

## Human Impacts on Biogeochemical Cycles

Professor: Dr. Rebecca Barnes

Email: rebecca.barnes@coloradocollege.edu

Office: Tutt 130F

Paraprof: Kyra Wolf (kyra.d.wolf@coloradocollege.edu)

EV Technical Director: Darren Ceckanowicz (darren.ceck@coloradocollege.edu)

Office hours: We will be together a lot – if you need to meet with me outside of class time just set up a meeting via email or in class, I am happy to meet with you.

In this course we will explore the large biogeochemical cycles of our planet (N, C, P, S) plus water. By the end of the block you should know how they work (i.e. the chemical, biological, and geological mechanisms that drive them) and how humans have altered them. We will explore this intersection primarily through the lens of **agriculture** and introduce you to modeling, lab, and field techniques.

### Course Format:

Class will begin every morning at **9 AM** unless otherwise noted. Morning sessions will usually last until about noon and will rely on you doing the reading so that class discussions are not completely boring. There will be a lab (inside, in the field, in the lab – it really depends on the day) on many days so please check the schedule, with the exception of our first field trip you should always be done with class by 3:30 PM. We will have two field trips: November 3<sup>rd</sup> and 8<sup>th</sup>. As a professor of mine once said – there is no such thing as bad field conditions, just bad field clothes – i.e. unless there is lightening or it is otherwise dangerous to be outside, we will go.

### Attendance:

We will be covering a lot of material in this course, with every day building on the previous day. Therefore, it is necessary that you show up for *every* class. I realize that sometimes life becomes overwhelming at moments and therefore you are allowed **one unexcused absence**. Each subsequent *unexcused absence* will result in a 3% reduction in your final grade. If you have two unexcused absences, the Dean of Students will be notified. Please note that if you get sick during the block I will do everything I can to help you catch up on the material – but you need to have a note from Boettcher or another doctor for your absence to be considered *excused*.

If you need to miss class for any justifiable reason during the block (e.g., athletic team travel, religious observance), please notify me **on the first day of class** so we can make arrangements on how you will receive the material for that day.

**Canvas, Readings, & Online Questions:** I will use Canvas extensively throughout the course. I will do my best to have everything posted multiple days in advance but always by 4 PM for the following day. **All readings are posted on Canvas.** It is your responsibility to do the readings BEFORE class. You will be held accountable for the readings, so come to class prepared. Being prepared goes beyond reading, however. You should allow for adequate time to *think* about the readings as well. There will often be **questions posted on Canvas** that you must complete. The goals of these questions is to (1) assess your comprehension of the reading material, and (2) to get you to start thinking about the material prior to classroom discussions.

### Exams & Assignments:

You will have two exams this block The first *in class, closed book* exam will be on the first Friday of week 1 and will test your knowledge of the chemistry basics that we learn in the first week. The second exam will be on Tuesday of week 4 – this exam will be *oral* and comprehensive.

There will be *three STELLA models* that you will complete (one per week of the class: Population, Carbon Cycling, Nitrogen Cycling). You will need to install the 30-day free trial version of STELLA on your computer (files on Canvas). STELLA is a visual modeling program and it enables you to model a system without writing code (and translates your model into differential equations); as such it is a great way to get introduced to modeling. You will have the option of incorporating STELLA into your final project.

There will be *three small lab assignments* that you must complete, one per week. These labs are designed to introduce you to various field and lab methods. You will use these methods in your final project.

You will all present *one peer reviewed article* to the class (~2 students will present each day). This serves two roles: 1) you learn how to digest a paper quickly and present the relevant facts and 2) increases the breadth of material covered in the course. How it works: everyone will sign up for a day and find a peer reviewed article that examines a human impact on a biogeochemical cycle. By **8 AM** of the **day you are presenting** you must **send me the article** and designate **one or two figures** that you will focus on. In class, all students will receive these figures (I will make the handouts) and you will lead a brief (~10 min) discussion.

There will be *one large project*, the **Wiley Ranch Project** (weeks 2-4; paper). This project will explore the interactions between land management, plant communities, and soil biogeochemistry. We will collect data as a class and you will work in groups to test specific hypotheses. The first draft of your *individual* paper is due 8 AM Monday of week 4, we will spend Monday's class doing *peer review* and the final version is due 12 PM Wednesday (last day of class).

### Grading:

Article presentation & participation	10%
STELLA models & small labs	25%
Exams (1 <sup>st</sup> exam: 10%, final: 15%)	25%
Final Project	40%
First Draft (10%) & Peer Review (5%)	
Final Draft (25%)	

### Grading Assignment ("+" and "-" will also be given when appropriate):

A = 90-100%

B = 80-89%

C = 70-79%      S = 70-100%

D = 65-69%      CR = 65-69%      NC = below 65%

D+, D, CR, and NC does not fulfill EV Department major requirements.

### Late assignment policy

Papers (first draft and final draft) will NOT be accepted late. Any late lab assignments will get a deduction of 1/3 of a letter grade for every day it is late (part of 1 day counts as a day). For example, if the paper is due Monday at 9 AM and you turn it in at 3 PM, that would count as being 1 day late and the grade would go from a B to B-.

### Honor Code:

Failure to properly document sources in papers, plagiarism, copying from other student's work, or turning in assignments that have already been submitted for credit in other courses are among some of the actions considered intellectual theft under the Colorado College Honor System. I encourage you to work together and talk through issues, but your final written work must be your own. I will give you further information on how the honor code applies to specific assignments as we go. If you are uncertain about the Honor Code's application to a

particular project, please ask me. If you have questions or to read further details of the Honor Code see: <http://www.coloradocollege.edu/other/honorcouncil/constitution-bylaws/constitution.dot>

### Disability Accommodations

If you have a disability and require accommodations for this course, please speak with me privately as soon as possible so that your needs may be appropriately met. If you have not already done so, you will need to register with Accessibility Resources (Learning Commons in Tutt Library, 227-8285), the office responsible for coordinating accommodations and services for students with disabilities.

### Course Schedule

Each day's lectures, labs, and discussions will be based upon a question that we will try and answer. By the end of the course, you should be able to have a meaningful discussion about these questions.

*The syllabus and schedule are subject to change depending on the progress of the course.*

## Week 1: Chemistry Basics and Systems Thinking

### Day 1

- Course introduction
- Causal loops & feedbacks
- **LAB, 1:15 PM:** How to read a paper
- Caraco & Cole 1999 *Ambio* (you don't need to read it ahead of time, just bring it to class)
- Sign up for article presentation date

### Day 2

- Chemistry basics – what is matter, atoms & periodicity, chemical reaction, ideal gas law
- Introduction to soils
- C&C pgs 15-27, 53-57, 115-119
- Chapin et al. Chapter 3, pgs 63-69, 78-89
- **LAB, 1:15 PM:** Introduction to soils (be prepared to go outside and to work in lab, closed toe shoes and pants required)

### Day 3

- Chemistry basics – formal charges, Lewis structures, chemical bonding
- C&C pgs 57-62, 104-112
- **Soil lab due 1:30 PM** [upload to Canvas]
- **LAB, 2 PM:** Introduction to STELLA
- *Install* STELLA on your computer [files on Canvas]
- Cohen 1995 *Science*

### Day 4

- Introduction to elemental cycling & agriculture
- Weathers et al. Chapter 5

- Foley et al. 2005 *Science*
- **STELLA population lab due 4 PM** [upload to Canvas]

**Day 5**

- **Exam 1 – 9 AM** Chemistry Concepts, Systems Thinking, Lab skills

**Week 2: Agriculture, Soil, & Carbon**

**Day 6 – Happy Halloween!**

- Introduction to the C cycle
- Chemistry Basics – oxidation states
- Weathers et al. Chapter 6
- Falkowski et al 2000 *Science*

**Day 7**

- More on soil & agricultural impacts on C cycling
- Chapin et al. Chapter 3 pgs 69 - 78
- Houghton & Hackler 2000 *Global Ecology & Biogeography*
- Robertson et al. 2000 *Science*
  
- **LAB, 1 PM:** Plant Transects. Meet outside Tutt Science at 1 PM (Nevada Side)

**Day 8**

- Agricultural management and C sequestration
- Lal 2004 *Science*
- Post & Kwon 2000 *Global Change Biology* **or** West & Marland 2003 *Biogeochemistry*
- Pimental et al. 2005 *Bioscience*
- **Plant Transect lab due 1 PM**
  
- **LAB, 1:15 PM:** STELLA C lab
- Schultz 2000

**Day 9**

- **Wiley Ranch Field Trip**, meet at **7:45 AM** outside Tutt Science (Nevada Side), *bring a lunch*

**Day 10**

- **LAB, 9 AM.** Meet in Olin 170 (EV Teaching Lab) to process your soil samples
- **STELLA carbon lab due 9 AM** [upload to Canvas]

**Week 3: Agriculture and Nutrients, Downstream Effects**

**Day 11**

- N Cycle
- Chemistry basics – redox reactions
- Weathers et al Chapter 7
- Redox Primer (Findlay)

- Vitousek et al. 1997 *Ecological Applications*
- **LAB, 1:15 PM:** STELLA N lab

**Day 12**

- **Chico Basin Ranch Field Trip**, meet at **7:45 AM** outside Tutt Science (Nevada side), *bring a lunch*
- **STELLA N lab due by 6 PM** [upload to Canvas]

**Day 13**

- P cycle & agricultural impacts on aquatic ecosystems: N & P
- Introduction of Final Project
- *Skim* Weathers et al Chapter 8
- Ryther & Dunstan 1971 *Science*
- Schindler et al. 2008 *PNAS* or Michalek et al. 2013 *PNAS*
- **LAB, 1:15 PM:** Wiley Ranch Data work up

**Day 14**

- S cycle & agriculture impacts on aquatic ecosystems: H<sub>2</sub>O & S
  - *Tentative: Guest Lecture Dr. Kate Brauman*
- Brauman et al 2013 *ERL*
- Schlesinger & Bernhardt pgs 471-482
- Hinckley & Mason 2011 *PNAS*
- **Standard Curve** work-up due **1 PM**
- **OPTIONAL LAB, 1:15 PM:** processing of Wiley Ranch Soils

**Day 15**

- **Final Project Work Day** (lab work, dive into peer reviewed literature)

**Sunday 12 PM: First draft of your final paper due** [upload to Canvas]

**Day 16**

- Peer Review of your Wiley Ranch Papers

**Day 17**

- **Oral Final**

**Day 18**

- **Final Paper due 12 PM**