Conservation Biology
Class Schedule

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November 19, 2009

Introduction

The following outlines the readings, discussions, and assignments associated with this course. Some of the readings are from the text:

> Primack, R. B. 2006. *Essentials of Conservation Biology*. Sinauer, Sunderland, Massachusetts, fourth edition.

Other readings are from the primary literature. It is important that you develop your research skills. Consequently, it is your responsibility to look these papers up and download them for yourself. I suggest using the ISI Web of Science literature search engine, which is available from the NMSU library web page under "Articles, Books, Journals, etc." link. You are responsible for reading the text sections and the primary literature associated with this course.

Lecture outline

Updates This schedule may be incomplete, especially with regard to later portions of the semester. I will try to minimize changes and to announce them in class. However, it is your responsibility to follow the current schedule as it may change throughout the semester.

Introduction

1 Introduction: extent of wildlife trade (lecture)

Hewitt, J. December 2005a. Failing the forests—Europe's illegal timber trade. Technical report, World Wildlife Fund. http://assets.panda.org/downloads/failingforests.pdf.

Hewitt, J. November 2005b. Failing the forests. Executive summary. Technical report, World Wildlife Fund. http://assets.panda.org/downloads/illegalloggingeu_1.pdf.

Hirschberger, P. July 2008. Illegal wood for the European market. Technical report, World Wildlife Fund. http://assets.panda.org/downloads/illegal_wood_for_the_european_market_july_2008.pdf.

Oldfield, S., editor. 2003. *The Trade in Wildlife. Regulation for Conservation*. Earthscan Publications, London, England.

TRAFFIC. 2008. What's driving the wildlife trade? A review of expert opinion on economic and social drivers of wildlife trade and trade control efforts in Cambodia, Indonesia, Lao PDR and Vietnam. Technical report, East Asia and Pacific Region Sustainable Development Department, World Bank, Washington, DC. URL http://siteresources.worldbank.org/INTEASTASIAPACIFIC/Resources/226262-1223319129600/wildlife_fullreport.pdf.

Wasser, S. K., B. Clark, and C. Laurie. 2009. The ivory trail. *Sci. Am.*, 301:68–76.

2 What is conservation biology? (lecture)

Primack (2006, Chapter 1)

Soulé, M. E. 1985. What is conservation biology? *BioScience*, 35:727–734.

(a) How can conservation biology be defined?

(b) What are some characteristics of it?

(c) What are the major questions conservation biology tries to address?

(d) How does conservation biology differ from other sciences?

Quantifying Biodiversity

3 What is biological diversity? (lecture)

Primack (2006, Chapter 2)

4 Quantifying biodiversity (lecture)

Purvis, A. and A. Hector. 2000. Getting the measure of biodiversity. *Nature*, 405: 212–219.

5 How is biodiversity distributed? (lecture)

Primack (2006, Chapter 3)

6 **Disscussion**: major patterns of biodiversity

Gaston, K. J. 2000. Global patterns in biodiversity. *Nature*, 405:220–227.

Grenyer, R., C. D. L. Orme, S. F. Jackson, G. H. Thomas, R. G. Davies, T. J. Davies, K. E. Jones, V. A. Olson, R. S. Ridgely, P. C. Rasmussen, T.-S. Ding, P. M. Bennett, T. M. Blackburn, K. J. Gaston, J. L. Gittleman, and I. P. F. Owens. 2006. Global distribution and conservation of rare and threatened vertebrates. *Nature*, 444:93–96.

Orme, C. D. L., R. G. Davies, M. Burgess, F. Eigenbrod, N. Pickup, V. A. Olson, A. J. Webster, T.-S. Ding, P. C. Rasmussen, R. S. Ridgely, A. J. stattersfield, P. M. Bennett, T. M. Blackburn, K. J. Gaston, and I. P. Owens. 2005. Global hotspots of species richness are not congruent with endemism or threat. *Nature*, 436:1016–1019.

Volkov, I., J. R. Banavar, S. P. Hubbell, and A. Maritan. 2007. Patterns of relative species abundance in rainforests and coral reefs. *Nature*, 450:45–49.

7 Exemplars of human impact: Polynesia, Rapa Nui and New Zealand (lecture)

Diamond, J. 2000. Blitzkrieg agains the moas. *Science*, 287:2170–2171.

Flenley, J. and P. Bahn. 2002. *The Enigmas of Easter Island*. Oxford University Press, Oxford, England.

Steadman, D. W. 1995. Prehistoric extinctions of Pacific island birds: biodiversity meets zooarchaeology. *Science*, 267:1123–1131.

(a) What is known of the history of the human society on Rapa Nui and its interaction with the environment?

(b) What are the major factors that influenced the collapse of the Rapa Nui ecosystem and society?

(c) What might explain the absence of a successfully implemented solution to the environmental problems?

(d) What lessons can be learned from Rapa Nui concerning issues related to conservation biology?

(e) What has been the common history for avifauna throughout the Pacific islands?

(f) What is the correlation between that history and human colonization?

(g) What are some specific examples illustrating your points above?

Valuing Biodiversity

8 Direct economic value of biodiversity (lecture)

Primack (2006, Chapter 4)

(a) What are the two main types of direct use values for biodiversity?

(b) How do they differ?

(c) What is the "tragedy of the commons"? (Hardin, 1968)

9 Indirect economic value of biodiversity (lecture)

Primack (2006, Chapter 5)

(a) What are the three main types of indirect economic value?

(b) How do they differ?

(c) Provide specific examples of each.

(d) How much do you spend annually on nature-related activities? How much do three of your friends spend?

(e) How much would you be willing to spend each year on protection of major, well-known species such as grizzly bears, bald eagles, and song birds? How much would your three friends be willing to spend?

10 **Disscussion**: estimating direct value of biodiversity

Peters, Charles, M., A. H. Gentry, and R. O. Mendelsohn. 1989. Valuation of an Amazonian rainforest. *Nature*, 339:655–656.

(a) Today, you will divide into groups. Each group will estimate the direct value of the biodiversity of a plot of tropical rainforest with respect to a particular economic use.

(b) What is the best use of this plot of tropical rainforest?

11 Estimating the value of ecosystem services (lecture)

Costanza, R., R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R. V. O'Neill, J. Paruelo, R. G. Raskin, P. Sutton, and M. van den Belt. 1997. The value of the world's ecosystem services and natural capital. *Nature*, 387: 253–260.

(a) What is the annual value of worldwide ecosystem services?

(b) How is that value estimated?

12 Tragedy of the Commons (lecture)

Hardin, G. 1968. The tragedy of the commons. *Science*, 162:1243–1248.

13 **Role playing game**: timber harvesting and the bushmeat trade

Threats to Biodiversity

14 Threats to biodiversity: extinction (lecture)

Primack (2006, Chapter 7)

Sutherland, W. J. 2003. Parallel extinction risk and global distribution of languages and species. *Nature*, 423:276–279.

(a) What quantitative lessons does the fossil record provide with respect to extinction?

(b) How do current rates of extinction compare with historical ones?

(c) What is the "island biogeography model"? (MacArthur and Wilson, 1967)

(d) How is it useful for assessing extinction?

(e) If 50% of the species present today go extinct within the next 200 years, how long do you estimate it will take the process of speciation to replace them?

15 What does the fossil record show about recovery? (lecture)

Kirchner, J. W. 2002. Evolutionary speed limits inferred from the fossil record. *Nature*, 415:65–68.

Kirchner, J. W. and A. Weil. 2000. Delayed biological recovery from extinctions throughout the fossil record. *Nature*, 404:177–180.

16 What makes populations and species vulnerable? (lecture)

Primack (2006, Chapter 8)

Groom, M. J. 1997. Quantifying extinction rates. Approaches and limitations. In Meffe, G. K. and C. R. Carroll, editors, *Principles of Conservation Biology*, chapter 5, pages 137–139. Sinauer, Sunderland, Massachusetts, second edition. Box 5B.

May, R. M., J. H. Lawton, and N. E. Stork. 1995. Assessing extinction rates. In Lawton, J. H. and R. M. May, editors, *Extinction Rates*, chapter 1, pages 1–24. Oxford University Press, Oxford, England.

(a) What are five characteristics of species that increase their vulnerability to extinction?

(b) Give a specific example of a species that exemplifies each. Explain the biological characteristics that are important.

(c) What are some organizations that categorize vulnerability to extinction?

(d) How is vulnerability to extinction categorized?

(e) What criteria are used in the categorization?

17 Global warming and extinction

Blaustein and A. Dobson. 2006. A message from the frogs. *Nature*, 439:143–144.

O'Reilly, C. M., S. R. Alin, P.-D. Plisnier, and B. A. Cohen, Andrew S.a nd McKee. 2003. Climate change decreases aquatic ecosystem productivity of Lake Tanganyika, Africa. *Nature*, 424:766–768.

Parmesan, C. and G. Yohe. 2003. A globally coherent fingerprint of climate change impacts across natural systems. *Nature*, 421:37–42.

Pounds, J. A., M. R. Bustamante, L. A. Coloma, J. A. Consuegra, M. P. L. Fogden, P. N. Foster, E. La Marca, K. L. Masters, A. Merino-Viteri, R. Puschendorf, S. R. Ron, G. A. Sánchez-Azofeifa, C. J. Still, and B. E. Young. 2006. Widespread amphibian extinctions from epidemic disease driven by global warming. *Nature*, 439:161–167.

Walther, G.-R., E. Post, P. Convey, A. Menzel, C. Parmesan, T. J. C. Beebee, J.-M. Fromentin, O. Hoegh-Guldberg, and F. Bairlein. 2002. Ecological responses to recent climate change. *Nature*, 416:389–395.

(a) Parmesan and Yohe (2003) identify a "globally coherent fingerprint" of global warming. Describe two of their specific quantitative results that support this conclusion.

18 **Disscussion**: effects on world resources

Chapin, III, F. S., E. S. Zavaleta, V. T. Eviner, R. L. Naylor, P. M. Vitousek, H. L. Reynolds, D. U. Hooper, S. Lavorel, S. O. E., S. E. Hobbie, M. Mack, and S. Diaz. 2000. Consequences of changing biodiversity. *Nature*, 405:234–242.

Imhoff, M. L., L. Bounoua, T. Ricketts, C. Loucks, R. Harriss, and W. T. Lawrence. 2004. Global patterns in human consumption of net primary production. *Nature*, 429:870–873.

Pauly, D., V. Christensen, S. Guénette, T. J. Pitcher, U. R. Sumaila, C. J. Walters, R. Watson, and D. Zeller. 2002. Towards sustainability in world fisheries. *Nature*, 418:689–695.

Worm, B., E. B. Barbier, N. Beaumont, J. E. Duffy, C. Folke, B. S. Halpern, J. B. C. Jackson, H. K. Lotze, F. Micheli, S. R. Palumbi, E. Sala, K. A. Selkoe, J. J. Stachowicz, and R. Watson. 2006. Impacts of biodiversity loss on ocean ecosystem services. *Science*, 314:787–790.

19 Wildlife trade

20 **Role playing game**: wildlife trade

Conservation at the Population and Species Levels

21 Problems associated with small populations (lecture)

Primack (2006, Chapter 11)

(a) What are three factors that affect the viability and persistence of small populations?

(b) Give a specific example illustrating each.

22 Applied population biology (lecture)

Primack (2006, Chapter 12)

(a) What is the distinction between inventories and demographic studies?

(b) How are they both useful in the monitoring of populations?

(c) What is a "PVA"?

(d) What a biological characteristics define a "metapopulation"?

(e) How might genetic information be useful to a monitoring program?

23 Population growth models: geometric (lecture)

Gotelli, N. J. 1995. *A Primer of Ecology*. Sinauer, Sunderland, Massachusetts.

(a) What is a population growth model?

(b) What is the difference between a continuous time and a discrete time model?

(c) What are the basic assumptions that underly many simple population growth models?

(d) Characterize the difference between projection and prediction.

24 **No classes: 12–23 October.** Please use this time to work on your group projects and to accomplish the following homework assignment.

Homework due: 28 October

Spreadsheet tutorial

Group project outline due: 28 October Your outline should be as complete as possible. It should indicate clearly the logic of your presentation/paper. At the beginning, include a well-crafted, short, abstract that clearly identifies the main points and provides context. At the end, be sure to include the set of references (formated in the style of *Conservation Biology*) you are currently working with.

25 Probability and life tables (lecture)

Homework due: 28 October

Gotelli, N. J. 1995. *A Primer of Ecology.* Sinauer, Sunderland, Massachusetts.

(a) Construct the survivorship schedule, $l(x)$, and the age-specific survival probability, $g(x)$.

(b) Construct the expected survivorship of a cohort of size 30 newborns.

(c) What is the *fertility schedule* in an age-classified demographic population growth model? What is a *survivorship schedule*?

(d) Calculate the net reproductive rate, R_0, the generation time, G, the intrinsic rate of increase, r, and the finite rate of increase, λ for this population.

26 Projecting population size (lecture)

Homework due: 30 October

27 Stage structured populations (lecture)

Homework due: 2 November

28 Population viability analysis case study: marine turtles (lecture)

Crouse, D. T., L. B. Crowder, and H. Caswell. 1987. A stage-based population model for loggerhead sea turtles and implications for conservation. *Ecology*, 68:1412–1423.

(a) How was the demographic analysis organized?

(b) How did the demographic analysis change our understanding of critical life-history stages for loggerhead sea turtles?

(c) What were the management implications of completing a formal demographic analysis of *Caretta caretta*?

(d) Is population size a sufficient piece of information for predicting the fate of this population? How does your answer influence your thoughts about how populations and species are traditionally classified with regard to vulnerability?

Practical Applications

29 Establishing protected areas (lecture)

Primack (2006, Chapter 15)

(a) What are the three core questions that conservation planners must address?

(b) What elements contribute to prioritizing biodiversity for preservation?

(c) How can potential reserve areas be identified?

(d) How can the necessary extent of reserves be determined?

(e) Imagine a rare species of flamingo limited to a single lakeshore. The nesting colong is threatened by a logging operation. You have a $1,000,000 budget. You can purchase the lake from the timber company for $1,000,000. An effective management program would cost $750,000. How would you allocate your funds? Can you suggest other possibilities?

30 Designing networks of protected areas (lecture)

Primack (2006, Chapter 16)

(a) What are the main biological issues associated with reserve design?

(b) Give specific examples of each.

31 Quantifying populations using genetics (lecture)

Eggert, L. S., J. A. Eggert, and D. S. Woodruff. 2003. Estimating population sizes for elusive animals: the forest elephants of Kakum National Park, Ghana. *Mol. Ecol.*, 12:1389–1402.

32 **Disscussion**: using genetics to monitor wildlife trade (lecture)

Palsbøll, P. J., M. Bérubé, H. J. Skaug, and C. Raymakers. 2006. DNA registers of legally obtained wildlife and derived products as means to identify illegal takes. *Conserv. Biol.*, 20:1284–1293.

Wasser, S. K., W. J. Clark, O. Drori, E. S. Kisamo, C. Mailand, B. Mutayoba, and M. Stephens. 2008. Combating the illegal trade in African elephant ivory with DNA forensics. *Conserv. Biol.*, 22:1065–1071.

National and International Conservation Efforts

33 Value of unprotected habitats (lecture)

Primack (2006, Chapter 18)

(a) Why might it be important to consider the conservation value of areas not designated as formally "protected?"

(b) How might one characterize the concept of *ecosystem management* that seeks to manage large tracts of land?

(c) What do you see as the main opportunities and challenges associated with conservation involving unprotected areas?

34 Conservation and sustainable development

Primack (2006, Chapter 20)

35 National conservation activities: Costa Rica

Vaughan, C. and C. M. Rodreguez. 1997. Managing beyond borders: the Costa Rican national system of conservation areas (SINAC). In Meffe, G. K. and C. R. Carroll, editors, *Principles of Conservation Biology*, chapter 13, pages 441–451. Sinauer, Sunderland, Massachusetts, second edition.

(a) What was the progression of wildland management in Costa Rica?

(b) What were the principle objectives for wildland management?

(c) Why were those objectives originally difficult to achieve?

(d) What is the organizational structure of SINAC?

(e) How does the funding and organizational structure make achieving the objectives more likely?

(f) How can this model be extended to other situations?

36 National challenges: China (lecture)

Liu, J. and J. Diamond. 2005. China's environment in a globalizing world. *Nature*, 435:1179–1186.

37 Economic drivers for sustainability: biodiversity credits

Bruggeman, D. J., M. L. Jones, F. Lupi, and K. T. Scribner. 2005a. Landscape equivalency analysis: methodology for estimating spatially explicit biodiversity credits. *Environ. Manage.*, 36:518–534.

James, A. N., K. J. Gaston, and A. Balmford. 1999. Balancing the Earth's accounts. *Nature*, 401:323–324.

38 International approaches

Primack (2006, Chapter 21)

Group reports

39 Group reports

(a) Internet wildlife trade

(b) TRAFFIC interceptions

40 Group reports

(a) Bushmeat trade: potential impact on human health

(b) Impact of legal and illegal whaling

41 Group reports

(a) Timber harvesting trade and impact

(b) Fisheries trade and impact

Prospects

42 An agenda for the future (lecture)

Primack (2006, Chapter 22)

43 **Disscussion**: Millenium Ecosystem Assessment

Millennium Ecosystem Assessment. 2005. Ecosystems and human well-being: Biodiversity synthesis. Technical report, World Resources Institute, Washington, D.C.

(a) What are the main issues identified by the MEA?

(b) What are the potential futures considered by the MEA?

(c) How do the likely outcomes of the scenarios differ?

(d) Are any of the scenarios preferable to others? Would any be worth working toward making happen?

References

Blaustein and A. Dobson. 2006. A message from the frogs. *Nature*, 439:143–144.

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Chapin, III, F. S., E. S. Zavaleta, V. T. Eviner, R. L. Naylor, P. M. Vitousek, H. L. Reynolds, D. U. Hooper, S. Lavorel, S. O. E., S. E. Hobbie, M. Mack, and S. Diaz. 2000. Consequences of changing biodiversity. *Nature*, 405:234–242.

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Crouse, D. T., L. B. Crowder, and H. Caswell. 1987. A stage-based population model for loggerhead sea turtles and implications for conservation. *Ecology*, 68:1412–1423.

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Kirchner, J. W. 2002. Evolutionary speed limits inferred from the fossil record. *Nature*, 415: 65–68.

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TRAFFIC. 2008. What's driving the wildlife trade? A review of expert opinion on economic and social drivers of wildlife trade and trade control efforts in Cambodia, Indonesia, Lao PDR and Vietnam. Technical report, East Asia and Pacific Region Sustainable Development Department, World Bank, Washington, DC. URL `http://siteresources.worldbank.org/INTEASTASIAPACIFIC/Resources/226262-1223319129600/wildlife_fullreport.pdf`.

Vaughan, C. and C. M. Rodreguez. 1997. Managing beyond borders: the Costa Rican national system of conservation areas (SINAC). In Meffe, G. K. and C. R. Carroll, editors, *Principles of Conservation Biology*, chapter 13, pages 441–451. Sinauer, Sunderland, Massachusetts, second edition.

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Walther, G.-R., E. Post, P. Convey, A. Menzel, C. Parmesan, T. J. C. Beebee, J.-M. Fromentin, O. Hoegh-Guldberg, and F. Bairlein. 2002. Ecological responses to recent climate change. *Nature*, 416:389–395.

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Worm, B., E. B. Barbier, N. Beaumont, J. E. Duffy, C. Folke, B. S. Halpern, J. B. C. Jackson, H. K. Lotze, F. Micheli, S. R. Palumbi, E. Sala, K. A. Selkoe, J. J. Stachowicz, and R. Watson. 2006. Impacts of biodiversity loss on ocean ecosystem services. *Science*, 314:787–790.