ESM 201: ECOLOGY OF MANAGED ECOSYSTEMS
Course Syllabus, Winter 2018

Lectures: 8:00 - 9:15 AM, Monday/Wednesday, 1414 Bren Hall
Course materials at https://gauchospace.ucsb.edu
Dr. David Tilman email: tilman@ucsb.edu Office: 4414 Bren Hall
Office Hours: Monday 12:00-1:00 & Wednesday 9:25 – 10:30 AM, or by appointment
Discussion Sections Led By
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The goals of this course are to help you understand
• the scientific principles, concepts and theories that are the foundation of ecology and
• how these are applied to major environmental issues, including those related to human
  impacts on the functioning and sustainability of ecosystems at local to global scales

The course is presented as a series of lectures and discussion sections. The subjects of lectures
are listed in this syllabus. Unless you have already learned about the mathematics of basic
ecological theory (population growth, competition, predation, mutualism, foodwebs), you will
find it important to purchase and read A Primer of Ecology by Nicholas J. Gotelli (called simply
“Gotelli” below). Page numbers in this syllabus are based on the 4th edition of Gotelli, but other
versions are sufficiently similar. Required readings will be available on GauchoSpace. Read
assigned papers before each lecture.

The recitation is designed to clarify and amplify points raised in lecture, to discuss all
readings, and to help you learn how to analyze and interpret environmental data using statistics.

Tuesday
Jan. 16  Introduction to Ecology and the Grand Challenge of Human Domination of
  Global Ecosystems (special lecture time: Tuesday 11 – 12 AM, 1414 Bren)
  What is ecology? How we study ecology. Seeking simplicity in complex systems.
  Wolves and Yellowstone. The scientific method, hypothesis testing and scientific
  “proof.” How humans impact species and ecosystems. Human domination of
  ecosystems. Inadvertent management or informed management?

  Related readings: McLaren, B.E. and R.O. Peterson. 1994. Wolves, moose and

Jan. 17  Density Independent and Dependent Growth (lecture by Owen Liu)
  Birth and death rates affect population size. Growth in an unlimited habitat. The
  power of exponential growth and ecological explosions. The continuous logistic
  growth model. Density-dependent versus density-independent regulation of
  population size. The controversy and resolution. Maximum Sustainable Harvest
  of Fish and Other Renewable Natural Resources

  Related readings: Gotelli, p. 2-11; 20-31; and 32-48.

Jan. 22  The Ecology of Humans: Human Population Dynamics and Consumption
  Human population now exceeds 7,000,000,000. When will global population stop
  increasing? What is the earth’s carrying capacity for humans? Why will
  population stop increasing? The roles of demographic transitions, education of
females, per capita consumption, and disease. Trends in per capita incomes and the implications.


**Jan. 24**

**Population Oscillations, Population Regulation and Chaos: Takens’ Theorem and the Conceptual Foundations of Simplification**


**Jan. 29**

**The Ecology of Diseases**

R\textsubscript{0}, the minimum level Related to sustain pathogen populations. What are the biological attributes that govern disease dynamics? The dynamics of vaccination. Herd immunity. Most human diseases were originally diseases of other animal species. Animal diseases also are transmitted from one species to another, especially after animals are moved to a new geographic realm via the pet trade. Large-scale livestock production is especially susceptible to new diseases, and to devastating outbreaks of established diseases.

**Related Reading:** R. M. Anderson and R. M. May. 1982. Directly Transmitted Infectious Diseases: Control by Vaccination. Science 215: 1053-1060. (If the mathematics is to complex for your background, skim it, and read the paper for its major findings and implications).

**Jan. 31**

**Diseases Ecology (continued) and Diseases of Plants and Animals**

Herd immunity. Most human diseases were originally diseases of other animal species. Crop diseases. Animal diseases also are transmitted from one species to another, especially after animals are moved to a new geographic realm via the pet trade. Large-scale livestock production is especially susceptible to new diseases, and to devastating outbreaks of established diseases.


**Feb. 5**

**Humans as the Worlds Greatest Evolutionary Force: Malthus, the Power of Exponential Growth, and Darwin's Logic**


Feb. 7  **Interspecific Competition, Tradeoffs and Coexistence**

Many species compete with other species in natural and managed ecosystems. The classical Lotka-Volterra model of competition. The qualitative processes that lead to competitive dominance or stable coexistence. Indirect effects and multispecies competition. Competition for a single limiting resource. The R* concept. Theory and experimental studies.

**Related reading:** Gotelli, p. 100-124;
Tilman, D. Chapter 3 from Resource competition and community structure. Princeton University Press. Related
Ricklefs, R. 2010. Evolutionary diversification, coevolution between populations and their antagonists, and the filling of niche space.

Feb. 12  **Predator-Prey Interactions and Top-Down versus Bottom-Up Management of Food Webs**

Density-density dependent prey growth and predator-prey stability. Isocline models of predator-prey interactions. What is a more important control of plant community biomass – nutrient supply or herbivores/predators?

**Related readings:** Gotelli, p. 126-143;

Feb. 14  **The Ecology of Humans: Food, Dietary Choices and Escalating Global Food Demand**

Are the next 50 years the final period of rapid expansion of global human impacts? Per capita income and culture are two major drivers of dietary choices – choices that have major global environmental implications. Current food demand and its likely trajectory. Can increases in yields meet global food demand?

**Related readings:**
S. Bonhommeau et al. 2013. Eating up the world’s food web and the human trophic level. PNAS 110: 20617-20620.
Tilman, Balzer, Hill and Befort. 2011. Global food demand and the sustainable intensification of agriculture. PNAS 108: 20260-20264. (Note: Focus on the first two pages. Read the rest if you are interested)
P. Grassini, K Eskridge & K Cassman. 2013 Distinguishing between yield advances and yield plateaus in historical crop production trends. NATURE COMMUNICATIONS 4:2918 | DOI:10.1038/ncomms3918.

Feb. 19  **Presidents’ Day – No Classes**
Feb. 21  **The Environmental Impacts of Agriculture**
Global magnitudes of agriculturally-driven land clearing, greenhouse gas
emissions, nitrogen and phosphorus use and movement, water use, and pesticides,
and their environmental impacts.

**Related readings:** Vitousek et al. 1997. Human alteration of the global nitrogen
Gruber, N. and J.N. Galloway. 2008. An Earth-system perspective of the
Tilman et al. 2001. Forecasting Agriculturally-Driven Global

Feb. 26  **FIRST EXAMINATION** – Covers all material through the Feb 12 lecture.

Feb. 28  **Agricultural Sustainability and Healthy Diets**
What will be needed to greatly increase the environmental sustainability of global
agriculture? How can the diet and human health dilemma be solved? Is local food
a solution? Can we be rescued by higher yields or GMO crops? Does each crop
have a maximum potential yield, and are yields close to such maxima?
How can the yield gap be closed, or diets changed, and what would be the
environmental benefits of such actions?

**Related readings:**
doi:10.1038/nature10452.
Tilman, D. and M. Clark. 2014. Global diets link environmental
(Optional) For a markedly different perspective, see J. Ausubel et al.

Mar. 5  **The Ecology of Humans: Land Clearing, Habitat Destruction, the Extinction
Debt**
The species-area curve illustrates the effect of habitat size on biodiversity and the
effects of habitat destruction on species extinctions. Habitat destruction and the
biased, time-delayed extinction of many species.

**Related reading:** Gotelli, p. 82-97; Tilman, May, Lehman and Nowak. 1994.
Tilman, D, M Clark, D Williams, K Kimmel, S Polasky & C Packer. 2017.
Future Threats to Biodiversity and Pathways to their Prevention. *Nature*
and  M Burgess, C Costello, A Fredston-Hermann, M Pinsky, S Gaines, D
*PNAS*.

Mar. 7  **Biodiversity, Stability and Productivity**
The debate and its resolution. How and why does biodiversity impact the
functioning of ecosystems, including their productivity, disease dynamics, nutrient dynamics, carbon storage capabilities and exotic invasive species?


**Mar. 12**  
**Ecosystem Functioning, the Loss of Biodiversity and Preventing Extinction Risks from Agriculture**  
The universal tradeoff hypothesis and the potential for universal impacts of biodiversity loss. The effects of biodiversity loss compared to other human-driven environmental changes. Loss of biodiversity as an intermediary driver of the effects of human-driven environmental changes.

Tilman, D, M Clark, D Williams, K Kimmel, S Polasky & C Packer. 2017. Future Threats to Biodiversity and Pathways to their Prevention. *Nature*  
Optional: Tilman, D., P. Reich and F Isbell. 2012. Biodiversity impacts ecosystem productivity as much as resources, disturbance, or herbivory. PNAS

**Mar. 14**  
**Sustainably Balancing the Needs of 9 Billion for Energy, Food and Livable Environments**  
Modern industrial societies have immense demands for energy and food, and require a livable and sustainable global environment. Solutions to one problem, like climate, change, can negatively impacts other human needs. How can multiple linked problems be solved? How can 9 billion people make choices that lead to a livable and equitable planet?


**Final exam – Friday, March 23 from 8-11am in Bren 1414**
Student Services – Where to go when you need help

- Campus Learning Assistance Services (CLAS) [http://clas.sa.ucsb.edu](http://clas.sa.ucsb.edu)
- Counseling & Psychological Services [http://caps.sa.ucsb.edu](http://caps.sa.ucsb.edu)
- Disabled Students Program [http://dsp.sa.ucsb.edu](http://dsp.sa.ucsb.edu)
- Educational Opportunity Program (EOP) [http://eop.sa.ucsb.edu](http://eop.sa.ucsb.edu)
- Health and Wellness [http://wellness.sa.ucsb.edu](http://wellness.sa.ucsb.edu)
- Little Big Engineer: [https://orgsync.com/129034/chapter](https://orgsync.com/129034/chapter)
- MultiCultural Center [http://mcc.sa.ucsb.edu/](http://mcc.sa.ucsb.edu/)
- Non-Traditional Student Resource Center [http://wgse.sa.ucsb.edu/nontrad/](http://wgse.sa.ucsb.edu/nontrad/)
- Office of the Ombuds [https://ombuds.ucsb.edu/](https://ombuds.ucsb.edu/)
- Office of Student Life (OSL) [http://osl.sa.ucsb.edu/](http://osl.sa.ucsb.edu/)
- Opening New Doors to Accelerating Success (ONDAS) Center [http://www.ondas.ucsb.edu/home](http://www.ondas.ucsb.edu/home)
- Resource Center for Sexual and Gender Diversity: [http://wgse.sa.ucsb.edu/RCSGD/home](http://wgse.sa.ucsb.edu/RCSGD/home)
- Transfer Student Center (TSC) [http://transfercenter.ucsb.edu](http://transfercenter.ucsb.edu)
- UCSB Alcohol and Drug Program: [https://alcohol.sa.ucsb.edu/](https://alcohol.sa.ucsb.edu/)
- UCSB Student Health Services: [http://studenthealth.sa.ucsb.edu/](http://studenthealth.sa.ucsb.edu/)
- Undergraduate Mentorship Program [http://duels.ucsb.edu/academics/academic-success/mentor](http://duels.ucsb.edu/academics/academic-success/mentor)
- Undocumented Student Services [http://www.sa.ucsb.edu/dreamscholars/home](http://www.sa.ucsb.edu/dreamscholars/home)
- Veterans’ Resource Center: [http://www.sa.ucsb.edu/veterans/home](http://www.sa.ucsb.edu/veterans/home)
- Women’s Center [http://wgse.sa.ucsb.edu/WomensCenter/home](http://wgse.sa.ucsb.edu/WomensCenter/home)