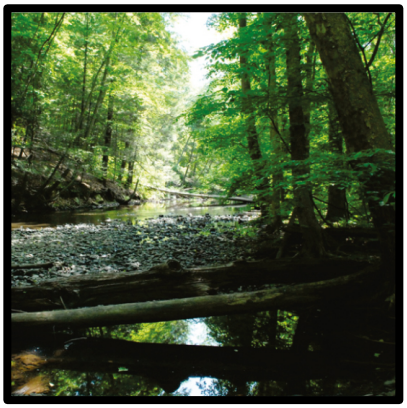
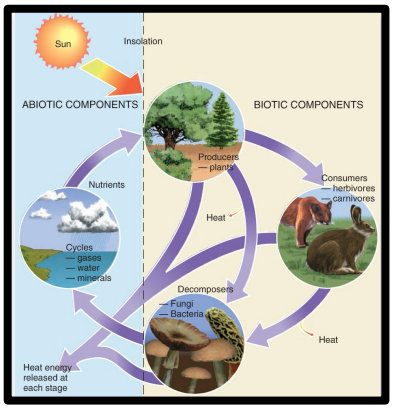
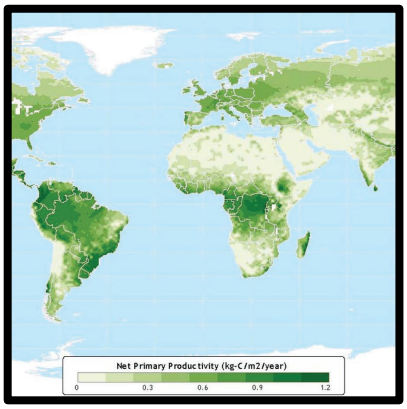
Feb. 14, 2016

BIOL 6060 - Spring 2016
Ecosystem Ecology







TIME AND LOCATION
Tues/Thurs 9:30-10:50
Rieveschl Hall 615B
Office hours by appointment

INSTRUCTOR
Dr. Ishi Buffam
731H Rieveschl Hall
ishi.buffam@uc.edu
556-9745

COURSE THEME AND APPROACH: This course is designed for beginning graduate students and upper-level undergraduates. The goal of the course is to introduce the history, key concepts and principles, and practice of ecosystem ecology. Ecosystem ecology, first introduced as a sub-discipline of ecology in the 1940's-1950's, is the study of the flow of energy and materials within the environment, and between organisms and their environment. The focus can be at any spatial scale, from microscopic to global. In the course we will primarily study the cycling of energy, water, and the biologically important elements carbon, nitrogen, and phosphorus. As the course progresses, we will study how these cycles relate to global and local environmental issues.

This field of ecology has been dynamically evolving over the past several decades through interactions and research conducted by highly-motivated, forward-thinking, interdisciplinary scientists working in both terrestrial and aquatic ecosystems as well as at the terrestrial-aquatic interface. Because of this recent history, it is vital that students of ecosystem ecology are able to read and discuss the scientific literature, and interact with other researchers in the field. Therefore, students will read both textbooks and primary scientific literature. This course will highlight student discussion and presentation, and be an opportunity to improve speaking and discussion skills, as well as serving as an introduction to the history and core concepts of the discipline. Student teams will lead in-class discussions based on the reading materials. Knowledge will be assessed periodically with PRS quizzes and two exams, as well as a final project involving the construction of energy and element budgets for an ecosystem of the student's choosing.

LEARNING OUTCOMES: If you put your all into this course, you can expect to come away with the ability to do the following:

1. Identify and describe the most important ecosystem processes in aquatic and terrestrial ecosystems, including but not limited to energy flow, ecosystem production and nutrient cycling.

2. Identify and compare current methods for measuring critical ecosystem variables such as energy and nutrient stocks and pools in a range of environments.

3. Offer a reasoned critique of ecosystem ecology studies published in the peer-reviewed literature.

4. Create, illustrate and describe an ecosystem energy or nutrient budget for an ecosystem of the student's choosing.

5. Communicate effectively via spoken and written means, about ecosystem research and core ecosystem ecology concepts.

6. Identify the most pressing current environmental issues, locally and globally, in the context of ecosystem concepts.

COURSE READINGS: Readings will come from the required books (below) and will be supplemented by materials from a variety of other sources, including primary literature (research articles). Supplementary readings can be found in the "Course Documents" folder on Bb, as pdf files or links to online documents. Reading for each topic should be read prior to coming to class, and will typically be covered in quiz questions either before or in class. **You are responsible for reading each day's assigned readings <u>before</u> coming to class.**

Required books:

(1) **Weathers, Strayer and Likens.** 2013**.** *<u>Fundamentals of Ecosystem Science (FES)</u>*. Academic Press, Elsevier, Amsterdam, 312 pp. (AVAILABLE IN UC BOOKSTORE or on Amazon.com, about $60) This book is essentially an expanded version of an intensive 2-week course taught every January the Cary Institute of Ecosystem Studies (IES) near the Hudson River in eastern New York State. IES is the premier research institute for Ecosystem Science nationally, and perhaps globally. Drs. Kathy Weathers and Dave Strayer are world-renowned Ecosystem Ecologists who work as Research Scientists at IES; Weathers is a biogeochemist, and much of her research focuses on atmospheric chemistry and air quality-related impacts on ecosystems. Strayer is a stream ecologist who focuses mainly on freshwater invertebrates and their distribution, interactions, and role in ecosystems. Dr. Gene Likens is the retired director of IES, and is one of the pioneers of modern ecosystem science – he is responsible for the most famous watershed research program in the world (Hubbard Brook, NH, which has been continuously studied since the 1950s) and for pioneering research on acid rain and its impacts starting in the 1960s.

(2) **Chapin, Matson and Vitousek.** 2011. *<u>Principles of Terrestrial Ecosystem Ecology (PTEE)</u>*. Springer, New York, 529 pp. (AVAILABLE FREE THROUGH THE UC LIBRARIES WEBSITE as an eBook or a pdf file; Or if you want a hard copy, available on Amazon.com for about $50) Dr. Terry Chapin is a Professor Emeritus at the University of Alaska-Fairbanks, and is one of the most prolific and well-respected thinkers in ecosystem science, with >400 published scientific research papers. He studies the sustainability of ecosystems and human communities in a rapidly changing planet, and has carried out groundbreaking research on resilience (recovery from perturbation) of ecosystems. See **terrychapin.org** for more information and additional resources, including a link to powerpoint files for all of the figures in the textbook. Pamela Matson and Peter Vitousek are Professors at Stanford University in California. Matson is also the Dean of the School of Earth, Energy & Environmental Sciences, and Vitousek has carried out much of the foundational research on the nitrogen cycle in terrestrial ecosystems, using the differently-aged islands of Hawaii as model ecosystems to study long term ecosystem succession and nutrient dynamics.

EXPECTATIONS FOR STUDENTS:

1. Students will be prepared for class and participate fully in class activities
2. Students will arrive for class, be in their seats, and ready to begin on time. Students will stay until the end of class and will not pack up before that time.
3. Students will turn off all music, communication, and game devices during class. Laptops/tablets can be used only for class-related activities. If you need to be reached on an emergency basis (e.g. medical professional on call or kids in day care), let me know ahead of time.
4. Course-related email will include BIOL 6060 in the subject line
5. Students will be respectful and civil with other students, the professor, and class guests.
6. Students will conduct themselves with personal integrity and honesty.

WHAT YOU CAN EXPECT FROM YOUR PROFESSOR:

1. I will be prepared for class, and start and end the class on time.
2. I will do my best to make sure class time is valuable to the students who attend.
3. I will abide by the grading scale and course policies listed in the syllabus.
4. I will answer email questions from students within 48 hours, during the work week.
5. I will listen to in-class questions from students and will address them thoroughly, if relevant to the topic being discussed. If I do not know the answer, I will do my best to find it out and report back.
6. I will be respectful, civil, and professional in my dealings with students.

ADDITIONAL COURSE INFORMATION: BIOL 6060

Class information and communications will be disseminated online through Blackboard. It is your responsibility to stay informed of any Bb communications or assignments, and to download and read the required readings prior to the beginning of class.

PRS "Clickers": We will be using Turning Point PRS clickers for rapid response feedback and quizzes during class. Make sure that you have a clicker that you can use (available at the UC bookstore if you don't already have one), and register it on the class Bb site, and set it to **channel 65** for use in our classroom.

The work you will do in this course is subject to the University of Cincinnati Code of Conduct. The Code of Conduct is a commitment to the highest degree of ethical integrity in academic conduct, a commitment that, individually and collectively, the students of the University of Cincinnati will not lie, cheat, or plagiarize to gain an academic advantage over fellow students or avoid academic requirements. While we will sometimes work in groups, you will prepare your assignments independently unless otherwise indicated by the instructor. If you are unsure about the rules for a particular assignment, it is your responsibility to ask the instructor. The Student Code of Conduct (SCOC) document can be accessed at: http://www.uc.edu/conduct/Code_of_Conduct.html.

Special Needs Statement: If you have any special needs related to your participation in this course – including identified visual, hearing or physical impairments, a communication disorder, and/or a specific learning disability that may influence your performance in this course – please contact me to arrange for reasonable provisions to ensure an equitable opportunity to meet all course requirements. Some accommodations may require prior approval by Disability Services (513-556-6823).

BASIS FOR GRADES: Grades will be based on a variety of assignments, with relative weight assigned as described below.

Assignment	**Nr of Points**	**% of Total for Undergraduate Students**
In-class Participation	40	10%
Pre-Questions from Reading (Bb)	40 (20 x 2)	10%
Ecosystems in the News Presentations	20 (2 x 10)	5%
Leading Discussion	30	7.5%
Quizzes and Assignments	60	15%
Midterm Exam	60	15%
Project - Poster Presentation	40	10%
Project - Paper	30	7.5%
Final Exam	80	20%
UNDERGRADUATE STUDENT TOTAL	**400**	100%
Proposal (Grad students only)	70	
Second Time Leading Discussion	30	
GRADUATE STUDENT TOTAL	**500**	

Your final grade will be determined by summing credit for all of the above, with Undergraduate students graded out of a total of 400 points, and Graduate students out of a total of 500, and with the grade breakdown planned as follows.

Letter Grade	**Percentage**	**Grade points/credit**	**Rating**
A	93-100%	4.0	Excellent
A-	90-93	3.7	Very Good
B+	87-90	3.3	Good
B	83-87	3.0	Good
B-	80-83	2.7	Above Average
C+	77-80	2.3	Above Average
C	73-77	2.0	Average
C-	70-73	1.7	Below Average
D	60-70	1.0	Inferior
F	<60	0.0	Fail

In-class Participation: This is a very important part of the class. The expectation is that you will make an effort to regularly and constructively contribute to class discussion, ask questions, etc. Knowing that we are all starting with different levels of experience and comfort in terms of public speaking, I will be doing my best to evaluate each student based on their progress throughout the semester with respect to in-class participation, rather than giving a grade specific to any given day in class. Also, although I will not be explicitly tracking attendance, excessive absences will impair my ability to evaluate your performance in the grading scheme outlined above. Since this class is focused on building speaking and discussion skills, missing class will hurt your ability to improve these skills and prevent your peers from gaining your insight into their presentations.

Pre-Questions on Blackboard: For every day with a reading assignment (almost all days), you are responsible for uploading your answers to the reading questions to the Bb site by 7:00AM on the day of class. These will either be assigned questions specific for that date, or as a default: (1) what did you like most, get most out of from the reading; and (2) what did you not understand, not like, or feel was not fully/clearly explained in the reading. A few sentences/short paragraph is fine, and the responses should be typed/pasted directly into Bb (not uploaded as a file).

Focal Questions in Class: For every day with a reading assignment (almost all days), you are responsible for coming to class prepared to contribute to the discussion, which is framed around several focal questions that are presented by either the professor, or a pair of student discussion leaders. See "Discussion Leaders" section for more detail. Those responsible for the discussion, are also responsible for posting the focal questions ahead of time in order to encourage creative thinking about the questions even before class. As a discussion participant, you are expected to spend time outside of class considering the focal questions, and come to class prepared to discuss them.

Ecosystems in the News: We will start off each day of class with a short (about 5 minutes) session on Ecosystems in the News. This will be led by a different student each day, and each student will do this twice during the semester. The student's responsibility is to find a recent news article, event or topic that relates to Ecosystems or Ecosystem Science, then present that finding to the class. Ideally the news event will align with some of the specific topics we are covering in class that week, but that is not required. It should be something interesting, intriguing, surprising, thought-provoking – have fun with it! Any type of media is fine – but this should NOT be something only in the scientific literature, it should be something that rises to the level of having public interest and being in popular media.

Discussion Leaders: A major part of your responsibility in this class will be contributing to in-class discussions of the readings and related topics; and on at least one occasion, leading the discussion (1 day for undergraduate students, 2 days for graduate students). The goal is to have two discussion leaders for a given day. The two leaders, together, will give a very brief (10 minutes or so at most) introduction to the readings (with visual aids if desired) and more importantly, introduce 3+ focal questions or problems that you think would be interesting for us to discuss as a group. These should include some factual questions that you feel are useful to emphasize, but should also include 1+ questions or problems to which there is no single simple right answer. That is, the purpose is not just testing people on how well they've read the papers/chapter or know the topic –instead, the goal is also to encourage people to critically evaluate some aspects of the reading and engage in an open debate. If the reading is a research paper, the goal is to critically evaluate the approach and/or conclusions of the paper(s) and come up with a defined opinion about that, or an idea about how to improve on the approach. If the reading is a book chapter, more emphasis will be placed on learning and discussing the key concepts. Open discussion of the topic/paper(s) is expected to take up the bulk of class time, i.e. 30-45 minutes. Hopefully the group leaders won't have to do too much aside from introducing the original questions; all members of the group should contribute to the conversation. The group should at least touch upon the focal questions, although if they are interested in going in different directions related to the topic, that is ok too.

Quizzes and Assignments: There will be quizzes most days, covering the assigned readings or material discussed in class. These will be typically offered in class using PRS clickers. Periodic out-of-class assignments will be due at the beginning of class on the due date. Details will be supplied both in class and on the Bb site.

Exams: There will be one midterm exam this semester (in addition to the final exam). The exam format will be a mixture of multiple choice, fill-in-the-blank, matching, and short answer. You will have approximately one class period to complete the exam. The focal questions from the reading are fair game

for the exam, as are all of the Review questions from the chapters we read in the Chapin et al. textbook and any other topics that we cover in class or that are emphasized in the readings.

Final Exam: The final examination for this course is scheduled for *Thursday, April 28, at 7:30AM*. The final exam will emphasize knowledge and skills from the second half of the course primarily, but will also include the larger concepts that were introduced earlier in the course. The format will be the same as the midterm exam – a mixture of types of questions.

Ecosystem budget project: Throughout the semester, each student will select an ecosystem of interest to them (real or imaginary), and carry out an exercise to characterize that ecosystem. This will involve describing the ecosystem, researching the ecosystem, and creating two distinct "budgets" for the ecosystem: an energy budget and an element budget for one other element aside from Carbon. To do this: **(0) Define the research topic of interest, and give rationale for selecting the study ecosystem, boundaries and element of interest;** (1) define the spatial boundaries; (2) define the main pools (compartments) of organic matter or biota; (3) define the main fluxes into/out of the system, and between compartments; (4) define the time frame of interest; (5) Describe the main environmental factors (state factors and internal controls) that would influence the key fluxes in the ecosystem; (6) Describe the types of measurements that would need to be made, and the methods that would be required, to characterize each of the fluxes and pools. (7) Guess/estimate values for each of the pools and fluxes. The end result of this project will be a short research paper, with citations; and a poster presentation shared with your peers during the last week of class.

Due date	Ecosystem Budget Project Benchmark
2/16	Read at least one of the "Classic Energy Budget" papers posted on Bb, and summarize (about 1 page) the paper by answering the same questions as required for your Budget Project. For this summary, I suggest you include a budget diagram for the entire system, but you only need to select 2 fluxes and 2 pools (stocks) to discuss in detail (their environmental drivers, how to measure them, etc.)
2/18	Rough outline for your project (bullet-point list is fine): Proposed ecosystem type, location, spatial extent, time frame of interest, element of interest, a list (or figures) of the proposed pools and fluxes for both energy and element of interest. Be as **specific** as possible. You will get **feedback** on the idea. **For graduate students:** include a focal research question(s) of interest which will motivate your eventual proposal.
3/3	Read at least one of the "Element Budget" papers posted on Bb, and summarize (about 1 page) as above.
3/8	Submit a list of at least 5 (more encouraged) citations to good peer-reviewed journal articles of relevance; other sources are welcome, but at least 5 peer-reviewed papers.
3/17	Submit Draft of your paper to Bb for peer review
3/29	Review 2 of your peers' papers, upload reviews to Bb and come to class prepared to Discuss with the author of the draft.
4/5	Final Paper Due
4/12	(**Grad students only**): Proposal draft due on Bb for peer-review
4/19	Poster Session in Class
4/21	(**Grad students only**): Proposal Final Draft Due

Additional Responsibilities of Graduate Students: In addition to the standard assignments, graduate students are expected to lead Discussion twice rather than once, and also to write a short research proposal focused on an ecosystem **and scientific question(s)** of their choice – likely, the same ecosystem as they use for their ecosystem budget poster and paper. The details of the proposal assignment will be clarified by the instructor.

Schedule

Day	Date	Topic	Readings, Assignments	News	Disc. Leaders
1	T 1/12	Introduction to Ecosystem Science	FES p.3-12		
2	R 1/14	Ecosystems - the big picture	Chapin ch. 1	Tessa	
3	T 1/19	History of Ecosystem Science and Origin of the term "Ecosystem"	FES p.19-22 Tansley 1935 (p.289-292, 295-307)	Robert E.	
4	R 1/21	Tools of Ecosystem Science	FES p.12-19 Carpenter 1998	Jalynn	1. Megan and Alicia
5	T 1/26	State Factor #1: Climate	Chapin ch. 2 (p.23-50, 60-61)	Caitlin	
6	R 1/28	Biomes and the Effects of Climate Change	Chapin ch. 2 (p. 50-61), Grimm et al. 2013	Adam	2. Rob T. and Alyssa
7	T 2/2	Ecosystem Energetics and Energy Budgets - Overview	FES Section II Intro: Ecological Energetics (p.25-26)	Rob T.	
8	R 2/4	Primary Production	FES ch. 2 (p. 27-51)	Alicia	3. Sharon and Jalynn
9	T 2/9	Controls on Primary Production (GPP)	Chapin ch. 5 (p. 123-156); **Konza Prairie Exercise**	Caitlin	
10	R 2/11	Water and Energy Balance (*Patrick Ray seminar – meet in class at normal time*)	Chapin ch. 4 (p.93-122); Ray et al. 2012	Sharon	*Patrick Ray seminar – meet in class at normal time*
11	T 2/16	Plant C budgets and NPP	Chapin ch. 6; Hamilton et al. 2002	Alyssa	
12	R 2/18	Decomposition and Ecosystem C budgets	Chapin ch. 7; Davidson and Janssens 2006	Alicia	4. Rob T. and Travis
13	T 2/23	Global carbon balance and concept review	Canadell et al. 2007	Rob T.	
14	R 2/25	**Midterm Exam**	**Midterm Exam**	N/A	
15	T 3/1	Nutrient Cycling and Redox Reactions	Chapin ch. 9; Chapin p. 86-89 (soil chemistry); FES Appendix (297-301)	Travis	
16	R 3/3	Nutrient Budgets and the small watershed approach	Bormann and Likens 1967; Schelker et al. 2016	Megan	5. Alicia and Chelsea
17	T 3/8	Nitrogen	Davidson et al. 2012; Readings TBD	Jade	
18	R 3/10	Phosphorus	Elser et al. 2007; Reading TBD	Sharon	6. Jade and Robert E.
19	T 3/15	Trophic dynamics	Chapin ch. 10;	Chelsea	

			Marcarelli et al. 2011		
20	R 3/17	Trophic cascades	Reading TBD; **Paper Draft 1 due to peers**	Jade	7. Adam and Caitlin
		SPRING BREAK			
21	T 3/29	In-class discussion and friendly critique of paper drafts	**In-class discussion and friendly critique of paper drafts**	Alyssa	
22	R 3/31	Carbon cycling in terrestrial and aquatic systems	Battin et al. 2009; Buffam et al. 2011	Megan	
23	T 4/5	Synthesis: Stream Ecosystems	FES ch. 16 (Meyer - Streams and their Valleys); Bernot et al. 2010 **Paper Final Draft due**	Chelsea	*Guest presentation: Jeremy Alberts*
24	R 4/7	Temporal Change in Ecosystems – Two Perspectives from Two Different Eras	Odum 1969; Chapin Ch. 12	Adam	8. Robert E. and Jessica
25	T 4/12	Global Change	Chapin Ch. 14; IPCC 2014; **Proposal Draft 1 due to peers (grad students only – review out of class)**	Robert E.	
26	R 4/14	Ecosystem Management	Chapin Ch. 15; Daily et al. 1997; Millenium Assessment 2005	Jessica	
27	T 4/19	Poster session	**Poster session**	N/A	
28	R 4/21	Wrap-up and review session	Readings TBD; **Proposal Final Draft due (grad students only)**	Jessica	

(*Megan and Tessa - will lead discussion at a later date, probably either 3/31 or 4/14).

Final exam: Thursday, April 28, 7:30-9:30

***NOTE: This syllabus is subject to change, but I will keep you informed of any substantive changes I make. When we have out-of-class assignments, these are due at the beginning of class, with -10% per day late.*