ESM 201: ECOLOGICAL PRINCIPLES FOR HUMAN DOMINATED ECOSYSTEMS.
Course Syllabus, Winter 2024
Syllabus may be modified as the class progresses

Lectures: 9:30 – 10:45 AM PDT, Tuesday and Thursday
Course materials at https://gauchospace.ucsb.edu
Dr. David Tilman – email: tilman@ucsb.edu

TA’s: Leonardo Feitosa (lmfeitosa@bren.ucsb.edu)
Zoe Sims (zsims@ucsb.edu)

OFFICE HOURS
Dr. Tilman - 12:00 - 1:00 Tuesday and Thursday in Bren 4414 or by appointment (tilman@ucsb.edu)
Leonardo Feitosa - TBD
Zoe Sims – TBD

The goals of this course are to have you learn
- The principles, concepts and theories that are the scientific basis for conservation policy and for the preservation of biodiversity and ecosystem services.
- How this scientific knowledge is applied to major societal and scientific issues, especially those related to human impacts on the functioning, productivity and sustainability of ecosystems at local to global scales.
- How and why humans impact and manage all of Earth’s ecosystems, and how this can be done in more sustainable ways.

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 the mathematics of ecological concepts theory (population growth, competition, predation, mutualism, foodwebs, biodiversity, and ecosystem functioning), it is highly important for you to read our textbook, 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. All other 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, and to discuss readings.

Class Grading: The Midterm Exam and the Final Exam are each worth 100 points. Homework and other recitation activities are worth 50 Points. Total is 250 points.
Jan. 9  **Human Environmental Impacts**
From Foodwebs to Endangered Species. What is known? What must be known to make wise conservation decisions? The central role of population ecology. Birth and death rates and extinction risks. Growth in an unlimited habitat -- exponential growth and ecological explosions.

**Required reading:** Gotelli, p. 2-11
Vitousek_1997_Human domination of the Earth's ecosystems. Science


Jan. 11  **Population Growth: Density Independent and Dependent Growth**

**Required reading:** Gotelli, p. 26-32.

Jan. 16  **Population Growth Continued; Extinction Risk for Rare Species; Time Lags and Population Dynamics**
Maximum Sustainable Harvest of Fish and Other Renewable Natural Resources. The logic, and math, of extinction risks. A different model of population growth.

**Required reading:** Gotelli, p. 14-23.

Jan. 18  **Population Regulation, Population Oscillations and Chaos; Takens’ Theorem and the Conceptual Foundations of Simplification**

**Required reading:** Gotelli, p. 11-13; and 31-48.

Jan. 23  **The Ecology of Humans: Human Population Dynamics**
Human population now exceeds 8,000,000,000. 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.

**Required reading:**

Jan. 25  **The Ecology of Humans: What controls how much a person consumes?**
Are the next 50 years the final period of rapid expansion of global human impacts? People purchase and use – and thus consume – thousands of products, including metals, rare earth elements, wood, cement, fossil fuels, and food. How can we forecast future demand? Income, culture, religion? Ethics of food and food as a basic human right.

**Required reading:** S. Bonhommeaua et al. 2013. Eating up the world’s food web and the human trophic level. PNAS 110: 20617-20620.

**Jan. 30**  
**Humans as the World’s Greatest Evolutionary Force: Malthus, the Power of Exponential Growth, and Darwin’s Logic**  

**Required reading:**  

**Feb. 1**  
**The Ecology of Human Diseases**  
$R_0$, the minimum level Required to sustain pathogen populations. What are the biological attributes that govern disease dynamics? The dynamics of vaccination. Herd Immunity. Age and disease dynamics. Most human diseases were originally diseases of other animal species, especially those animals that we eat.

**Required Reading:**  

**Feb. 6**  
**Interspecific Competition and Causes of 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.

**Required reading:** Gotelli, p. 100-124;  

**Feb. 8**  
**Competition for Limiting Resources, Tradeoffs and Multispecies Coexistence**  
The R* concept. Theory and experimental studies.
Tradeoff Example: Competition for two resources, interspecific tradeoffs, and multispecies coexistence. Indirect Effects of Multi-Species Competition.

**Required Reading**
Tilman, D. Chapter 3 from *Resource competition and community structure*. Princeton University Press. Required


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**Feb. 13**

**Predator-Prey Interactions; The Ecological Impacts of Predators and Their Loss**

**Required reading:** Gotelli, p. 126-143; Pace et al. 1999. Trophic cascades revealed in diverse ecosystems. TREE 14: 483-488.


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**Feb. 15**

**First Hourly Examination (covers all material through Feb. 6 lecture)**

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**Feb. 20**

**Top-Down versus Bottom-Up Management of Food Webs; Direct and Indirect Food Web Effects**
What is a more important control of plant community biomass – nutrient supply or herbivores/predators? Would the presence of herbivore-resistant plant species change these relationships? How can you manage a multi-species ecosystem to make a species more or less abundant?

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**Feb. 22**

**The Ecology of Humans: Habitat Destruction and the Extinction Debt**

**Then:** The fossil record, how the Earth became so biologically diverse, and the universal tradeoff hypothesis. **Now:** Human-caused habitat destruction and the biased, time-delayed extinction of many species.

**Required reading:**

**Optional:** Gotelli, p. 82-97;

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**Feb. 27**

**Biodiversity, Stability and Productivity**
The Diversity and Stability Debate. Elton, May and others. Theory and concepts. 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?

**Required reading:**


**Optional:** Tilman, D., P. Reich and F Isbell. 2012. Biodiversity impacts ecosystem productivity as much as resources, disturbance, or herbivory. PNAS

**Feb. 29**
**Impacts of Biodiversity continued; Preventing Extinctions, Protected Areas and the Future of Earth’s Species Diversity**

**Mar. 5**
**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. Agricultural air pollution and mortality. Environmental justice: pesticides; food for rich and malnourished farmers?; food to biofuels when 800 million people are malnourished?

**Required readings:**

**Mar. 7**
**Health Impacts of Foods and Diets**

**Required readings:**


**Mar. 12**
**Agricultural Sustainability**
How can the environmental sustainability of global agriculture be greatly increased? Benefits of 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, and what would be the environmental benefits of such actions? Nitrogen use efficiency.
Required readings:


Required Reading:

Mar. 14  Achieving Sustainability; Balancing the Needs/Wants of 9 Billion for Energy, Food & Livable Environments
Efficiency. Increased agricultural biodiversity to improve yields and the stability of the food supply, increase soil fertility, increase soil carbon stores, reduce the incidence of crop diseases, and create biofuels that REDUCE CO2 levels. The ultimate question: How can the choices of 9 billion consumers be guided to create a livable and equitable planet?

Required readings:


Tuesday, Mar. 19  FINAL EXAMINATION. 8 AM – 10 AM
This final exam will cover the entire course, but will mainly focus on lecture material from February 8 through March 14.

Class Grading: Each exam is worth 100 points, and an additional 50 points come from recitation, for a total of 250 points for the class.

Student Services – Where to seek help
• Campus Learning Assistance Services (CLAS) http://clas.sa.ucsb.edu
• Campus Advocacy Resource and Education (CARE): http://wgse.sa.ucsb.edu/care/home
• Counseling & Psychological Services http://caps.sa.ucsb.edu
• Disabled Students Program http://dsp.sa.ucsb.edu/
• Educational Opportunity Program (EOP) http://eop.sa.ucsb.edu
• Health and Wellness http://wellness.sa.ucsb.edu
• MultiCultural Center http://mcc.sa.ucsb.edu/
• Non-Traditional Student Resource Center  http://wgse.sa.ucsb.edu/nontrad/
• Office of International Students and Scholars  http://oiss.sa.ucsb.edu/
• Office of the Ombuds  https://ombuds.ucsb.edu/
• Office of Student Life (OSL)  http://osl.sa.ucsb.edu/
• Opening New Doors to Accelerating Success (ONDAS) Center  http://www.ondas.ucsb.edu/home
• Resource Center for Sexual and Gender Diversity:  http://wgse.sa.ucsb.edu/RCSGD/home
• Transfer Student Center (TSC)  http://transfercenter.ucsb.edu
• UCSB Alcohol and Drug Program:  https://alcohol.sa.ucsb.edu/
• UCSB Social Work Services:  http://studenthealth.sa.ucsb.edu/behavioral-health/social-work
• UCSB Student Health Services:  http://studenthealth.sa.ucsb.edu/
• Undergraduate Mentorship Program  http://duels.ucsb.edu/academics/academic-success/mentor
• Undocumented Student Services  http://www.sa.ucsb.edu/dreamscholars/home
• Veterans’ Resource Center:  http://www.sa.ucsb.edu/veterans/home
• Women’s Center  http://wgse.sa.ucsb.edu/WomensCenter/home