Environmental Studies 20, 18S

Conservation of Biodiversity

Course Description
This course will examine the range of ways in which human society interacts with and influences biological diversity. We will begin with a consideration of the biological nature of diversity. What is biodiversity and how is it created? What are the global patterns of biodiversity and how are these created and maintained? Secondly, we will consider the influence of human societies on biodiversity. Is there a biodiversity crisis? What is the current rate of extinction and what is the natural extinction rate? What does humankind do to cause animal and plant extinctions? What properties of individual species make them vulnerable to extinction. What are the major threats to biodiversity? We will also ask what value does humanity draw from biodiversity, or, in other words, why should we care about biodiversity? We will examine the ways in which we exploit natural resources, particularly forests and fisheries, and learn the scientific tools that can be used to manage this exploitation. These topics will be addressed through lecture material, course readings, discussion, computer simulation and writing assignments.

Primary learning objectives:

- Understand the natural evolutionary and ecological processes that generate and maintain biological diversity.
- Understand how human activities interact with these processes to cause declines in biodiversity
- Understand how biological knowledge is used to help conserve biodiversity and manage natural resources.
- Understand the uses and limitations of mathematical models in the management of populations and natural resources

Prerequisites: ENVS2 or BIOL16
Class meetings: MWF 12:50-1:55; x-hour Tu 1:20-2:10, 101 Fairchild

Office hours :
Prof. Doug Bolger: W 2:00-4:00 or by appt. 106 Steele. If you are planning to come to office hours please email me ahead of time.
TA Elliott Steele. Mon 200-400 or by appt. 135 LSC (Life Sciences Center) (Elliott.P.Steele.GR@dartmouth.edu)

Requirements

Midterm exam #1	100 points
Final exam (not cumulative)	100 points
Three homework assignments	100 points
Class participation	50 points
Final project	150 points
Total	500 points

Required Texts:

1. L. Scott Mills, Conservation of Wildlife Populations, 2nd edition, Blackwell Publishing, Malden MA, 2013, 326 pp.
2. Sodhi, NS, Ehrlich PR (2010) Conservation Biology for All. Oxford University Press, Oxford, UK. 344 pp. Free e-textbook. Available on the course Canvas site
3. Other course readings are available as PDFs on the Canvas site

NetLogo and STELLA software. Your homework assignments will be done using the NetLogo or STELLA computer simulation software. NetLogo is freeware and STELLA is keyserved and available on the Dartmouth computing website. This software will enable us to explore the use of computer simulations in the management and conservation of animal and plant populations without requiring programming knowledge on your part. You will be instructed in the use of the software at the appropriate time.

Final Projects. Each student will be required to complete a final project that will involve conducting a Population Viability Analysis for a selected species. You will create a STELLA model to represent the relevant aspects of the population dynamics of the species. You will also write a management plan based partly on the results of the STELLA simulation and partly on the basis of the biological and conservation principles taught in the lectures and readings in the course. The principles and techniques of Population Viability Analysis will be presented through lecture and readings. Review the papers by Armbrister & Lande or McKelvey et al., for examples of population viability analyses.

Class participation. Class participation is an important component of this course. There are a number of discussions scheduled throughout the term and 10% of the final grade is based on participation. Learning to critically read and discuss the primary literature is an important goal of the course. For each discussion you will need to come prepared to discuss the reading assigned for that day. The success of these discussions depends upon a high degree of preparation. ***If a class discussion is denoted on the calendar you should read the material assigned for that date in advance of class.*** If needed, I will call upon students to keep the discussions moving and to ensure participation. Some discussions will be led by students – more details on this to come. Final participation grades will be based upon the degree of preparation that is reflected in responses to questions and the degree to which the individual student intellectually engages with the course material.

Chronic Illness or Disability. If you have a chronic illness or a disability and think you will need some adjustment in the course requirements or other accommodations, or if you think it will influence the way you approach the course in more subtle ways, please come talk to me in the first week of the term. Our discussions, of course, will be confidential.

Honor Principle. This course is conducted under the principles of the Dartmouth College Academic Honor Principle. I encourage you to review the Honor Principle. You are also responsible for the information concerning plagiarism found in *Sources: Their Use and Acknowledgment*, available in the Deans' Offices or online. You are encouraged to discuss course content outside of class. You are also encouraged to discuss *approaches* to the solution of problem sets or *approaches* to writing final projects. However, the specific solutions or the specific writing and researching of your project should be done only by the individual. I encourage cooperative study groups for exams.

Attendance. You are responsible for all information presented in classes and x-hours. That includes lecture material as well as announcements about homework assignments, course readings, exams, and papers. Obviously, the most reliable way to get this information is to attend all class meetings. Being absent during discussions will count against your participation grade.

Please be on time for class. I will endeavor to begin class promptly at 12:30. Please be here and seated by that time. Students trickling in during the first 15 minutes of class is distracting and disrupts the class. Please extend this courtesy to your classmates and me.

Laptops. Laptops are useful for note-taking. However, their use for other purposes can be distracting to your classmates and me. Please only use laptops for note-taking. Their use for email or accessing the internet is not permitted during class and if I become aware of their use for those purposes you will be asked to leave the room.

Cell phones. A ringing cell phone is very disruptive to class discussion. Please leave your cell phones home or be absolutely certain to turn them off before coming to class.

X - hour. Currently I have activities scheduled for most of the X-hour periods. The TA will lead some of these sessions. Again, you will be held responsible for all material presented in X-hour. Currently unscheduled X-hour sessions may be scheduled later in the term to catch up on lecture material, hold problem help sessions, or for guest lectures. Please hold these periods open in your schedule.

Field Trip. We are scheduled for a local forestry field trip for Saturday, May 5 from 1100am to 200pm. We will visit local forest lands owned and managed by Dartmouth. We will discuss the field trip further as the time approaches.

Necessary biological background. To fully understand and appreciate the material presented in this course a certain degree of biological background knowledge is necessary. In the following paragraph I briefly review the necessary background. If you have taken the prerequisites of BIOL 16 or ENVS 2 you should have this background. None of these topics are that hard to understand, and some degree of unfamiliarity with a few of these topics should not preclude you from taking the class. If you are having problems recalling any of this material, I have placed an ecology textbook (Begon et al. 4th Edition) on reserve at the Kresge Library. Consult that text (I've listed appropriate chapters below) or your text from BIOL16 or ENVS2 if you need to review any of these topics. And see the TA or me.

In short, you should be aware of the ways in which physical (e.g. pH, temperature, moisture, nutrients, etc.) and biotic factors (competition, predation, etc.) place limits on the distribution and abundance of organisms (Begon et al. Ch. 1-3). You should understand how these limits combine to define the ecological niche of a species. You should be familiar with the effects of birth and death rates on the growth of populations and be aware that the dynamics of a population can be represented by a population growth equation or model (Begon et al. Ch.4). You should have a basic understanding of evolution by natural selection (Begon et al. Ch. 1). You should also be conversant with the manner in which biologically important elements (e.g. Nitrogen, Phosphorous, Carbon) are cycled in ecosystems (Begon et al. Ch. 18).

Other Required Readings

Armbruster, P. and R. Lande. 1993. A population viability analysis for African elephant (Loxodonta africana): How big should reserves be? *Conservation Biology* 7:602-610.

Begon, M., J.L. Harper and C.R. Townsend. 2006. Ch. 21 (pp. 602-632) in *Ecology: From Individuals to Ecosystems*, Fouth Edition. Blackwell Publishing, Malden, MA.

Both, C., S. Bouwhuis, C. M. Lessells and M.E. Visser. 2006. Climate change and population declines in a long-distance migratory bird. *Nature*, 441:81-83.

Burgman, M., and H. Possingham. 2000. Population viability analysis for conservation: the good, the bad and the undescribed. Ch. 6 (pp. 97-112) in *Genetics, Demography and Viability of Fragmented Populations*. A.G. Young and G.M. Clarke, eds. Cambridge University Press, UK.

Cardinale BJ, Duffy JE, Gonzalez A, Hooper DU, Perrings C, Venail P, Narwani A, Mace GM, Tilman D, Wardle DA, Kinzig AP, Daily GC, Loreau M, Grace JB, Larigauderie A,

Srivastava DS, Naeem S (2012) Biodiversity Loss and its Impact on Humanity. *Nature* 486(7401): 59-67
Charnley, S. 2006. The Northwest Forest Plan as a Model for Broad-Scale Ecosystem Management: a Social Perspective. *Conservation Biology* 20:330–340.
Collins, S.L. et al. 1998. Modulation of diversity by grazing and mowing in native tallgrass prairie. *Science* 2280:745-747.
Damschen ,E.I., N.M. Haddad, J.L. Orrock, J.J. Tewksbury, and D.J. Levey. 2006. Corridors Increase Plant Species Richness at Large Scales. *Science*. 313:1284-1286.
Dewes, C.M. 1998. Effects of Individual Quota Systems on New Zealand and British Columbia Fisheries. *Ecological Applications* 8:S133-S138.
Fogarty, M.J. and S.A. Murawski. 1998. Large-scale disturbance and the structure of marine systems: fishery impacts on George's Bank. *Ecological Applications* 8:S6-S22.
Frank, K.T., B. Petrie, J.S. Choi and W.C. Leggett. 2005. Trophic Cascades in a Formerly Cod-Dominated Ecosystem. *Science* 308:1621-1623.
Hilborn, R. and D. Ludwig. 1993. The limits of applied ecological research. *Ecological Applications* 3:550-552.
Jump, A.S. and J. Peñuelas. 2005. Running to stand still: adaptation and the response of plants to rapid climate change. *Ecology Letters 8*: 1010–1020.
Knops, J.M.H., D. Tilman, N.M. Haddad, S. Naeem, C.E Mitchell, J. Haarstad, M.E. Ritchies, K.M. Howe, P.B. Reich, E. Siemann, and J. Groth. 1999. Effects of plant species richness on invasion dynamics, disease outbreaks, insect abundances and diversity. *Ecology Letters* 2:286-293.
Kummer, D.M. 1994. The human causes of deforestation in Southeast Asia. *Bioscience* 54:323-328.
Laurance, W.F. 2004. Forest–climate interactions in fragmented tropical landscapes. *Phil. Trans. R. Soc. Lond. B* 359: 345–352.
Ludwig, D., R. Hilborn and C. Walters. 1993. Uncertainty, Resource Exploitation, and Conservation: Lessons from History. *Science* 260: 17+36.
May, R.M. 1986. How many species are there? *Nature* 324:514.
McKelvey, K. et al. 1993. Conservation planning for species occupying fragmented landscapes: The case of the Northern Spotted Owl. Pp. 424-450 in *Biotic interactions and global climate change*, Kareiva, Kingsolver and Huey eds. Sinauer Assoc.
McKinnon, J.S. and H.D. Rundle. 2002. Speciation in nature: the threespine stickleback model systems. Trends in Ecology and Evolution, 17: 480-488.
Meine, C., M.E. Soulé and R.F. Noss. 2006. "A mission-driven discipline'': the growth of conservation biology. *Conservation Biology* 20: 631–651.
Mora C, Tittensor DP, Adl S, Simpson AGB, Worm B (2011) How Many Species Are There on Earth and in the Ocean? *PLoS Biol* 9(8): e1001127
Nepstad, D.C., C.M. Stickler and O.T. Almeida. 2006. Globalization of the Amazon soy and beef industries: opportunities for conservation. *Conservation Biology* 20: 1595–1603.
Newmark, W.D. 1987. A land-bridge island perspective on mammalian extinctions in western North American parks. *Nature* 325: 430-432.
Norris, S. 2004. Only 30: A Portrait of the Endangered Species Act as a Young Law. *BioScience*, 54(4): 288-294
Olff, H. and M.E. Ritchie. 1998. Effects of herbivores on grassland plant diversity. *Trends in Ecology and Evolution* 13:261-265.
Pimm, S.L., and R.A. Askins. 1995. Forest losses predict bird extinctions in eastern North America. *Proceedings of the National Academy of Sciences*, 92:9343-9347.
Ricketts, T.H., G.C. Daily, P.R. Ehrlich and C.D. Michenor. 2004. Economic value of tropical forest to coffee production. *Proceedings of the National Academy of Science*. 101:12579-12582.
Robinson, S.K., F.R. Thompson III, T.M. Donovan, D.R. Whitehead, J. Faaborg. 1995. Regional forest fragmentation and the nesting success of migratory birds. *Science* 267:1987-1990.
Spies, T. 1997. Forest stand structure, composition, and function. Chapter 2 (Pp. 11-30) in *Creating a forestry for the 21st century*, Kohm, K.A. and J.F. Franklin eds. Island Press, Washington D.C.
Thomas, J.W., J.F. Franklin, J. Gordon, and K.N. Johnson. 2006. The Northwest Forest Plan:

Origins, Components, Implementation Experience, and Suggestions for Change. *Conservation Biology* 20: 277–287.
Tilman, D., D. Wedin and J. Knops. 1996. Productivity and sustainability influenced by biodiversity in grassland ecosystems. *Nature* 379:718-720.
Tilman, D., J. Knops., D. Wedin, P. Reich, M. Ritchie, and E. Siemann. 1997. The influence of functional diversity and composition on ecosystem processes. *Science* 277:1300-1302.
Wake, D.B. and V.T. Vredenburg. 2008. Are we in the midst of the sixth mass extinction? A view from the world of amphibians. *Proceedings of the National Academy of Sciences* 105 S1:11466–11473.
Walther, G. et al. 2002. Ecological response to recent climate change. *Nature* 416:389-395.
Wardle,D.A., L.R. Walker,and R.D. Bardgett. 2004. Ecosystem Properties and Forest Decline in Contrasting Long-Term Chronosequences. *Science*, 305:509-513.
Westermeier, R.L. 1998. Tracking the long-term decline and recovery of an isolated population. *Science* 282:1695-1698.

Class Calendar

Week	Date	Day	Topic	Reading
1	26-Mar	M	Introduction	Mills ch. 1
	27-Mar	Tu	X-hour, **Discussion** - Foundations of Conservation	Sodhi & Ehrlich Ch. 1, Ludwig et al., Hilborn & Ludwig
	28-Mar	W	What is biodiversity - how much is there?	May, skim Mora et al.
	30-Mar	F	Determinants of Diversity	Begon et al.
2	2-Apr	M	Determinants of Diversity - Discussion of grassland papers	Olff & Ritchie, Collins et al.
	3-Apr	Tu	x-hour, NetLogo Software Demonstration	
	4-Apr	W	Habitat loss - deforestation, Habitat fragmentation	Sodhi & Ehrlich Ch. 4 & 7, Wake & Vredenburg
	6-Apr	F	Tropical deforestation **discussion**/Population modeling and PVA	Kummer, Laurence, Nepstad et al. /Mills Ch. 5(pp. 79-91)
3	9-Apr	M	Guest speaker: Dr. Morgan Hauptfleisch,	
	10-Apr	Tu	X-Hour - STELLA software demonstration **(Homework 1 due)**	
	11-Apr	W	Population modeling and PVA/Habitat fragmentation discussion	Mills Ch. 7 /Newmark, Robinson et al., Damschen et al.
	13-Apr	F	harvest management models	Mills Ch. 14 (pp. 251-260)
4	16-Apr	M	Fisheries management	Frank et al.
	17-Apr	Tu	**Discussion** Fisheries Papers	Dewes, Fogarty & Murawski
	18-Apr	W	Video: Fisheries **(Homework 2 due)**	
	20-Apr	F	Extinction rates	Pimm & Askins
5	23-Apr	M	Population viability analysis (PVA) Discussion final project	Mills Ch. 6
	24-Apr	Tu	X-hour - Review Session for Exam	
	25-Apr	W	class cancelled **//Midterm Exam 7-10 pm**	
	27-Apr	F	**Discussion** - PVA Papers	Mills Ch. 12, Armbrister & Lande, Burgman & Possingham
6	30-Apr	M	Spatial population models	Mills, Ch. 10, skim McKelvey et al.
	1-May	Tu	X-Hour - PVA help session	
	2-May	W	Forestry Practices	Spies
	4-May	F	Ecosystem effects of forestry	Wardle et al.
	5-May	Sa	**FORESTRY FIELD TRIP - 1100am to 200pm**	Review Spies
7	7-May	M	Evolution and population genetics	Mills Ch. 3, McKinnon & Rundle
	8-May	Tu	X-Hour - PVA help session	
	9-May	W	Population Genetics and Conservation, **(Homework 3 due)**	Mills Ch. 9, Westermeier et al.
	11-May	F	ESA and other U.S. policy	Norris
8	14-May	M	**Discussion** - Spotted Owl Case Study	Charnley, Thomas et al., review McKelvey et al.
	15-May	Tu	X-Hour - PVA help session	
	16-May	W	Climate Change & Biodiversity	Walther et al., Jump & Peñuela, Both et al.
	18-May	F	Biodiversity and Ecosystem function	Mills Ch. 13, Cardinale et al., skim Sodhi & Ehrlich Ch. 3
9	21-May	M	**Discussion** - Biodiversity and Ecosystem function	Tilman et al. 1996, Tilman et al 1997., Knops et al.
	22-May	Tu		
	23-May	W	PVA help session	Ricketts et al.
	25-May	F	Student PVA presentations	
10	28-May	M	Memorial Day - no classes	
	29-May	Tu	X-Hour - Student PVA presentations	
	30-May	W	Last day of classes (PVA's due) Student PVA presentations	
	1-Jun	F	Exams begin	**envs20 exam 300pm**
	4-Jun	M	Last day of exams	