

**Volume 21**

# **Environmental & Natural Resource Economics**

**Economics Reading Lists,  
Course Outlines, Exams,  
Puzzles & Problems**

**Volume 21**

**Environmental &  
Natural Resource Economics**

**Economics Reading Lists,  
Course Outlines, Exams,  
Puzzles & Problems**



Compiled by Edward Tower, *Duke University*, August 1990

## NOTES TO USERS AND POTENTIAL CONTRIBUTORS

*These teaching materials are drawn from both undergraduate and graduate programs at 93 major colleges and universities. They are designed to widen the horizons of individual professors and curriculum committees. Some include suggestions for term-paper topics, and many of the lists are useful guides for students seeking both topics and references for term papers and theses. Thus, they should enable faculty members to advise students more effectively and efficiently. They will also be useful to prospective graduate students seeking more detailed information about various graduate programs; to those currently enrolled in programs who are preparing for field examinations; and to librarians responsible for acquisitions in economics. Finally, they may interest researchers and administrators who wish to know more about how their own work and the work of their department is being received by the profession.*

*The exams, puzzles and problems include both undergraduate and graduate exams contributed by economics departments and individual professors. They should be especially useful to professors making up exams and problem sets and to students studying for comprehensive exams. They may also serve as the focus for study groups.*

*From time to time we will reprint updated and expanded versions. Therefore, we would welcome new or updated teaching materials, especially those which compliment material in this collection or cover areas we missed. Potential contributors should contact Ed Tower, Economics Department, Duke University, Durham, North Carolina 27706, U.S.A.*

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### Acknowledgement

*The associate compilers for this series are Cliff Carrubba, Maia Sisk, and Ron Temple. Cliff is a senior at Duke, majoring in Economics and Political Science. Maia is a senior at Duke, majoring in Economics and Computer Science. Ron is a graduate student at Harvard's John F. Kennedy School of Government. Andy Seamons, Kathy Shelley, and Geoff Somes also provided important help with production of the volumes. The cover was designed by the Division of Audiovisual Education, Duke University, and the volumes were printed by Multipart, Inc., New York.*

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# ENVIRONMENTAL & NATURAL RESOURCE ECONOMICS

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\* \* \*

U = Undergraduate G = Graduate  
R&E = Reading Lists & Exams and/or Problems

Department of Agricultural and Resource Economics  
University of California at Berkeley

PENR 1  
Peter Berck  
Fall Semester, 1988

## INTRODUCTION TO POLITICAL ECONOMY OF NATURAL RESOURCES

### Reading List

- Brookshire, David S., James L. Merrill, and Gary L. Watts. "Economics and the Determination of Indian Reserved Water Rights." Natural Resources Journal, Vol. 23, No. 4, (October, 1983), pp. 750-765.
- Burness, H. S., R. G. Cummings, W. D. Gorman, and R. R. Lansford. "The 'New' Arizona vs. California: Practicably Irrigable Acreage and Economic Feasibility." Natural Resources Journal, Vol. 22, No. 3 (July, 1982), pp. 517-523.
- Coppock, Roy. "Resources at Risk in the San Joaquin Valley: Drainage Source Control on the Farm." Number 3 in a Series on Drainage Issues, Agricultural Issues Center, University of California, \_\_\_\_\_ (19\_\_).
- Economic Report of the President. Washington, D. C.: U. S. Government Printing Office, "Toward Agricultural Policy Reform" (January, 1987), pp. 147-178.
- Houck, J. P. and M. E. Ryan. "Supply Analysis for Corn in the United States: The Impact of Changing Government Programs." American Journal of Agricultural Economics, Vol. 54, No. 2 (May, 1972), pp. 184-191.
- Hyde, William F., Roy G. Boyd, and Barbara L. Daniels. "The Impacts of Public Interventions: An Examination of the Forestry Sector." Journal of Policy Analysis and Management, Vol. 7, No. 1 (Fall, 1987), pp. 40-61.
- McKean, Roland N. "Efficiency in Government Through Systems Analysis with Emphasis on Water Resources Development." Publications in Operations Research, Rand Corporation, Chapter 12, (19\_\_), pp. 214-243.
- Ranney, Christine and John Kushman. A Study of the Interdependent Food Stamp Program Participation and Food Demand Decisions. Giannini Foundation Research Report No. 336, Division of Agriculture and Natural Resources, University of California at Berkeley (March, 1987), pp. 1-11.
- Ruff, L. E. "The Economic Common Sense of Pollution." Public Interest, No. 19 (Spring, 1970), pp. 69-85.
- Timmer, C. Peter. Choice of Technique in Rice Milling on Java, "Bulletin of Indonesian Economic Studies," Vol. 9, No. 2 (July, 1973).
- Tweeten, Luther. Foundations of Farm Policy, Iowa State University Press: Ames, Iowa, Chapters 10 and 11, (19\_\_), pp. 300-360.

Department of Agricultural and Resource Economics  
University of California, Berkeley

ARE 261  
Peter Berck  
Anthony Fisher  
Fall Semester, 1989

**NATURAL RESOURCE ECONOMICS**  
**(formerly ECONOMICS OF RENEWABLE NATURAL RESOURCES)**

**Reading List**

**PART I (FISHER)**

**Elementary Resource Theory**

- J. M. Hartwick and N. D. Olewiler. *The Economics of Natural Resource Use*. Chapter 3.
- M. H. Miller and C. W. Upton. "A Test of the Hotelling Valuation Principle." *Journal of Political Economy*, No. 93 (1985), pp. 1-25.

**Theory of Exhaustible Resource Depletion**

- R. M. Solow. "Richard T. Ely Lecture: The Economics of Resources or the Resources of Economics." *American Economic Review*, No. 64 (1974), pp. 1-14.
- J. E. Stiglitz. "A Neoclassical Analysis of the Economics of Natural Resources," in *Scarcity and Growth Reconsidered*, edited by V. K. Smith. Baltimore: Johns Hopkins University Press, 1979.
- W. D. Schulze. "The Optimal Use of Nonrenewable Resources: The Theory of Extraction." *Journal of Environmental Economics and Management*, No. 1 (1974), pp. 53-73.
- M. C. Weinstein and R. J. Zeckhauser. "The Optimal Consumption of Depletable Natural Resources." *Quarterly Journal of Economics*, No. 89 (1975), pp. 371-392.
- A. C. Fisher. *Resource and Environmental Economics*. Cambridge: Cambridge University Press, 1981. Chapter 2.
- P. S. Dasgupta and G. M. Heal. *Economic Theory and Exhaustible Resources*. Cambridge: Cambridge University Press, 1979. Chapters 6 and 9.
- J. M. Conrad and C. W. Clark. *Natural Resource Economics*. Cambridge: Cambridge University Press, 1987. Chapter 3.

### **OPEC and the World Oil Market**

- J. M. Griffin and H. B. Steele. *Energy Economics and Policy*. Orlando: Academic Press, 1986. Chapter 4.
- J. M. Hartwick and N. D. Olewiler. Chapters 4 and 7 (pp. 183-203).
- R. S. Pindyck. "Gains to Producers from the Cartelization of Exhaustible Resources." *Review of Economics and Statistics*, No. 60 (1978), pp. 238-251.
- E. Hnyilicza and R. S. Pindyck. "Pricing Policies for a Two-Part Exhaustible Resource Cartel: The Case of OPEC." *European Economic Review*, No. 2 (1976), pp. 139-159.
- A. C. Fisher. "Whither Oil Prices: The Evidence from Theory." *Natural Resource Modeling*, Vol. 2 (1987), pp. 5-22.
- W. W. Hogan. "World Oil Price Projections: A Sensitivity Analysis." Discussion Paper E-89-04, Kennedy School of Government, Harvard University (1989).

### **Energy in the Economy: Modeling and Policy**

- J. M. Hartwick and N. D. Olewiler. Chapter 7 (pp. 221-238).
- W. W. Hogan and A. S. Manne. "Energy-Economy Interaction: The Fable of the Elephant and the Rabbit," in *Modeling Energy -Economy Interactions: Five Approaches*, edited by C. J. Hitch. Washington: RFF, 1977.
- W. D. Nordhaus. "The Allocation of Energy Resources." *Brookings Papers*, No. 3 (1973), pp. 529-570.
- E. A. Hudson and D. W. Jorgenson. "U. S. Energy Policy and Economic Growth, 1975-2000." *Bell Journal of Economics and Management Science*, No. 5 (1974), pp. 461-514.
- K. A. Despotakis and A. C. Fisher. "Energy in a Regional Economy: A Computable General Equilibrium Model for California." *Journal of Environmental Economics and Management*, Vol. 15 (1988) pp. 313-330.

### **Resources in the Long Run: Growth and Sustainability**

- H. J. Barnett and C. Morse. *Scarcity and Growth: The Economics of Natural Resource Scarcity*. Baltimore: Johns Hopkins Press, 1963. Chapter 1.



- D. A. Brobst. "The Systems Approach to the Analysis of Resource Scarcity," in *Scarcity and Growth Reconsidered*, edited by V. K. Smith. Baltimore: Johns Hopkins Press, 1979.
- H. E. Goeller and A. Zucker. "Infinite Resources: The Ultimate Strategy." *Science* (February 3, 1984).
- Dasgupta and Heal. Chapter 7.
- A. C. Fisher. Chapter 4.
- J. M. Hartwick and N. D. Olewiler. Chapters 6 and 7 (pp. 203-221).
- M. E. Slade. "Trends in Natural Resource Commodity Prices: An Analysis of the Time Domain." *Journal of Environmental Economics and Management* (June, 1982).
- W. D. Nordhaus. "World Dynamics—Measurement Without Data." *Economic Journal*, No. 83 (1973), pp. 1156-1183.
- J. Simon. "Resources, Population, Environment: An Oversupply of False Bad News." *Science* (June 27, 1980). See also "Letters," *Science* (December 19, 1980).
- The World Bank, Development Committee. *Environment, Growth, and Development*. Washington, D. C.: August, 1987.

### **Conservation and the Environment**

- J. V. Krutilla. "Conservation Reconsidered." *American Economic Review*, No. 47 (1967), pp. 777-786.
- A. C. Fisher. Chapter 5.
- A. C. Fisher and W. M. Hanemann. "Option Value and the Extinction of Species." *Advances in Applied Micro-Economics*, Vol. 4 (1986).

### **PART 2 (BERCK)**

#### **Open Access Models and the Phase Space**

- M. W. Hirsch and S. Smale. *Differential Equations, Dynamical Systems, and Linear Algebra*.
- J. M. Hartwick and N. D. Olewiler. Chapter 8 (except optimal stuff).
- P. Berck. "Open Access and Extinction." *Econometrica*, No. 47 (1979), pp. 877-882.

V. L. Smith. "On Models of Commercial Fishing." *Journal of Political Economy*, No. 77 (1969), pp. 181-198, Sections 1 and 2.

### **Optimal Management and the Hamiltonian**

P. P. Varaiya. *Notes on Optimization*. New York: Van Nostrand, 1972. (Out of print.)

J. M. Hartwick and N. D. Olewiler. Chapter 9.

V. L. Smith. "Economics of Production from Natural Resources." *American Economic Review*, No. 58 (1968), pp. 409-431.

R. F. Fullenbaum, E. W. Carlson, and F. W. Bell. "Economics of Production from Natural Resources: Comment and V. L. Smith Reply." *American Economic Review*, No. 61 (1971), pp. 483-491.

P. Berck. "Optimal Management of Renewable Resources with Growing Demand and Stock Externalities." *Journal of Environmental Economics and Management*, No. 8 (1981), pp. 105-117.

A. C. Fisher. *Resource and Environmental Economics*. Cambridge: Cambridge University Press, 1981. Chapter 3.

### **Stochastic Calculus and Option Value in Resources**

A. G. Malliaris and W. A. Brock. *Stochastic Methods in Economics and Finance*. Amsterdam: North Holland Publishing Co., 1981. Chapter 2.

G. C. Chow. "Optimum Control of Stochastic Differential Equation Systems." *Journal of Economic Dynamics and Control*, No. 1 (1979), pp. 143-175.

B. Pindyck. "Uncertainty and Exhaustible Resource Markets." *Journal of Political Economy*, No. 88 (1980), pp. 1203-1225.

C. Smith. "Option Pricing: A Review." *Journal of Financial Economics*, No. 3 (1976), pp. 3-51.

R. McDonald and D. Siegel. "The Value of Waiting to Invest." *Quarterly Journal of Economics* (1986), pp. 707-727.

J. Paddock, D. Siegel, and J. Smith. "Option Valuation of Claims on Real Assets: The Case of Offshore Petroleum Leases." *Quarterly Journal of Economics* (1988), pp. 479-508.

M. Brannan and E. Schwartz. "Evaluating Natural Resource Investments." *Journal of Business*, No. 58 (1985), pp. 135-157.

#### **Estimation of Resource Models**

F. W. Bell. "Technological Externalities and Common Property Resources: . . . ." *Journal of Political Economy*, No. 80 (1972), pp. 148-158.

M. Spence. "Blue Whales and Applied Control Theory." *Technical Report 108*.

G. Johns and P. Berck. "Estimating Structural Resource Models When Stock is Uncertain: Theory and Application to Pacific Halibut" (June, 1989).

W. L. Griffin, R. D. Lacewell, and J. P. Nichols. "Optimum Effort and Rent Distribution in the Gulf of Mexico Shrimp Fishery." *American Journal of Agricultural Economics*, No. 58 (1976), pp. 644-652.

P. Berck. *Estimation Based on Hotelling's Theory: Transitory and Permanent Effects*. Proceedings, IFAC, 1989.

M. H. Miller and C. W. Upton. "A Test of the Hotelling Valuation Principle." *Journal of Political Economy*, No. 93 (1985), pp. 1-25.

#### **Forestry**

W. F. Hyde. *Timber Supply, Land Allocation, and Economic Efficiency*. Chapter 5 and Appendix B.

S. T. Dana and S. K. Fairfax. *Forest and Range Policy*.

K. N. Johnson and H. L. Scheurman. "Techniques for Prescribing Optimal Timber Harvest." *Forest Science Monograph*, No. 18 (1977).

P. Berck and T. Bible. *Solving and Interpreting*.

P. Berck. "Economics of Timber: A Renewable Resource in the Long Run." *Bell Journal of Economics*, No. 10, No. 2 (Autumn, 1979).

B. Dixon and R. Howitt. *Resource Production Under Uncertainty*.

D. Adams and R. Haynes. "1980 Softwood Timber Assessment Market Model: Structure, Projections, and Policy Simulations." *Forest Science Monograph*, No. 22 (1980).

A. G. McQuillan. "The Declining Even Flow Effect—Non-Sequitur of National Forest Planning." *Forest Science*, No. 32 (1986), pp. 960-972.

Resources and Time

Ag Econ 760  
Fall, 1988-89

Richard C. Bishop  
330 Taylor Hall  
University of Wisconsin-Madison  
Madison, WI 53706  
(608)262-8966

Course Description:

The goal of this course is to survey the economics literature on natural resource exploitation and management over time. Mathematical tools for this purpose are introduced at the outset. Applications include mineral exploitation, growth with finite resources, fisheries, forestry, groundwater, and soil. A term project will deal with an actual application to forestry in Wisconsin. Emphasis will be on improving students' technical abilities to read more broadly in the literature and on intuitive interpretation of results.

Required Text: Hartwick and Olewiler (Available in University Bookstore).  
Conrad and Clark ( " " " " " ).

Prerequisites: Consent of instructor.

<u>Grading:</u>	Final:	100 points
	Term Project:	50 points
	Class Participation:	<u>50</u> points
	Total	200 points

Schedule: 9:00-10:40 WF  
B-30 Taylor Hall  
(Bakken-Schaars Room)

## COURSE OUTLINE

- Oct. 26 - Introduction; Forestry  
 Read: Hartwick Text, Chapter 11  
 Clark, pp. 256-263  
 Optional: Clark, pp. 263-268
- Oct. 28 - Forestry (cont.)  
 Read: Chang  
 Optional: Samuelson  
 Anderson
- Nov. 2 - Introduction to Optimal Control  
 Read: Conrad Text, Chapter 1  
 Segerson
- Nov. 4 - Land  
 Read: McConnell  
 Hartwick Text - Chapters 1 and 2
- Nov. 9 - Introduction to Nonrenewable Resources  
 Read: Brobst  
 Hartwick Text, Chapter 5 and Appendix B  
 Optional: Hotelling  
 Stiglitz  
 Herfindahl
- Nov. 11 - More Complex Models of Nonrenewable Resource Extraction  
 Read: Conrad Text, Chapter 3  
 Hartwick Text, Appendix C  
 Optional: Peterson and Fisher  
 Devarajan and Fisher
- Nov. 16 - Nonrenewable Resources and Market Structure  
 Read: Hartwick Text, Chapter 4 and Appendix D  
 Clark, Section 5.2  
 Optional: Levhari and Liviatan  
 Weinstein and Zeckhauser
- Nov. 18 - Exploration; Uncertainty  
 Read: Peterson  
 Hartwick Text, Chapter 5  
 Optional: Pindyk  
 Fisher

- Nov. 23 - Nonrenewable Resources and Growth  
 Read: Hartwick Text, Chapter 6  
 Page. Chapter 7 and Appendices E & F
- Optional: Meade  
 Dasgupta and Heal  
 Solow
- Nov. 25 - Thanksgiving Recess
- Nov. 30 - Introduction to Fishery Economics  
 Read: Hartwick Text, Chapters 8 & 9
- Optional: Clark and Munro  
 Gordon  
 Anderson (This book covers a wide range of topics and provides an excellent bibliography of the voluminous literature on fisheries, many items from which would have served as good supplemental reading for this course.)
- Dec. 2 - Fishery Regulation  
 Read: Conrad Text, Chapter 2
- Optional: Wilson
- Dec. 7 - More Fisheries Management  
 Read: Hartwick Text, Chapter 10  
 Bishop, et al., 1988
- Optional: Bishop and Samples
- Dec. 9 - Groundwater  
 Read: Burt
- Dec. 14 - Uncertainty  
 Read: Conrad Text, Chapter 5

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- Anderson, Lee, G. The Economics of Fisheries Management. Revised Edition. (Baltimore: Johns Hopkins University Press, 1986).
- Bishop, Richard C. and Karl Samples. "Sport and Commercial Fishing Conflicts: A Theoretical Analysis," Journal of Environmental Economics and Management 7: 220-233 (1980).
- Bishop, Richard C., Scott R. Milliman, Kevin J. Boyle, and Barry L. Johnson. "Economic Evaluation of Fishery Rehabilitation Projects: Theoretical Principles and a Case Study." Unpublished paper, Department of Agricultural Economics, University of Wisconsin-Madison, September, 1988.
- Brobst, Donald A. "Fundamental Concepts for the Analysis of Resource Availability," in Scarcity and Growth Reconsidered, V. Ferry Smith, ed. pp. 106-142.
- Burt, O. "Temporal Allocation of Groundwater," Water Resources Research 3(1): 45-56 (First Quarter, 1976).
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- Conrad, Jon M., and Colin W. Clark. Natural Resource Economics: Notes and Problems. (Cambridge: Cambridge University Press, 1987).
- Clark, Colin W. Mathematical Bioeconomics: The Optimal Management of Renewable Resources (New York: John Wiley & sons, Inc., 1976).
- Clark, Colin W. and G. R. Munro. "Economics of Fishing and Modern Capital Theory: A Simplified Approach," J. of Environmental Economics and Management 2: 91-106 (1975).
- Dasgupta, Partha and Geoffrey Heal. "The Optimal Depletion of Exhaustible Resources," Review of Economic Studies, Symposium Issue, 1984.
- Devarajan, S. and A.C. Fisher, "Hotelling's 'Economics of Exhaustible Resources': Fifty Years Later," J. of Economic Literature 19: 65-73 (1981).
- Fisher, William L. "Can the U.S. Oil and Gas Resource Base Support Sustained Production?" Science 236: 1631-1636 (June 26, 1987).
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- Levhari, David and Nissan Liviatan. "Notes on Hotelling's Economics of Exhaustible Resources," Canadian Journal of Economics 10(2): 177-192 (May, 1977).
- McConnell, Kenneth E. "An Economic Model of Soil Conservation," American J. of Ag. Economics 65(1): 81-89 (Feb., 1983).
- Meade, J.E. "Economic Policy and the Threat of Doom," in J.A. Butlin, ed., Economics of Environmental and Natural Resources Policy (Boulder, CO: Westview Press, 1981), pp. 9-29.
- Page, Talbot. Conservation and Economic Efficiency: An Approach to Materials Policy (Baltimore: Johns Hopkins Press for Resources for the Future, 1977).
- Peterson, Frederick M., "A Model of Mining and Exploring for Exhaustible Resources," Journal of Environmental Economics and Management 5(3): 236-251 (Sept., 1978).
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- Pindyck, Robert S. "The Optimal Exploration and Production of Nonrenewable Resources," Journal of Political Economy 86(5): 841-861 (Oct., 1978).
- Samuelson, Paul A. "The Economics of Forestry in an Evolving Society," Economic Enquiry 14: 466-492 (December, 1976).
- Segerson, K. "An Introduction to Optimal Control," unpublished.
- Solow, R. "The Economics of Resources or the Resources of Economics," American Economic Review 64(2): 1-14 (May, 1974).
- Stiglitz, J.E. "A Neoclassical Analysis of the Economics of Natural Resources," in Smith, V.K. ed. Scarcity and Growth Reconsidered (Baltimore: Johns Hopkins U. Press, 1979).
- Weinstein, Milton C. and Richard J. Zeckhauser. "The Optimal Consumption of Depletable Natural Resources," Quarterly Journal of Economics 89(3): 371-392 (August, 1975).
- Wilson, James A. "The Economic Management of Multispecies Fisheries," Land Economics 58(4): 417-434 (November, 1982).



Picked up: Date \_\_\_\_\_; Time \_\_\_\_\_. Returned: Date \_\_\_\_\_; Time \_\_\_\_\_.

- I. (25 points) On p.151, Hartwick and Olewiler state that rents make a better measure of resource scarcity than mineral prices "because rents rise more rapidly than prices." Do you accept the proposition that in general rents for a mineral resource will rise faster than its prices over time? Demonstrate your answer using graphs or a mathematical model.
- II. Develop the Howarth and Norgaard model for the case where  $d = .1$ . Assume that the social welfare function involves unweighted summation of the two individual utility functions posited in that paper. Answer the following questions.
- A. (5 points) Determine the socially optimal level of consumption of resources and labor for Person 1 and Person 2 in all three periods.
- B. (5 points) Determine the optimal share of the resource to be allocated to Person 1 and Person 2 so that social optimality will be achieved.
- C. (10 points) Show that if Person 1 receives the optimal amount, she will indeed be willing to trade labor for the resource in period 2 in the amounts necessary to achieve social optimality.
- D. (5 points) Very briefly outline what you think this model should mean for policy. You need not agree with me. This part will be graded on the quality of your argument. One paragraph will be plenty.
- III. Suppose that a fishery has a cost function such that  $C(X) = c/qX$  where all terms are defined as in class. Make all the other assumptions we made in class: that  $F(X)$  has the parabolic shape and passes through the origin; that the price of fish is constant with respect to  $H$  and time; etc.
- A. (5 points) Assume that technology improves such that  $q' > q$  now serves at the "catchability" coefficient. Show what effect that would have on the open access equilibrium levels of  $X$ ,  $E$ , and  $H$ .
- B. (5 points) Continuing to assume that the technology improvements, what would be the effect on the socially efficient levels of  $X$ ,  $E$ , and  $H$ , assuming that the social rate of discount is zero.
- C. (5 points) Now assume that the social rate of discount is positive. What would be the effect of such a change in technology on  $X$ ,  $E$ , and  $H$ ? Explain why.