 11–1 pm and by appointment

Teaching assistant: Russell Callahan
Contact: rcallaha@uwyo.edu
Office: via Zoom
Office hours: Th 10–12 pm and by appointment

Course Overview: In this course, we will explore the fundamentals of environmental data analysis focusing on practical applications using real data and addressing real-world problems. Topics include: the quantitative display and description of data; error propagation; statistical significance and power; t-tests and analysis of variance; fitting functions to data; environmental time series data; serial correlation; and multiple regression. This course will be online with synchronous web-conferencing. We will meet twice per week for lecture, and once per week for hands-on, computer-based laboratory exercises, all via Zoom. The synchronous online course content means attendance of Zoom meetings is required for all scheduled class meeting times.

This course is cross listed in the Department of Geology and Geophysics and the Haub School, so it draws mainly from environmental, ecological, and biogeochemical problems to illustratee key concepts. The course is also dual listed at the 4000 and 5000 levels, and there are different expectations for achievement depending on which listing you are enrolled under. In accordance with University guidelines, students enrolled in the 5000-level listing can expect to do about 20% more work on average than students in the 4000-level listing. This will include additional problems to solve in the labs and problem sets. It will also involve problems with a higher level of difficulty and/or complexity and more open-ended exercises. Adventurous 4000-level students are welcome to attempt these higher-level problems and exercises, but no extra credit will be awarded for doing this work correctly and likewise no penalty will be assessed for not doing it correctly.

Disability Statement: If you have a physical, learning, sensory, or psychological disability and require accommodations, please let the instructor know as soon as possible. You will need to register your disability with University Disability Support Services.

WyoCourses: We will use the *WyoCourses* system to post your grades; to make announcements about course organization, reading assignments and due dates; and to provide electronic copies of course materials, including readings, assignments and recorded lectures. ***Reading and understanding is mandatory for any course advisories, updates, and materials that are distributed via WyoCourses or directly from us by e-mail.***

Contacting the Instructors Outside of Class: As your instructors for the course, we are committed to responding to student queries as quickly as possible. To make this possible in an interconnected world where there are so many ways to contact people, it is important to establish a preferred method of contact. For interactions about this course, if you need to contact us outside of the classroom, please do so during office hours, or at the end of class, particularly if you have a complicated question or if you have specific questions about an assignment. ***If regularly scheduled office hours do not work for you, you are welcome to arrange another time to meet.*** If you have a simple (e.g., "yes-or-no") question, or if you need to contact us about missing a class (e.g., because you are sick) or about setting up an appointment outside of office hours, please feel free to contact us by e-mail at the addresses listed above. ***Please do not use*** the e-mail system that is built into *WyoCourses*. We will not be checking it nearly as often! We will respond to e-mails sent to the addresses above as quickly as possible, but it may take up to 24 hours on weekdays or 48 hours on weekends to get back to you.

Readings and Recorded Lectures: You should carefully read any assigned readings and watch any recorded lectures before class, so that you are adequately prepared for discussions, ***which will commonly include graded participation activities*** (see below). You may be held responsible for understanding material in assigned readings and recorded lectures even if we don't address it explicitly in class or in problem sets. ***All materials posted on WyoCourses are required reading.*** In addition, there will be required reading from the freely available, and newly updated textbook, ***Statistical Methods in Water Resources***, by authors Helsel et al. (2020).

Course Assignments, Labs, & Projects: This course requires learning facts and concepts, developing problem-solving skills, mastering data analysis skills, and honing critical-thinking abilities. Your progress will be graded based on your performance in a midterm exam; a final exam; computer-based exercises during labs; and problem sets completed both in class-time activities and in take-home assignments. Also, you need to be alert during class for pop quizzes about the most recent recorded lecture; these quizzes will count as problem sets. A tentative schedule of lecture topics is provided at the end of the syllabus.

Labs: There will be 13 or 14 weekly computer-based lab sessions with exercises worth a total of 30% of your grade. ***The labs start during the first week of classes***. Note: You can work on labs at home using the UWStudent Remote Lab system (http://microlab.uwyo.edu/uwsremote/), or using a version of the software installed on your personal computer (stay tuned for details on how to do this). However, ***your attendance at each lab session is required unless you have a valid University-sponsored excuse***. If you do not show up to lab, the best score you can receive on that lab is 3 (on a scale of 0–5). To receive full credit, completed lab assignments must be turned in by the start of the next lab on the following Friday. *Late lab assignments will be docked 50%.* Please note: the penalties are cumulative.

Problem Sets: There will be a series of in-class and take-home problem sets worth 30% of your grade. Problem sets will normally be due a week after they are distributed. *Late homework will be docked 50%.* Your participation and performance in classroom activities (including problem sets and pop quizzes) will be graded. These activities will be based in part on recorded lectures and reading assignments. ***It is therefore vital that you attend class and keep up with assigned readings and recorded lectures.*** Since we will not be meeting in person, problem sets need to be turned in online through *WyoCourses*. We ask that you scan your written work using a scanner or an app on your phone. In addition, please do your best to upload a neat, complete, and easy-to-read scan of your work. This will help us more accurately grade your assignment. If access to a scanner or phone camera is an issue, please communicate with us as soon as possible to make other arrangements for turning in your assignments. Illegible or disorganized work will be assessed a score of 0 (i.e., incomplete).

Exams: The schedule includes time for two exams: a midterm worth 10% of your grade; and a comprehensive final exam that is also worth 10% of your grade.

Term Project: This course includes a term project worth 20% of your grade. The term project is due on the last day of class. ***Late term projects will not be accepted (i.e., will receive a score of 0).*** Undergraduate students will be assigned a term project. Graduate students are strongly encouraged to work with the instructor to design a project that focuses on data collected as part of their research. (Adventurous undergraduate students may also opt for an independent project, but only after consultation with—and with the permission of—the instructor, and only with the understanding that no extra credit will be given for choosing this path.) All students will need to write a concise report explaining their analyses and justifying their conclusions. Grading on the final project will be evenly weighted by the quality of the analyses (50% of grade) and the quality of the writeup (the other 50%).

Showing Your Work: The graded work in this course can involve many calculations. It is vital that you show enough of the math in each exercise to demonstrate that you actually did the work and to demonstrate your competence at it. If you do not show your work, you will lose most or all of the available points, even when you show the correct answer. Note: by showing your work, and thus allowing us to follow it, you make it possible for us to see if you made a simple computational error after setting the problem up correctly, and thus give you the grade you deserve. We recognize that striking a balance between showing enough and not too much work can be challenging. To help illustrate my expectations and set standards for the work you do throughout the course, we will provide you with some worked example problems early in the semester.

We recommend that you ***work all math problems by hand*** (e.g., with pencil on paper) and that you ***do not*** use Equation Editor, MathType, or other software to show math (because students who do so tend to err on the side

of showing too little work and thus lose points). Problems that require or direct you to use a computer are an exception, of course. It is acceptable to answer written questions using Microsoft Word (or other word processor). In fact, we recommend you do so if your handwriting is not very good.

Grading: We will grade and return your assignments as soon as possible, usually within one week of the time it is due. You can keep track of your grades in this course on *WyoCourses*. Each assignment will receive a whole-number score **based on the rubrics posted on WyoCourses**. A generalized rubric, to give you a general idea of what to expect, is provided in Table 1.

Table 1. Generalized rubric for assignments in GEOL/ENR 4525/5525*

Score	Labs	Problem sets	Exams	Final project – analyses	Final project – writeup
5 Data master	The answers to the questions posed in the lab are virtually flawless and are well supported by references to relevant graphics.	The answers to the questions posed in the problem sets are virtually flawless and all solutions to problems are set up correctly.	The answers to the questions posed in the exam are virtually flawless and all solutions to problems are set up correctly.	The answers to the questions posed in the project are virtually flawless. All solutions to problems are set up correctly.	The analysis is well supported by a concise, cogent, grammatically correct, and therefore well-written report.
4 Data analyst	The answers to the questions posed in the lab are mostly correct, but some errors are present and/or the discussion is largely supported by relevant graphics, but some plots may be missing or insufficiently described.	The answers to the questions posed in the problem sets are mostly correct, but some errors are present and/or the solutions to problems are set up correctly for the most part, but some flaws may be present.	The answers to the questions posed in the exam are mostly correct, but some errors are present and/or the solutions to problems are set up correctly for the most part, but some flaws may be present.	The answers to the questions posed in the project are mostly correct, but some errors are present and/or the solutions to problems are set up correctly for the most part, but some flaws may be present.	The report rambles at times or focuses on at some irrelevant topics and/or has some significant grammar errors. All questions raised in the project are adequately addressed.
3 Data cruncher	The answers to the questions posed in the lab have substantial flaws and/or the discussion is supported by some relevant graphics, but the documentation is incomplete.	The answers to the questions posed in the problem set have significant flaws and/or one or more problems may not be set up correctly.	The answers to the questions posed in the exam have significant flaws and/or one or more problems may not be set up correctly.	The answers to the questions posed in the exam have significant flaws and/or one or more problems may not be set up correctly.	The report rambles or focuses on multiple irrelevant topics and/or has many grammatical errors. Questions raised in the project are not adequately addressed.
2 Aspiring data cruncher	The answers to the questions posed in the lab are inadequate and/or the discussion is not well supported by relevant graphics.	The answers to the questions posed in the problem set are inadequate and/or multiple problems are not set up correctly.	The answers to the questions posed in the exam are inadequate and/or multiple problems are not set up correctly.	The answers to the questions posed in the exam are inadequate and/or multiple problems are not set up correctly.	The report is unfocused and poorly organized and/or the report is riddled with grammatical errors. Questions raised in the project are not adequately addressed.
1 Novice data cruncher	The answers to the questions posed in the lab are incorrect and/or not elaborated upon and/or few if any graphics are included to support the answers.	The answers to the questions posed in the problem set are incorrect and/or few if any problems are set up correctly.	The answers to the questions posed in the exam are incorrect and/or few if any problems are set up correctly.	The answers to the questions posed in the exam are incorrect and/or few if any problems are set up correctly.	The report is poorly written, with incomplete sentences, poorly structured paragraphs and/or an emphasis on issues that are largely irrelevant to the main thrust of the calculations.
0 Incomplete**	One or more problems posed in the assignment is not completely addressed. Therefore, no credit can be given.	One or more problems posed in the assignment is not completely addressed. Therefore, no credit can be given.	Many of the problems are incompletely addressed in the student's response.	One or more problems is not completely addressed. Therefore, no credit can be given.	The report is unintelligible, is written by hand instead of on a word processor, and/or does not fully address the questions raised in the project.

*A more detailed rubric for each type of assignment will be included with each assignment on WyoCourses.
**Assignments with a score of "0" are not eligible for being dropped.

At the end of the semester, in recognition of the fact that we all trip up sometimes even as we grow, ***we will drop your lowest non-zero score for both the labs and the problem sets*** (so they are not counted against you) before calculating of your final grade. After doing this, we will average your scores in each assignment group (i.e., labs, problem sets, exams, and project), then scale them according to the percentages in each category (i.e., 30% for labs, 30% for problem sets, 20% for exams, and 20% for the project) to calculate your final weighted-average score. After rounding these averages to the nearest tenth of a point, we will use them to assign a final grade for the course as follows: A = 4.5–5.0; B = 3.5–4.4; C = 2.5–3.4; D = 1.5–2.4; F = 0.0–1.4.

We will set *WyoCourse*s up so that it shows your total score as a percentage of 5 points in real time, with scaling according to the rules outlined here. The instructor reserves the right to change the grading policy. Any changes will be announced in writing via *WyoCourses*.

Missed and Late Assignments: If you miss a class, the burden is on you to make up any missed work and turn it in on time. This is true ***even if you have a University-sponsored excuse.*** You still need to turn your work in on time! This means you will need to plan ahead (if you have an upcoming excused absence) or scramble to make up lost time (due to illness and other unforeseen issue). All materials will be posted on *WyoCourses* when they are assigned, so there is no way you can receive an assignment late. Therefore, the work will be due at the same time for you and your classmates, even if you did not attend class on the day the assignment was made. We will accept late work, ***but only up until graded work is returned to other students.*** Note: credit for late work will be docked 50%. We therefore strongly recommend that you turn your work in on time. See University Regulation 6-713, available on the Office of General Council website, for the University's official Student Absence Policy. If you think you have a valid excuse for turning in an assignment late, we will be happy to entertain the possibility on a case-by-case basis. An example of a potentially valid exception is exposure covid-19. Student who have tested positive for covid-19 or have been exposed to someone who has tested positive may need to isolate for up to two weeks (https://www.uwyo.edu/alerts/campus-return/index.html). Students who need to self-quarantine for either reason will not be penalized but are nevertheless expected continue to complete course work on time, to the extent possible, for the duration of their isolation as they are able.

Academic Honesty: ***The work you turn in must always be your own.*** If you fail to adhere to this rule on **any** assignment, we will initiate a case of Academic Dishonesty against you with the College of Arts and Sciences. Both the university and the college have well-defined procedures for judging cases of suspected academic dishonesty, and serious sanctions, including failure of the course and even expulsion from the university may be assessed to offenders. For the university's official policy on academic honesty, see University Regulation 6-802, revision 3. It defines Academic Dishonesty as "*an action attempted or performed which misrepresents one's involvement in an academic endeavor in any way, or assists another student in misrepresenting his or her involvement in an academic endeavor.*" This means you should **never copy anyone else's work**. This includes anyone who has taken the course previously. It also means that you must do all required calculations on your own. Section IV of regulation 6-802 has definitions of seven distinct acts of academic dishonesty. One of them is "complicity," which is defined as assisting another person in an act of dishonesty. **Never give your work to another student for any reason**, including the seemingly innocent purpose of showing them how to set up a problem. However, it is acceptable on problem sets to seek and provide clarifications on questions asked in the problem set and to **discuss** how to set problems up with other students in the course. Likewise, in lab, it is acceptable to give and receive help from your classmates on how to use the software and how to interpret the questions posed in the lab handouts. However, **it is never acceptable to work on an assignment together unless we expressly and unambiguously allow it**. There is a clear line between helping a fellow student who is confused about a question and violations of the academic honesty policy, such as turning in someone else's work. Please do not cross it. Because the central goal of this course is to improve understanding of the power and limits of data in telling the truth about natural phenomena, our minimum recommendation as a penalty for any instance of Academic Dishonesty will always be harsh: **failure of the course**.

Conduct: An official ***Student Code of Conduct*** has been established under University Regulation 8-30. Like other regulations, it is available online from the University Office of General Council. There is also a code of conduct for this course, encapsulated in a document entitled ***A&S – Students and Teachers Working Together***, published by the College of Arts and Sciences. A copy is included in your handouts on day one.

Statement on Diversity: UW Regulation 2-117 contains the following statement: "The University of Wyoming values an educational environment that is diverse, equitable, and inclusive. The diversity that students and faculty bring to class, including age, country of origin, culture, disability, economic class, ethnicity, gender identity, immigration status, linguistic, political affiliation, race, religion, sexual orientation, veteran status, worldview, and other social and cultural diversity is valued, respected, and considered a resource for learning." This course embraces this statement, both in the way we expect students and instructors to interact and in the material that is covered in the readings, labs, and lectures.

In this classroom, you have the right to determine your own identity. You have the right to be called by whatever name you wish and to have that name pronounced correctly. You have the right to be referred to by whatever pronouns you wish. You have the right to adjust any of these things at any point in your education. If you find that there are aspects of course instruction, subject matter, or classroom environment that result in barriers to your inclusion, please contact the instructor privately without fear of reprisal.

Duty to Report: The instructors of this course are committed to upholding the university's non-discrimination policy. This includes supporting victims of sexual discrimination, harassment, and violence. You do not have to go through the experience alone. Assistance and resources are available, and you are not required to make a formal complaint or participate in an investigation to access them. For example, there are people on campus who can meet with you and afford you privacy and confidentiality. Faculty members can help direct you to these resources and you can find information about them at http://www.uwyo.edu/reportit. Please note that instructors are required as "Responsible Employees" of the university by federal law (i.e., Title IX of the Education Amendments Act of 1972) to report any suspected instances of sex- or gender-based discrimination and sexual harassment or violence to the university's Title IX Coordinator.

COVID-19 Policies: During the ongoing pandemic, you must abide by all UW policies and public health rules put forward by the City of Laramie, the University of Wyoming, and the State of Wyoming to promote the health and well-being of fellow students and yourself. The current policy is provided for review at: https://www.uwyo.edu/alerts/campus-return/index.html.

As with other disruptive behaviors, we have the right to dismiss you from the classroom (Zoom and physical), or other class activities if you fail to abide by these covid-19 policies. These behaviors will be referred to the Dean of Students Office using the UW Cares Reporting Form for Student Code of Conduct processes: https://cm.maxient.com/reportingform.php?UnivofWyoming&layout_id=5.

We will alert you to any course format changes in response to UW decisions about community safety during the semester.

Zoom and WyoCourses Expectations: As with all UW coursework, we stive to provide an educational and useful experience for everyone enrolled in the course. Our responsibilities include making this true and responding to questions, concerns, and feedback in a timely manner.

Your responsibilities include, but are not limited to:

- Interact with your instructor, your TA, and your classmates respectfully and constructively at all times. This includes in Zoom chats and on *WyoCourses* boards.
- Actively engage in discourse in a respectful manner. Use professional language in all course-related forums and on all course-related e-mails.
- Communicate professionally. Whenever you send class-related email or messages, please include a clear, specific subject line and use the body of the email or message to explain the purpose for the email and any attached materials. Conduct yourself professionally.
- Meet assignment deadlines. We expect you to interact with course material multiple times during the week.
- Ask for help when you need it. For assistance on academic aspects of this course please contact me for available resources. For Dean of Students assistance please see: https://www.uwyo.edu/dos/student-resources/covid-19-student-resources.html.
- Please let the university know if you know of another student who needs help using our (anonymous) WyoCares referral system https://www.uwyo.edu/dos/students-concern/index.html.

Information Technology (IT): If you have any IT-related challenges, please contact the UWIT Service Center: https://uwyo.teamdynamix.com/TDClient/1940/Portal/Requests/ServiceDet?ID=8890.

Changes in the Syllabus: The instructor reserves the right to change the syllabus as the course proceeds. Any changes will be announced in class. Substantive changes shall be communicated in writing by e-mail.

Tentative Schedule of Topics:

Week	Days	Topics	Week	Days	Topics
1	Aug 25 Aug 27	Introduction to course Describing data	9	Oct 20 Oct 22	ANOVA Multiple comparisons
2	Sep 1 Sep 3	The normal distribution Transforming data	10	Oct 27 Oct 29	Linear regression Uncertainty in linear regression
3	Sep 8 Sep 10	Central limit theorem Confidence intervals	11	Nov 3 Nov 5	Residuals and artifactual correlation Correlation in geological data sets
4	Sep 15 Sep 17	Error propagation (simple rules) Covariance	12	Nov 10 Nov 12	Serial correlation Alternate approaches to regression
5	Sep 22 Sep 24	Error propagation (w/ correlation) Hypothesis testing	13	Nov 17 Nov 19	Multiple regression Multiple regression
6	Sep 29 Oct 1	Statistical significance and power Two-sample tests	14	Nov 24 Nov 25	Multi-collinearity *No class (Thanksgiving holiday)*
7	Oct 6 Oct 8	Non-parametric tests Paired-sample comparisons	15	Dec 1 Dec 3	Outliers and censored data Sampling design
8	Oct 13 ***Oct 15***	Statistical Fishing expeditions ***Midterm Exam***	16	 ***Dec 10***	 ***Final Exam: 8–10 am***

Add/change deadline: Thursday, August 27.
Drop deadline: Wednesday, September 2.
Midsemester grades due: Thursday, October 22.
Advising Week: October 26–October 30.
Last day to withdraw from all classes: Monday, November 30.

Schedule is tentative. The instructor reserves the right to change it at any time. Minor changes will be announced in class. Substantive changes will be communicated in writing by e-mail.

Required Textbook: Required readings, assigned during class, will be from Helsel et al., ***Statistical Methods in Water Resources***, 2020, which is available free online: https://pubs.usgs.gov/tm/04/a03/tm4a3.pdf.

Additional Textbooks and Resources:

Zar**,** ***Biostatistical Analysis***, Prentice-Hall/Pearson, 5th ed., 2010.
Sall et al., ***JMP Start Statistics: A Guide to Statistics and Data Analysis Using JMP***, SAS Inc., 2012.
Taylor, ***An Introduction to Error Analysis***, University Science Books, 1997.
Tufte, ***The Visual Display of Quantitative Information***, Graphics Press, 1983.
Dreyer, ***Dreyer's English: An Utterly Correct Guide to Clarity and Style,*** Random House, 2019
University of Wyoming Writing Center www.uwyo.edu/ctl/writing-center/