ENV 252

Sustainability and Renewable Resource Economics

Nicholas School of the Environment and Earth Sciences
Duke University
Spring 2007, Tuesdays and Thursdays 10:05-11:20, A156 LSRC

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Rationale: Renewable resource management inherently involves multiple disciplines that span the natural and social sciences. For resources that are harvested and sold in the marketplace, economic analysis is particularly relevant for making management decisions. Nevertheless, successful management requires understanding the underlying biophysical systems for these resources, and such expertise typically resides with ecologists and other natural scientists. Unfortunately, modeling approaches across disciplines can differ substantially, making it difficult for researchers to bring together realistic depictions of economic and biophysical factors. Fundamental differences in normative perspectives across disciplines exacerbate these difficulties, yet resource managers inevitably must deal with them. Differing conceptions of sustainability and ideas about sustainable development provide the core motivation for this class.

Students pursuing environmental careers in renewable resource management must be able to understand analyses of natural resources that come from both the social science and natural science communities. In some cases, graduates will do basic natural resource modeling themselves, and in other cases, they will integrate analyses from multiple sources to make policy recommendations. This course confronts the challenges of renewable resource management by discussing different normative approaches to resource policy and by presenting modeling exercises that involve both economic and biophysical components. The aim is to train students to sort out the heterogeneous objectives coming from the scientific community and to do basic renewable resource modeling that incorporates some economic and biological realism.

Intended audience: The intended audience is 2nd year MEM students, PhD students, and advanced undergraduates with a particular interest in management of biological resources. Within the MEM program, the course should appeal to EEP students and, since half of the applications involve marine fisheries, to CEM students.

Format: The course will be a combination of lecture by the professor, discussion, class debates, and student presentations. Thus, attendance at class meetings is mandatory.

Prerequisites: MEM prerequisites (calculus, statistics, microeconomics) + ENV 270 (or equivalent training in environmental and resource economics)

Assignments and grading: Much of the work in the class will be reading and preparing for class discussion. Final grades will be based on your work in five areas: written responses to readings (20%), class debates and participation (10%), midterms (30%), quantitative/modeling exercises (25%), and a final project (15%). The TA will grade your responses to readings and will grade some of the quantitative/modeling exercises and midterm. I will grade your final papers.

Responses to Readings

You will write approximately 10 ½-1 page responses to readings over the course of the semester. Typically, in class I will pose a question about one or more of the following week's readings. Beyond just counting for 20% of your grade, your write-ups are important because they will help to initiate class discussion. Also, two of your responses will be for readings that relate to your final project. The responses related to your project should explain the relevance of a piece of academic research to a renewable resource management topic.

Class Debates and Participation

Participation in class discussion is essential for this class to succeed. This includes making comments and asking questions. Each student is also required to participate in one of the formal class debates.

Midterms

There will be two midterms with each counting for 15% of your grade. You will be asked to do one essay and 1-2 analytical problems on each exam.

Quantitative/Modeling Exercises

There will be four quantitative or modeling exercises, partly drawn from the Conrad, Walters, and Heal books. The goal is to continue to sharpen your skills from ENV 270 and to provide a basis for undertaking your own resource modeling. You may work with one other student on these exercises, but please make sure that both of you complete all of the work.

Final Project

This is a 7-10 page paper on a renewable resource topic with a strong quantitative focus. Ideally, your project will serve as a starting place for a Master's Project (MP), an honor's thesis, a Master's thesis, or even a dissertation prospectus. You should include at least 4 references to academic studies beyond the reading in the class. Your paper must include analytical modeling, statistical analysis, numerical simulation, or some combination of these. You must submit a 1 page preliminary proposal in the 8th week of class. Projects are due during the last week of class. I will work with students individually during office hours to help narrow your final projects.

Course outline:

The course will consist of three main topic areas. First, we will discuss conceptual issues in sustainable development. We will review ideas from both the natural sciences and the social sciences, and we will emphasize different normative theories of sustainability in economics. Our primary objective is to formalize conceptions of sustainable development and thus provide a foundation for quantitative management decisions. Second, we will discuss modeling difficulties in sustainable management of renewable resources. Here our focus will be on bringing together economic analysis with realistic depictions of biophysical systems. Inevitably, we will have to confront uncertainty about human behavior, "natural" systems, and the interaction of the two. Third, we will study applications in academic literature that deal with renewable resource management. In addition to understanding how these studies were conducted, we will question how different ideas about sustainability would alter the conclusions or even the study designs.

Throughout the course, we will transition back and forth between conceptual and applied work. Because much of my own research involved fisheries, we will place a heavy emphasis on the marine environment in the second and third topic areas. Below is a tentative outline of the topics that we will cover in each section. I write "tentative" because we will not be able to tackle all of these themes in one semester, and we will undoubtedly skip around a bit within each topic area.

I. Sustainability and Normative Theory: Conceptual Issues
   - A. Utilitarianism and environmental philosophies
   - B. Ecological economics versus bioeconomics
   - C. Objectives versus constraints in modeling sustainability
   - D. Economic definitions of sustainability
   - E. Discounting revisited

II. Renewable Resource Applications
   - A. Bioeconomics and open access
   - B. Renewable resources with intrinsic value
   - C. Bioeconomics of marine reserves
   - D. Fishery conflicts with marine mammals
   - E. Modeling Biodiversity
   - F. Invasive Species Management

III. Modeling Difficulties and Avoiding Surprises
   - A. Positive versus normative approaches
   - B. Modeling under Uncertainty
   - C. Adaptive Management
   - D. What does the economist lack?
   - E. What does the natural scientist lack?

Readings:

The readings will provide a basis for discussion in class, help to develop quantitative and analytical tools, and provide examples of applied research on renewable resource management. The first two weeks of readings will be qualitative in nature, but subsequently virtually all of the readings will be very mathematical. I will pass out detailed reading assignments with discussion questions on a week-by-week basis.

Required Book

Geoffrey Heal, *Valuing the Future: Economic Theory and Sustainability*, New York, Columbia University Press, Economics for a Sustainable Earth Series, 1998.

Recommended Books

Jon M. Conrad, *Resource Economics*, New York: Cambridge University Press, 1999.

Simon Levin, *Fragile Dominion: Complexity and the Commons*, Cambridge, MA: Helix Books, 1999.

We will read significant portions of Heal's book. Conrad is a good reference for tools and shows you how to do dynamic optimization in spreadsheets (something that we'll do some of in the course). Levin provides a nice overview of contemporary themes in ecology that relate to sustainability

Excerpted Books (available through Blackboard or through E-Reserves)

National Research Council, *Our Common Journey: a transition toward sustainability*, Washington, D.C.: National Academy Press, 1999.

Carl Walters, *Adaptive Management of Renewable Resources*, New York: Macmillan Publishing Company, 1986 (reprinted by Fisheries Centre, University of British Columbia, 1997).

Gareth Edwards-Jones, Ben Davies, and Salman Hussain, *Ecological Economics: An Introduction*, Malden, MA: Blackwell Science, 2000.

Ray Hilborn and Marc Mangel, *The Ecological Detective: Confronting Models with Data*, Princeton: The Princeton University Press, 1997.

Colin W. Clark, *Mathematical Bioeconomics: The Optimal Management of Renewable Resources*, Second Edition, New York: John Wiley and Sons, 1990.

Selected Articles

K.E. Boulding, "The Economics of the Coming Spaceship Earth," in *Environmental Quality in a Growing Economy*, The Johns Hopkins University Press, 1966.

J.E. Wilen, M.D. Smith, D. Lockwood, and L. Botsford, "Avoiding Surprises: Incorporating Fishermen Behavior into Management Models," *Bulletin of Marine Science*, in press, 2002.

J.E. Wilen, "Common Property Resources and the Dynamics of Overexploitation: The Case of the North Pacific Fur Seal," University of British Columbia, Resources Paper No. 3, September 1976.

J.D. Kaplan and M.D. Smith, "Optimal Fisheries Management in the Presence of an Endangered Predator and Harvestable Prey," *Proceedings of the 10th Biennial Conference of the International Institute for Fisheries Economics and Trade*, 2000.

R.B. Howarth and R.B. Norgaard, "Intergenerational Resource Rights, Efficiency, and Social Optimality," *Land Economics* 66, 1-11, 1990.

M.L. Weitzman, "Gamma Discounting," *American Economic Review* 91(1), 260-271, 2001

Brander, J.A. and M. Scott Taylor, "The Simple Economics of Easter Island: A Ricardo-Malthus Model of Renewable Resource Use," *American Economic Review* 88:1, 119-139, 1998.

C.W. Clark, "The Economics of Overexploitation," *Science* 181, 630-634.

J.M. Conrad and D. Ludwig, "Forest Land Policy: The Optimal Stock of Old-Growth Forest," *Natural Resource Modeling* 8, 27-45.

Solow,A., S. Polasky, and J. Broadus, "On the Measurement of Biological Diversity," *Journal of Environmental Economics and Management*, 24(1), January 1993, 60-68.

Lauck, T., C.W. Clark, M. Mangel, and G.R. Munro (1998), "Implementing the Precautionary Principle in Fisheries Management Through Marine Reserves," *Ecological Applications* 8(1), Supplement, S72-S78.

Roberts, C.M, J.A. Bonsack, F. Gell, J.P. Hawkins, R. Goodridge (2001), "Effect of Marine Reserves on Adjacent Fisheries," *Science* 294, 1920-1923.

Hastings, Alan and L. Botsford (1999). "Equivalence in Yield from Marine Reserves and Traditional Fisheries Management," *Science* 284, 1537-1538.

Russ, Gary R. and Agel C. Alcala (1996), "Marine Reserves: Rates and Patterns of Recovery and Decline of Large Predatory Fish," *Ecological Applications* 6, 947-961.

Polasky, S. J.D. Camm, and B. Garber-Yonts (2001), "Selecting Biological Reserves Cost-Effectively: An Application to Terrestrial Vertebrate Conservation in Oregon," *Land Economics* 77(1) February, 68-78.

Weitzman, M.L (1998), "The Noah's Ark Problem," *Econometrica* 66(6), 1279-1298.

Mainwaring, L. (2001), "Biodiversity, Biocomplexity, and the Economics of Genetic Dissimilarity," *Land Economics* 77(1) February, 79-83

Brown, G.M. Jr. and J.F. Shogren, "Economics of the Endangered Species Act," *Journal of Economic Perspectives* 12(3), 3-20.

"The Economics of Invasive Species Management," various authors, Principal Paper Session, American Agricultural Economics Association Annual Meetings (July 2002), *American Journal of Agricultural Economics* 84:5, 1303-1328.

Smith, M.D. and J.E. Wilen (2003), "Economic Impacts of Marine Reserves: The Importance of Spatial Behavior," *Journal of Environmental Economics and Management* 46(2), 183-206, 2003

I will add a few articles to this list and most likely delete a few, depending on our progress over the course of the semester.

Tentative Schedule

January 11	Introductions and a Layperson's View of 'Sustainability'
January 16, 18	Discussion of *Our Common Journey* and Introduction to Dynamics
January 18	7:00-8:30 Mathematics for Dynamic Economic Analysis (Makeup Class for Canceled Class on March 27)
January 19	Optional Seminar: 4:00-5:30pm - Steve Polasky, Fesler-Lampert Professor of Ecological/Environmental Economics, University of Minnesota, "Where to Put Things? Spatial Landscape Management with Biological and Economic Objectives," Location: Doris Duke Center, Sarah P. Duke Gardens
January 23, 25	Discussion of *Fragile Dominion*, History of Economics of Sustainability, Ecological Economics
January 30	Discussion of Boulding, Costanza, and Howarth and Norgaard Guest Discussant – Professor Lori Bennear

February 1	Class Debate: Neo-Classical Economics versus Ecological Economics Introduction to Mathematical Treatment of Sustainability
February 6	Optimal Control Problems and the Hotelling Model Revisited
February 8	Stock Effects and a Sustainability Interpretation of Renewable Resource Models
February 13	Green Golden Rule, Overtaking, and the Chichilnisky Criterion
February 15	Non-Constant Discounting
February 20	Class Debate: Constant Exponential Discounting Versus Alternative Approaches Discussion of Quantitative Assignment
February 22	Trading Off Resource Extraction and Conservation in a Dynamic Context
February 27	Guest Lecture: Dr. Rafe Sagarin, Associate Director for Ocean and Coastal Policy, Nicholas Institute for Environmental Policy Solutions, "Ecological Perspectives on Marine Protected Areas"
March 1	Spatial Dynamics and the Bioeconomics of Marine Protected Areas
March 6	Midterm 1 (Covers Material Through February 20)
March 8	Uncertainty and Resource Economics
March 8 or 9	Optional Seminar on My Current Research (Time and Place To Be Announced)
March 12-16	Spring Break
March 20	Analytical Treatment of Adaptive Management in Renewable Resource Systems
March 22	Class Debate: Deterministic Versus Stochastic Modeling Economics of Easter Island
March 27	No Class
March 29	Midterm 2 (Cumulative)
April 3, 5	Economics of Biodiversity
April 10	Invasive Species Management
April 12	Class Debate: Eradication Versus Prevention

	Introduction to Biological Sources of Energy
April 17	Renewable Energy and Sustainability
April 19-29	Reading Period
April 27	Optional Seminar: 12:00- 1:30, Lee Anderson, Professor of Marine Policy, University of Delaware, "Market-based Policies in Recreational Fisheries Management," Location To Be Announced
April 30	Final Paper Due (5:00 PM)