NRE 509: Ecology: Concepts and Applications Fall 2017

Primary Instructor: Dr. Sheila K. Schueller schuel@umich.edu
Office Hours (4556 Dana): Tuesday 12-2pm, Wednesday 1-3pm
Clinic in the Commons Hours: Monday & Wednesday 10-11:30am, Monday & Thursday 1-2:30pm
All Instructors are also available by appointment.

Lecture: Monday/Wednesday 11:30-1, 1040 Dana
Lab: G556 Dana
Lab Coordinator: Alex Clayton alexclay@umich.edu
002 - Monday 2-6 pm: Kesiree Thiamkeelakul kesireet@umich.edu
003 - Tuesday 10-2pm: Andrew Kinzer akinzer@umich.edu
004 - Tuesday 2-6pm: Jillian Mayer jbmayer@umich.edu
007 - Wednesday 2-6pm: Bolivar Aponte-Rolon apontbol@umich.edu
005 - Thursday 10-2pm: Lauren Schmitt lschmit@umich.edu
006 - Thursday 2-6pm: Santiago Bukovsky-Reyes sbukovsk@umich.edu

What to do if you are lost, confused, behind, don’t get it, and/or can’t find it:
- Read this syllabus!
- Go to the Canvas site. Use Piazza, instead of email, within Canvas to check announcements, ask questions, get updates, etc.
- Go to the Clinic in the Commons or meet with an instructor
- Read suggested pages in the textbook – a copy is on reserve in 1520 Dana.
- Use other resources on Canvas (lecture and lab notes, supplementary biology background, Statistics & Excel help, and more!)
- Ask your peers/ create a peer study group

Syllabus Contents
1. Course Goals: What should you walk out of this course with? (See Outcomes Tracker for more)
2. What is this course about?
3. Grading Breakdown and Rationale
4. What will you need for this course?
5. Important Course Policies and Expectations
6. Key Advice & Tips for Students: From experience and research
7. Schedule of lectures, readings, assignments, and labs

Course Goals: What should you walk out of this course with? (See Outcomes Tracker for more)
1. A basic understanding of the key parts and processes of ecological systems relevant for evidence-based design, planning, and decision-making in the real and changing world.
2. Skills in communication (the ability to use and understand a variety of ecological sources of information), research process and quantitative literacy (field observation, experimental design, data analysis, and interpretation), systems thinking (use of frameworks and logic models), and collaboration (team problem-solving and cooperative learning).
3. Inspiration and preparation to take more natural science courses in SEAS.
Overview of Course Content: What is this course about?
Through interactive lectures, discussions of real-world cases, and inquiry-based guided and independent field labs we will study the basic parts and processes of ecological systems – how organisms respond to their physical environment, interact with each other in populations and communities across the landscape, and affect the movement of energy and nutrients through terrestrial and aquatic ecosystems. This will include topics and questions relevant to global change, such as:

- **Evolutionary Ecology**: What is a species? What is the time scale of evolution? How is genetic variation important in conservation, restoration, agriculture, and public health?
- **Physiological Ecology**: How can organisms tolerate or respond to changes in climate, salinity, or acidity? How can indicator species inform citizen-science site assessments?
- **Population Ecology**: How can hunting-related changes in age distribution affect population growth? How can we estimate maximum sustainable yield to inform fisheries management?
- **Community Ecology**: How do species compete for limited resources? Why are some species invasive? How can restoration ecologists change the direction of a community over time?
- **Landscape Ecology**: What are organisms’ patterns of migration and movement? What are the consequences of connecting or fragmenting habitats in the landscape?
- **Ecosystem Ecology**: What are the fluxes and pools of nutrients in a system and how do they affect productivity? How can salmon feed forests and fertilizing crops lead to fish kills?
- **Assessment of Ecological Systems**: What is the indirect impact of one species on many others? How can I test a possible cause? What are appropriate measures of ecosystem “health”?

Grading Breakdown and Rationale (700 pts total)
Percentage point letter grade cut-offs are not pre-set but will be determined at the end of the term to maximize fairness and accuracy – e.g. to adjust for any grading discrepancies among sections.

1. **Quizzes** (8 x 10 pts each, drop lowest = 70 pts): What? Short low-stakes cumulative quizzes. Why? To practice retrieval, which assists in long-term memory retention more than just re-reading, and for you/me to regularly be aware of what you know and do not know so you/I can learn/teach adaptively. Though the focus is conceptual understanding, you do have to memorize (own) some facts in order to play with them in your brain and create your own meaningful chunks of information that you can then apply and transfer.

2. **Take-home Exams** (2 x 125 pts each = 250 pts): What? Longer set of questions/problems (including response to specific readings) to be completed over at least a week. You may discuss them with your peers, ask questions, but then complete them on your own. Why? Integrate, apply, and process lecture and lab material, and benefit from collaborative learning.

3. **Simutext Assignments** (6 x 20 pts = 120 pts): What? Online interactive chapters with questions on particular topics. Why? Opportunity to engage (including using simulations) with some important topics/skills on your own.

4. **Research skills assignments** (205 pts): What? Exercises related to the research process. Details are provided on Canvas. Why? Practice finding and interpreting primary literature, doing statistical analysis and creating graphs (basic excel skills), drawing conclusions, communicating research in abstracts and presentations, and designing and executing your own research based on your interests and the needs of local managers and planners. These skills are useful for being able to use and interpret scientific sources in your career, as well as work in interdisciplinary teams.
   a. **Finding and Reading Primary Literature** (25 pts)
   b. **Comparing and Relating Data** (35 pts)
   c. **Field Notebook** (30 pts)
   d. **Independent Project Proposal** (15 pts), **Plan** (20 pts), **Presentation** (65 pts), and **Abstract** (15 pts)

5. **Final exam** (55 pts) – What? Really just a longer quiz. Will be cumulative but weigh heavily on material not yet covered in the last take-home exam. Why? A great heated review week.
Course materials: What will you need for this course?

1. **Your 509 Canvas site** ([https://umich.instructure.com/courses/181737](https://umich.instructure.com/courses/181737)) will have all course info and resources, including assigned readings, assignments, and lecture notes.

2. **Piazza** is an online forum within the 509 Canvas site where you can share ideas and get answers quickly and efficiently from classmates and instructors. *Use Piazza instead of email to ask any questions or share resources.* You can opt to send messages privately and/or anonymously.

3. **Required SIMUTEXT Chapters:** See your first Simutext Assignment details in Canvas for how to purchase and use your Simutext package ($52).


6. **Appropriate outdoor clothing for field labs:** Dress for being OUTDOORS on lab days. This means solid, comfortable walking shoes (no flip flops or high heels), long pants (no business suits), rain gear, and warm layers. We WILL go out even if it is WET and/or COLD!!!

Important Course Policies and Expectations

- **Attend all lectures** (see student advice below!)

- **Attend all labs**: An unexcused absence from lab section will result in a 30pt deduction from your grade. Under certain circumstances, and only if you make appropriate arrangements with all relevant instructors IN ADVANCE, then you can make-up a lab by attending another section within the same week.

- **Plan on spending at least 3 hours per week** outside of lab and lecture on coursework.
  
  *About 70% of students agreed with this estimate, but because of varied backgrounds in ecology, some will need to spend more time.*

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*You are paying a lot to get an education, and that does take a significant time commitment!* According to the Rackham Graduate School, “it is assumed that each hour of class time spent in a lecture or seminar will be accompanied by 2 to 3 hours of time spent in independent preparation (readings, papers, etc.).”

Prepare for lecture:

1. **Print or download the lecture notes** from Canvas to review them to “prime your mental pump” before and refer to them during lecture (so you know what you do not have to write down)

2. **Read the Quick Reads** assigned to each lecture

Prepare for lab:

1. **Review that week’s lab introduction page on Canvas** (link from course schedule). *Note that these intros are not intended to provide details on exactly what we will do in lab. Labs in general are inquiry-based (how can we figure this out?) instead of cookbook style (first we will..., then we will...).*

2. **Read at least 1-2 of the related resources**, learn the key terms, and **write the “big question” and at least two additional questions** for that lab (any related issues/topics that you wonder about) in your field notebook.
• **Late Policy for Assignments**: A 5% loss of points per day will be assessed to all assignments handed in after the date and time they are due. Unless there are extenuating circumstances, there are no make-up exams and assignments will not be accepted more than one week past the due date.

• **Technology and attention**: While in lecture and lab please do not use a cell phone or laptop or other device in any way that is not directly related to class. Not only is it disrespectful, but your assumed productive multi-tasking is wasting your time!

• **Academic integrity**: The point of group work and discussions are to exchange ideas with others and refine your own, however, you must not hand in someone else’s words or ideas as your own. You are expected to understand what plagiarism is, both accidental and deliberate, and to be familiar with the University of Michigan standards on professional academic behavior, as stated here: [http://www.rackham.umich.edu/current-students/policies/academic-policies/section10](http://www.rackham.umich.edu/current-students/policies/academic-policies/section10). **Plagiarism is grounds for expulsion from the program and includes copying material from another student or source and/or writing the same thing as your friend on an assignment you turn in separately.** If you are at all unclear about what constitutes plagiarism or cheating, especially with group work, please ask one of the instructors before you hand in work with your name on it!!!

• **Student Support & Accommodations**: An equitable and inclusive classroom is important to me, and I do not wish to exclude anyone from a positive learning environment. Please approach me, another instructor, and/or other resources on campus to voice concerns and/or get the support you need to optimize your academic experience and performance.

    If you think you need an accommodation for a disability, let me know as soon as possible, so that we can work with the [Services for Students with Disabilities (SSD)](http://ssd.umich.edu) office to help us determine appropriate and helpful academic accommodations. 734-763-3000; [http://ssd.umich.edu](http://ssd.umich.edu)

    If English is not your first language and you may find it challenging to either understand or communicate well in this course. Please meet often with instructors and definitely use both the [English Language Institute](https://lsa.umich.edu/eli/) (https://lsa.umich.edu/eli/), which provides a variety of resources for international students, and the [Sweetland Center for Writing](http://lsa.umich.edu/sweetland), where you can receive feedback to improve clear communication in your written work.

    Diminished mental health, including significant stress, mood changes, or problems with eating and/or sleeping can interfere with your course experience and optimal academic performance. The [Counseling and Psychological Services](http://caps.umich.edu/) office provides free and confidential support and counseling options for students. If there are specific events or needs related to your academic performance that you think I can help with, please come and talk with me.

• **Inclusive classroom**: SEAS students represent a diversity of individual beliefs, backgrounds, and experiences. I try to use a variety of teaching approaches and examples, and I ask that in all activities every member and instructor of this class show respect for others. If you have a concern about an event, comment, or course content that affects your own or another student’s comfort or learning experience, please speak with an instructor about it.

    **You come to SEAS with diverse academic backgrounds.** For some, the course may feel too fast, for others parts will feel too basic. You may need to either:

    a) Share your knowledge/expertise with others if parts of this are what you already know, and/or
    b) Be a self-directed graduate learner and use supplemental resources as needed.

    Regularly attending office and clinic hours and reading the text will be necessities for some – and all can benefit from using all the resources you have available to you while you are here!
Key Advice & Tips from Students for Students

Here is a summary and some examples of how students responded to: **What advice would you give a future student about how to get the most out of this class and/or use their time effectively?**

1. **Prepare for class by printing & reviewing notes and resources:** “print lecture slides ahead of time to take rigorous notes.” “Take at least 15-30 mins to prep for each class by reading the articles, journals, textbook, or anything else to give you some insight into the day’s material and to help you generate relevant questions.” “read the lecture notes before class and try to answer the questions by yourself and then check the answer during lecture.”

2. **Attend and take good notes in lecture:** “Definitely attend all lectures to get the most out of this class.” “Go to every lecture, no matter what. If you miss a lecture, visit with a GSI who was in that lecture and go over the slides.” “it’s hard to get what you need to understand power point slides from other people's notes.” “Be engaged during lecture, ... take notes on the slides.”

3. **Don’t procrastinate:** “Start assignments early – if you rush through them, they aren’t very valuable.” “Keep up with the work.” “It is well worth putting the time into the assignments. All of the material is carefully crafted to help the students be successful, so if you put the time in, you will get a lot out of the class.” “Take the time to look over assignments early! Some require much more time than others!” “I wish I had spent more time engaging and reviewing in course material between classes. ... It’s tempting to take as many courses as you can stand in order to expose yourself to as many appealing classes as possible. There are so many interesting courses! But, is it better to stick to fewer classes and get as much out of them as you can?”

4. **Review as you go:** “review the material periodically and discuss ecological topics with classmates on a regular basis” “I would recommend going over the lectures and writing down a quick sheet of every one with the key concepts and ideas. This really helped me pull together knowledge for the quizzes and exams.” “review with friends every weekend.”

5. **Ask questions & converse with your classmates and instructors:** “meeting regularly with instructors for asking questions is the most important thing for this class for students who did not have ecology before.” “Do the assignments in groups - when you can - and argue with your friends.” “Work together with a group of students (5-6 ideally) on take home exams - I learned so much doing this.” “Do the take-homes on your own, in full. THEN, work in a group.” “Go meet with the instructors whenever you have any problems, they are always glad to help. That can make things much easier.”

6. **Use all the available resources:** “Extra readings are helpful in understanding better.” “Check out the additional materials. When I had a chance to look at them they were always really fascinating and further expanded my knowledge of a topic.” “I would recommend reading the textbook after the lecture, and going through the questions at the end of the chapter. This helps in absorbing concepts taught in class, and the textbook is super interesting. Secondly, the student should read everything (including the extra links) in the simutext assignments, as they are very helpful and are extremely fun.”

7. **Enjoy it!** “Have fun during labs” “Enjoy it, breathe it in” “Don't lose sight of how FUN it is to learn about bugs and stuff, go outside and experience nature!”

"Take it seriously and absorb as much as you can even if you don't think you're going to be a "scientist." The concepts will build fundamental knowledge that will definitely help you approach whatever environmental career you choose, and will give you tools to engage in conversations with decision-makers, skeptics, etc.”
More ways to get the most out of this course: 7 Evidence-Based Tips for Better Learning

1. **Take notes in class and then re-structure them.** Student lecture slides provided on Canvas are intentionally skeletal. I do not provide a “filled-in” version, because you learn more (and improve your grade) if you a) take notes by hand, not with your laptop during lecture, and b) take time soon after lecture to actively re-structure and re-organize your notes (combining the slides and your notes, memory, and other sources) into a coherent product (Cohen et al. 2013).

2. **Recall what you know from memory:** To best assist your long-term memory retention, instead of re-reading your notes or text, try recalling from memory or elaborating/explaining what you know – that is, test yourself and each other! See: Research finds practicing retrieval is best tool for learning and a very useful book by Brown et al. (2014) called Make It Stick, summarized in a video here: [https://www.youtube.com/watch?v=88X4zqkRWFs](https://www.youtube.com/watch?v=88X4zqkRWFs)

3. **You are learning for the long-term when learning feels slow & difficult,** not when you can improve your short-term retention through rote repetition. Fumbling, grappling, and unsuccessful attempts to solve a problem are actually good for your learning! **You also do not necessarily learn better when the style of teaching fits your preference** (Brown et al. 2014; Oakley 2014).

4. **Be an active vs. a passive learner:** “One must learn by doing the thing, for though you think you know it--you have no certainty until you try. “ (Sophocles, 5th c. B.C.); “Learning is not a spectator sport. Students do not learn much just by sitting in class listening to teachers, memorizing pre-packaged assignments, and spitting out answers. They must talk about what they are learning, write about it, relate it to past experiences, and apply it to their daily lives.”(Chickering and Gamson 1987)

5. **Collaborate (but do not free ride or be a leech):** Teach others, learn in groups, quiz & explain to each other! Students working in teams tend to learn, understand, and remember more, and acquire critical thinking as well as teamwork and communication skills that are key for the workplace (Marzano et al. 2001, Hanson 2006).

6. **Organize your thoughts, facts, concepts into mental models, diagrams, hierarchies or structures:** Working memory is limited to 9 slots. Chunking or clustering information into structures increases the amount of information that can be held in working memory (Brown et al. 2014). Graphically organized notes and creating nonlinguistic representations increase higher order thinking and have strong positive effects on learning (Marzano et al. 2001, Oakley 2014).

7. **Alternate between periods of intently focusing on a task or problem without distraction (try 25 minutes – see the Pomodoro Technique) and then diffuse, relaxed time (Oakley 2014), such as taking a walk or even a nap.**

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- Oakley, B. 2014. A Mind for Numbers: How to Excel at Math and Science (Even If You Flunked Algebra). See also the related very popular massive open online course: [https://www.coursera.org/learn/learning-how-to-learn](https://www.coursera.org/learn/learning-how-to-learn)
**Course Schedule**—This schedule is on Canvas with link to all files. Additional readings will be given within assignments and take-home exams. *Recommended textbook reading is in Stiling, Peter. 2014. *Ecology: Global Insights and Investigations*. Second Edition. McGraw Hill. (1st edition pages are on Canvas.)

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<tr>
<th>Date</th>
<th>Lecture topics (Relevant textbook* reading)</th>
<th>Quick Reads &amp; <em>What's due</em></th>
<th>Lab</th>
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| W, 9/6 | UNIT 1: Origin, study & state of biodiversity 1. Intro to ecological systems: Dung beetles; Levels of ecological study; parts & processes of ecosystems; Course info and input. (1:3-8) | * Systems Thinking  
* Independent Project Timeline | No lab first week |
| M, 9/11 | 2. Experimental Approaches in Ecology: Observations, hypotheses and predictions; If, then logic statement; Treatment, controls, & replicates; Natural, field, lab experiments, models & meta-analysis. (1:14-22) | * Rebuilding the Natural World (Coniff 2014)  
* Abstract, Table 1, & Panel 1 of *Adaptive experimentation* (Cook et al. 2004)  
* p. 380-381 of *Predator Control* (Treves, Krofel, & McManus 2016)  
* Citizen scientists, can help protect endangered species | 1. Insect Patterns |
* Evolution for Ecology Assignment (Simutext)  
* Skim Carroll et al. 2014. Applying evolutionary biology to address global challenges - especially "Core evolutionary concepts" & "Environmental heterogeneity used to delay the evolution of resistance" | 2. Tree ID & Herbivory |
| M, 9/18 | 4. Biodiversity cont. to Biomes: Species Concepts; Environmental variation across terrestrial biomes and aquatic ecosystems (22, 23, 24) *QUIZ 1* | * Widespread 'gray zone' of animals transitioning from one species to two  
* Tree planting can harm ecosystems | |
| W, 9/20 | UNIT 2: Physiological Ecology  
5. How and why does the physical environment vary? Conditions and resources; Soil; Climate at global, regional, local and micro scale(22:435-444) | * Finding & Reading Primary Literature Assignment | |
| M, 9/25 | 6. Organisms vary in their tolerance of conditions: Response/ tolerance curves; Indicator species; Conditional responses; Fundamental vs. Realized Niche; Habitat Suitability, Toxicity (5:102-114; 6, 7) | * Reintroduction experiments.  
* Mosquito pesticide risk to shellfish  
* Bioindicators | 3. Water quality |
* Optional: Environment producing phenotypes (Gilbert & Epel2009) | |
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<tr>
<td>W, 10/4</td>
<td><strong>UNIT 3: Population Ecology</strong> 8. Demographics: Density, dispersion; Age distribution, sex ratios; Life &amp; fecundity tables; Survivorship &amp; replacement; How might endocrine disrupters or trophy hunting change demographics? (8:159-166; 9)</td>
<td>* Demographic Side Effects of Selective Hunting in Ungulates and Carnivores (Milner et al. 2006)</td>
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<td>M, 10/9</td>
<td>9. How do populations change over time?: From demographics to dynamics; Exponential &amp; logistic growth; Carrying capacity; Density dependent &amp; independent regulation; inverse regulation &amp; risks of small populations (2: 38-43; 10:194-204)</td>
<td>* Understanding Population Growth Models Assignment (Simutext)</td>
<td>5. Agroecology</td>
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<td>W, 10/11</td>
<td>10. Life History Traits: Organisms vary in their reproductive strategies; Trade-offs; r vs. K-selection. (10:204-210) <strong>QUIZ 3</strong></td>
<td>* Hatchery fish may hurt wild salmon runs * Population equations study guide</td>
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<td>M, 10/16</td>
<td>NO CLASS M/T Fall Study Break</td>
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<td>W, 10/25</td>
<td>13. Competition: Interference &amp; exploitation; Removal, density series experiments; Coexistence or exclusion; Rank depends on the environment; Resource partitioning, Character displacement, Adaptive radiation. (11:236-241)</td>
<td><strong>TAKE-HOME EXAM 1 due (Units 1-3)</strong> * Competitive mechanisms underlying the displacement of native ants by the invasive Argentine ant (Holway 1999)</td>
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<td>W, 11/1</td>
<td>15. Mutualism and Facilitation: Protectors, cleaners, pollinators, dispersers; Conditionality and substitutability. (12)</td>
<td>* QUIZ 5 (online) * Caught in the act: Coral’s bleaching behavior * Pollinator extinctions alter structure of ecological networks</td>
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<td>M, 11/6</td>
<td>16. Indirect interactions: Do zebra mussels cause botulism? Unexpected consequences of indirect interactions and trophic cascades; Predator-mediated coexistence (keystone species); The ecology of fear; Top down or bottom up control? (14: 296-297; 16:321-328, 364-365)</td>
<td>* Isle Royal Assignment (Simutext) * Direct and Indirect Interactions</td>
<td>8. Greenhouse</td>
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<td>W, 11/8</td>
<td><strong>UNIT 5: Landscape Ecology</strong> 18. Movement among Patches in a matrix; Colonization, Migration, Range expansion; Island Biogeography, Species-area relationship, Metapopulation dynamics. (21)</td>
<td>* QUIZ 6 (online)</td>
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<td>M, 11/13</td>
<td>19. Fragmentation and Reserve/Landscape Design: Corridors, Single Large or Several Small; Beta diversity; The matrix matters. (8: 167-175)</td>
<td>* Herring fishery’s strength is in the sum of its parts * Movement of rain forest butterflies restricted by oil palm plantations</td>
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<td>W, 11/15</td>
<td><strong>UNIT 6: Ecosystem Ecology</strong> 20. Energy Flow and the production and decomposition of biomass: Systems approach; Productivity (NPP); Respiration, ecological efficiencies, energy pyramids, &amp; biomagnification; Net Ecosystem Productivity (NEP); Detritus; Decomposition; C cycle. (25: 502-514; 26:523-541; 27) NEP concept map handout</td>
<td>* Ecosystem Ecology Assignment (Simutext)</td>
<td>9. Lab &amp; IP Activities</td>
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<td>W, 11/22</td>
<td>22 cont: Marine Derived Nutrients; Eutrophication &amp; dead zones, From impervious surface to prairie strips, rain gardens &amp; aquaponics; N-Cycle game®</td>
<td>* Nutrient Cycling Assignment (Simutext) * What is Green infrastructure? (HRWC)</td>
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<td>M, 11/27</td>
<td><strong>UNIT 7: Ecosystem Change over time</strong>&lt;br&gt;23. Succession, Disturbance &amp; Stability&lt;br&gt;Glaciers, sand dunes; pioneer to climax; Primary vs. secondary; Species interactions and Disturbance; Restoration ecology; Prescribed burns; Alternative stable states. (20; 5:112-113)</td>
<td>* Succession: From Sand Dune to Forest video&lt;br&gt;* Effects of prescribed burns and bison grazing on breeding bird abundances in tallgrass prairie - Abstract (Powel 2006)</td>
<td>10. <strong>Greenhouse Part 2</strong>&lt;br&gt;Practice your IP Presentation with an instructor</td>
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<td>W, 11/29</td>
<td><strong>24. Climate Change:</strong> Physical and biological consequences of greenhouse gases; Fertilization effect?; Carbon sequestration; Ocean acidification (5:114-121; 26: 530; 27: 556-557 )</td>
<td>* Climate Change Assignment (Simutext)&lt;br&gt;* TAKE-HOME EXAM 2 due (Units 1-6)</td>
<td>*TAKE-HOME EXAM 2 due (Units 1-6)</td>
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<td>M, 12/4</td>
<td><strong>24 b. Climate Change, cont.</strong> Ecological consequences: trophic mismatches; Carbon sequestration; Climate change mitigation and “adaptation”, <strong>QUIZ 7</strong></td>
<td>* Beetles move, Pines Die and Bears Feel It&lt;br&gt;* Quick Guide to Climate-Smart Conservation&lt;br&gt;* A world without parasites (Wood &amp; Johnson 2015); especially p.433-434</td>
<td>11. <strong>Research Symposium</strong>&lt;br&gt;* IP Presentations &amp; Abstracts due</td>
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<td>W, 12/6</td>
<td><strong>UNIT 8: Maintaining and Measuring Ecosystems</strong>&lt;br&gt;25. Relationship between Biodiversity and ecosystem function &amp; services : How much do we need? Rivet-redundancy hypothesis; Functional diversity; Case Conversation with Drew Lathin (Creating Sustainable Landscapes, LLC): conversion of a suburban yard. (18; 19: 377-392)</td>
<td>* Urban Biodiversity&lt;br&gt;* Loss of Dung beetles Puts Ecosystems in Deep Doo-Doo&lt;br&gt;* Biodiversity impacts ecosystem productivity as much as resources, disturbance, or herbivory (Tilman, Reich &amp; Isbell 2012)&lt;br&gt;* What does biodiversity do for us? Video</td>
<td><em>Loss of Foundation Species - Panel 1 (Ellison et al. 2005)&lt;br&gt;</em> Conceptual Models for Grassland (Tinker &amp; Hild 2005) -Skim for figures</td>
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<td>M, 12/11</td>
<td><strong>26. How do we assess whole ecosystems?</strong>&lt;br&gt;Back to causes of biodiversity; Ecosystem Management; Sea of data; Which species, frameworks or models do we use to quantify ecological “health,” “integrity,” and other buzzwords? (22:443-463; 23 &amp; 24)</td>
<td>* QUIZ 8 (online)&lt;br&gt;* The portfolio concept in ecology and evolution (Schindler et al. 2015)&lt;br&gt;* Loss of Foundation Species - Panel 1 (Ellison et al. 2005)&lt;br&gt;* Conceptual Models for Grassland (Tinker &amp; Hild 2005) -Skim for figures</td>
<td>NO LAB&lt;br&gt;* If needed, Revised Abstracts due Dec. 13</td>
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<td>Fri, 12/19</td>
<td>4-6pm <strong>Final Exam in 1040 Dana</strong></td>
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