

## **Environmental Studies 20, 24S**

### **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.

**Instructors:** Prof. Doug Bolger, TA: Kristen Jovanelly (Ph.D. student)

#### **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

**Overall learning goal:** *To develop critical thinking skills in the realm of biodiversity issues. Effective critical thinking in this domain must be based on ecological reasoning (an understanding of the dynamics of ecological systems), quantitative reasoning, and model-based inferences.*

**Prerequisites:** ENVS2 or BIOL16

**Class meetings:** 12-hour, MWF 12:50-1:55; x-hour Tu 1:20-2:10, 101 Fairchild

#### **Office hours :**

Prof. Doug Bolger: By appointment, 106 Steele.

TA Kristen Jovanelly M 2:00-3:00 and by appointment. 112 Fairchild

## Requirements

Midterm exam #1	100 points
Final exam (not cumulative)	100 points
Three homework assignments	100 points
Class participation	50 points
Quizzes	50 points
Final project	150 points
Total	550 points

## Required Texts:

1. L. Scott Mills, Conservation of Wildlife Populations, 2<sup>nd</sup> edition, Blackwell Publishing, Malden MA, 2013, 326 pp. Library has electronic copy of textbook, so no need to buy.
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 and STELLA computer simulation software. NetLogo is freeware and STELLA is available on the Thayer 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, working in groups, 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.

**Learning accommodations.** Students requesting disability-related accommodations and services for this course are required to register with Student Accessibility Services (SAS; [Apply for Services webpage](#); [student.accessibility.services@dartmouth.edu](mailto:student.accessibility.services@dartmouth.edu); 1-603-646-9900) and to request that an accommodation email be sent to me in advance of the need for an accommodation. Then, students should schedule a follow-up meeting with me to determine relevant details such as what role SAS or its [Testing Center](#) may play in accommodation implementation. This process works best for everyone when completed as early in the quarter as possible. If students have questions about whether they are eligible for accommodations or have concerns about the implementation of their accommodations, they should contact the SAS office. All inquiries and discussions will remain confidential.

**Religious observances.** Dartmouth has a deep commitment to support students' religious observances and diverse faith practices. Some students may wish to take part in religious observances that occur during this academic term. If you have a religious observance that conflicts with your participation in the course, please meet with me as soon as possible—before the end of the second week of the term at the latest—to discuss appropriate course adjustments.

**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 <https://writing.dartmouth.edu/support/sources-and-citations>

*The faculty, administration, and students of Dartmouth College acknowledge the responsibility to maintain and perpetuate the principle of academic honor, and recognize that any instance of academic dishonesty is considered a violation of the Academic Honor Principle:*  
<https://policies.dartmouth.edu/policy/academic-honor-principle-1>

You are encouraged to discuss among yourselves 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.

**Use of Generative AI** - The use of Generative AI tools on any homework assignment, final paper, quiz or exam will be considered a violation of Dartmouth's honor code. You are free to use these tools to assist with your learning and studying for this course outside of the contexts listed above.

**Policy for late work.** All homework is due at the assigned time. Unexcused late submission will be penalized at the rate of 10% per day. If you want to ask for an extension because of unavoidable extenuating circumstances you must contact me before the due date/time. Extensions are not available for quizzes.

**Mental Health and Wellness.** The academic environment is challenging, our terms are intensive, and classes are not the only demanding part of your life. There are a number of resources available to you on campus to support your wellness, including: the [Counseling Center](#) which allows you to book triage appointments online, the [Student Wellness Center](#) which offers wellness check-ins, and your [undergraduate dean](#). The student-led [Dartmouth Student Mental Health Union](#) and their peer support program may be helpful if you would like to speak to a trained fellow student support listener. If you need immediate assistance, please contact the counselor on-call at (603) 646-9442 at any time. Please make me aware of anything that will hinder your success in this course.

**Title IX.** At Dartmouth, we value integrity, responsibility, and respect for the rights and interests of others, all central to our Principles of Community. We are dedicated to establishing and maintaining a safe and inclusive campus where all community members have equal access to Dartmouth's educational and employment opportunities. We strive to promote an environment of sexual respect, safety, and well-being. Through the Sexual and Gender-Based Misconduct Policy (SMP), Dartmouth demonstrates that sex and gender-based discrimination, sex and gender-based harassment, sexual assault, dating violence, domestic violence, stalking, etc., are not tolerated in our community.

For more information regarding Title IX and to access helpful resources, visit Title IX's website ([sexual-respect.dartmouth.edu](http://sexual-respect.dartmouth.edu)). As a faculty member, I am required to share disclosures of sexual or gender-based misconduct with the Title IX office.

If you have any questions or want to explore support and assistance, please contact the Title IX office at 603-646-0922 or [TitleIX@dartmouth.edu](mailto:TitleIX@dartmouth.edu). Speaking to Title IX does not automatically initiate a college resolution. Instead, much of their work is around providing supportive measures to ensure you can continue to engage in Dartmouth's programs and activities.

**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 12:50. 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. Use of laptops for non-class purposes will affect your participation grade.

**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 an optional local forestry field trip for Saturday, May 4 from 1200pm to 230pm. 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 recommend you review the following topics using your ENVS2 text or an ecology textbook from the library.

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. 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. You should have a basic understanding of evolution by natural selection. You should also be conversant with the manner in which biologically important elements are cycled in ecosystems.

**Diversity and Inclusion.** Academic research and conservation practice has historically been built on a small subset of privileged voices. In this class, we will make an effort to gain perspectives from a diverse group of scientists and practitioners, but limits still exist on this diversity. I acknowledge that it is possible that there may be both overt and covert biases in the material due to the lens with which it was written.

Furthermore, I would like to create a learning environment for my students that supports a diversity of thoughts, perspectives and experiences, and honors your identities (including race, gender, class, sexuality, religion, ability, etc.) To help accomplish this:

If you have a name and/or set of pronouns that differ from those that appear in your official university records, please let me know.

If you feel like your performance in the class is being impacted by your experiences outside of class, please don't hesitate to come and talk with me. I want to be

a resource for you. Remember that you can also submit anonymous feedback (which may lead to me making a general announcement to the class, if necessary to address your concerns).

I am still in the process of learning about diverse perspectives and identities. If something was said in class (by anyone) that made you feel uncomfortable, please talk to me about it. (Again, anonymous feedback is always an option.)

As a participant in course discussions, you should also strive to honor the diversity of your classmates.

**Socioeconomic Differences and Financial Difficulty.** Our community is composed of students from a variety of financial backgrounds. Socioeconomic diversity can be invisible, and you may be experiencing financial difficulties related to the cost of textbooks, materials, or other necessities for our class of which I am not aware.

If you encounter financial challenges related to this class, there may be sources of support for you. If you feel comfortable sharing your experience with me, you may. You may also consider meeting with a financial aid officer to discuss options, reaching out to the First-Generation Office if you are a first-generation student, browsing the [Funding Resources](#) page, or, for unexpected expenses, applying to the Barrier Removal Fund through the Financial Aid tile in [DartHub](#).

## **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*, Fourth 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.
- 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
- Olf, 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.

<b>Class Calendar</b>				
<b>Week</b>	<b>Date</b>	<b>Day</b>	<b>Topic</b>	<b>Reading</b>
<b>1</b>	25-Mar	M	Introduction	Mills ch. 1
	26-Mar	Tu	X-hour, <b>Discussion</b> - Foundations of Conservation	Sodhi & Ehrlich Ch. 1, Ludwig et al., Hillborn & Ludwig
		W	What is biodiversity - how much is there? Patterns of diversity	May, skim Mora et al.
	29-Mar	F	Diversity Theories. Ecological/Evolutionary Scale. Primary and secondary processes.	Begon et al.
<b>2</b>	1-Apr	M	Diversity Theories. Niche Theory, Non-equilibrium theories, others	
	2-Apr	Tu	x-hour, NetLogo Software Demonstration	
	3-Apr	W	Drivers of diversity loss. Habitat loss - deforestation, Habitat fragmentation. Discussion of grassland papers	Sodhi & Ehrlich Ch. 4 & 7, Oiff & Ritchie, Collins et al.
		F	Habitat Fragmentation. Tropical deforestation <b>discussion</b>	Kummer, Nepstad et al.
<b>3</b>	8-Apr	M	Introduction to Population Models and Fisheries Management	Mills Ch. 5(pp. 79-91) & Ch. 7
	9-Apr	Tu	X-Hour - STELLA software demonstration <b>(Homework 1 due)</b>	
		W	STELLA software demonstration	
	12-Apr	F	Fisheries management	Mills Ch. 14 (pp. 251-260)
<b>4</b>	15-Apr	M	Film: Empty Oceans Empty Nets	Frank et al.
	16-Apr	Tu		
	17-Apr	W	Fisheries discussion/Extinction rates/ <b>Homework 2 due</b>	Dewes, Fogarty & Murawski, Tolley
	19-Apr	F	Extinction rates/	skim Pimm & Askins;
<b>5</b>	22-Apr	M	Extinction Rates/habitat fragmentation discussion	Newmark, Robinson et al., Damschen et al.
	23-Apr	Tu		
	24-Apr	W	Review session for exam	
	25-Apr	Th	<b>Midterm exam (7-10 pm)</b>	101 Fairchild
	26-Apr	F	class cancelled	
<b>6</b>	29-Apr	M	Population viability analysis (PVA)/Age-structured population models. HW#3 assigned	Mills Ch. 6 , Mills, Ch. 10, skim McKelvey et al.
	30-Apr	Tu	Spatial population models	Mills Ch. 10
	1-May	W	Forestry Practices	Spies
	3-May	F	Ecosystem effects of forestry	Wardle et al.
		Sa	Forestry field trip (12:00-2:30) - optional but recommended	
<b>7</b>	6-May	M	Evolution and population genetics /Discuss PVA papers	Mills Ch. 12, Armbruster & Lande, Burgman & Possingham, Mills Ch. 3, McKinnon & Rundle
	7-May	Tu	Population Genetics and Conservation	Mills Ch. 9, Westermeier et al.
	8-May	W	ESA and other U.S. policy. <b>HW#3 due</b>	Norris
	10-May	F	PVA research session	
<b>8</b>	13-May	M	ESA and other U.S. policy. Discussion - Spotted Owl Case Study	Thomas et al., review McKelvey et al.
	14-May	Tu		
	15-May	W	Climate Change & Biodiversity	Walther et al.,
	17-May	F	PVA help session	
<b>9</b>	20-May	M	Climate Change & Biodiversity	Jump & Peñuela,
	21-May	Tu	PVA help session	
	22-May	W	Biodiversity and Ecosystem function	Mills Ch. 13, Cardinale et al., skim Sodhi & Ehrlich Ch. 3
		F	<b>Discussion</b> - Biodiversity and Ecosystem function	
<b>10</b>	27-May	M	Memorial Day - no classes	
	28-May	Tu	PVA presentations	Ricketts et al.
	29-May	W	Last day of classes - PVA presentations	PVA projects due at 5:00 pm
	1-Jun	M	<b>Final Exam, 300pm-500pm,</b>	<b>101 Fairchild</b>
4-Jun	Tu	Last day of exams		