

# The Development of Ecological Economics

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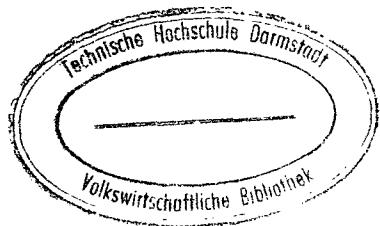
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# Contents

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<i>Acknowledgements</i>	ix
<i>Introduction by the editors</i>	xiii

## **PART I HISTORICAL ROOTS AND MOTIVATIONS**

1. Kenneth E. Boulding (1966), 'The Economics of the Coming Spaceship Earth', in Henry Jarrett (ed.), *Environmental Quality in a Growing Economy*, Baltimore MD: Resources for the Future/Johns Hopkins University Press, 3–14 3
2. Herman E. Daly (1968), 'On Economics as a Life Science', *Journal of Political Economy*, **76**, 392–406 15
3. Colin W. Clark (1973), 'The Economics of Overexploitation', *Science*, **181**, 17 August, 630–34 30
4. Juan Martinez-Alier (1987), 'Introduction', in *Ecological Economics: Energy, Environment, and Society*, Chapter 1, Cambridge MA: Blackwell, 1–19 and references 35
5. Cutler J. Cleveland (1987), 'Biophysical Economics: Historical Perspective and Current Research Trends', *Ecological Modelling*, **38**, 47–73 58
6. Paul P. Christensen (1989), 'Historical Roots for Ecological Economics – Biophysical Versus Allocative Approaches', *Ecological Economics*, **1**, 17–36 85

## **PART II BASIC ORGANIZING PRINCIPLES OF ECOLOGICAL ECONOMICS**

7. C.S. Holling (1986), 'The Resilience of Terrestrial Ecosystems: Local Surprise and Global Change', in William C. Clark and R.E. Munn (eds), *Sustainable Development of the Biosphere*, Chapter 10, Cambridge: Cambridge University Press, 292–317 107
8. John L.R. Proops (1989), 'Ecological Economics: Rationale and Problem Areas', *Ecological Economics*, **1**, 59–76 133
9. Richard B. Norgaard (1989), 'The Case for Methodological Pluralism', *Ecological Economics*, **1**, 37–57 151
10. Mick Common and Charles Perrings (1992), 'Towards an Ecological Economics of Sustainability', *Ecological Economics*, **6** (1), July, 7–34 172
11. Herman E. Daly (1992), 'Allocation, Distribution, and Scale: Towards an Economics that is Efficient, Just, and Sustainable', *Ecological Economics*, **6**, 185–93 200

12. Robert Costanza, Lisa Wainger, Carl Folke and Karl-Göran Mäler (1993), 'Modeling Complex Ecological Economic Systems: Toward an Evolutionary, Dynamic Understanding of People and Nature', *BioScience*, **43** (8), September, 545-55 209

### PART III MATERIAL AND ENERGY FLOWS IN ECOLOGICAL AND ECONOMIC SYSTEMS: THEORY AND APPLICATIONS

13. Howard T. Odum and Richard C. Pinkerton (1955), 'Time's Speed Regulator: The Optimum Efficiency for Maximum Power Output in Physical and Biological Systems', *American Scientist*, **43** (2), April, 331-43 223
14. Nicholas Georgescu-Roegen (1973), 'The Entropy Law and the Economic Problem', in H.E. Daly (ed.), *Economics, Ecology, Ethics: Essays Toward a Steady-State Economy*, Chapter 3, San Francisco: W.H. Freeman, 49-60 236
15. Bruce Hannon (1973), 'The Structure of Ecosystems', *Journal of Theoretical Biology*, **41**, 535-46 248
16. Robert U. Ayres (1978), 'Application of Physical Principles to Economics', in *Resources, Environment, and Economics: Applications of the Materials/Energy Balance Principle*, Chapter 3, New York: John Wiley & Sons, 37-71 260
17. Cutler J. Cleveland, Robert Costanza, Charles A.S. Hall and Robert Kaufmann (1984), 'Energy and the U.S. Economy: A Biophysical Perspective', *Science*, **225**, 31 August, 890-97 295
18. Charles Perrings (1986), 'Conservation of Mass and Instability in a Dynamic Economy-Environment System', *Journal of Environmental Economics and Management*, **13**, 199-211 303
19. Cutler J. Cleveland and Robert K. Kaufmann (1991), 'Forecasting Ultimate Oil Recovery and Its Rate of Production: Incorporating Economic Forces into the Models of M. King Hubbert', *The Energy Journal*, **12** (2), 17-46 316
20. David I. Stern (1993), 'Energy and Economic Growth in the USA: A Multivariate Approach', *Energy Economics*, **15** (2), April, 137-50 346
21. Matthias Ruth (1995), 'Information, Order and Knowledge in Economic and Ecological Systems: Implications for Material and Energy Use', *Ecological Economics*, **13** (2), May, 99-114 360

### PART IV ACCOUNTING FOR NATURAL CAPITAL, ECOLOGICAL LIMITS AND SUSTAINABLE SCALE

22. Peter M. Vitousek, Paul R. Ehrlich, Anne H. Ehrlich and Pamela A. Matson (1986), 'Human Appropriation of the Products of Photosynthesis', *BioScience*, **36** (6), June, 368-73 379

23. Herman E. Daly and John B. Cobb, Jr (1990), 'Misplaced Concreteness: Measuring Economic Success', in *For the Common Good: Redirecting the Economy toward Community, the Environment, and a Sustainable Future*, Chapter 3, London: Green Print, Merlin Press, 62–84 and references 385
24. Salah El Serafy (1991), 'The Environment as Capital', in Robert Costanza (ed.), *Ecological Economics: The Science and Management of Sustainability*, Chapter 12, New York: Columbia University Press, 168–75 409
25. Peter A. Victor (1991), 'Indicators of Sustainable Development: Some Lessons from Capital Theory', *Ecological Economics*, 4, 191–213 417
26. Karl-Göran Mäler (1991), 'National Accounts and Environmental Resources', *Environmental and Resource Economics*, 1 (1), 1–15 440
27. Robert Costanza and Herman E. Daly (1992), 'Natural Capital and Sustainable Development', *Conservation Biology*, 6 (1), March, 37–46 455
28. Gretchen C. Daily and Paul R. Ehrlich (1992), 'Population, Sustainability, and Earth's Carrying Capacity', *BioScience*, 42 (10), November, 761–71 465
29. Robert K. Kaufman (1995), 'The Economic Multiplier of Environmental Life Support: Can Capital Substitute for a Degraded Environment?', *Ecological Economics*, 12 (1), January, 67–79 476
30. Kenneth Arrow, Bert Bolin, Robert Costanza, Partha Dasgupta, Carl Folke, C.S. Holling, Bengt-Owe Jansson, Simon Levin, Karl-Göran Mäler, Charles Perrings and David Pimentel (1995), 'Economic Growth, Carrying Capacity, and the Environment', *Science*, 268, 28 April, 520–21 489

## PART V VALUATION OF ECOLOGICAL SERVICES

31. Robert Costanza, Stephen C. Farber and Judith Maxwell (1989), 'Valuation and Management of Wetland Ecosystems', *Ecological Economics*, 1, 335–61 493
32. Rudolf S. de Groot (1994), 'Environmental Functions and the Economic Value of Natural Ecosystems', in AnnMari Jansson, Monica Hammer, Carl Folke and Robert Costanza (eds), *Investing in Natural Capital: The Ecological Economics Approach to Sustainability*, Chapter 9, Washington DC: Island Press, 151–68 520
33. Jonas Larsson, Carl Folke and Nils Kautsky (1994), 'Ecological Limitations and Appropriation of Ecosystem Support by Shrimp Farming in Colombia', *Environmental Management*, 18 (5), 663–76 538
34. Clive L. Spash and Nick Hanley (1995), 'Preferences, Information and Biodiversity Preservation', *Ecological Economics*, 12 (3), March, 191–208 552

35. Gail Bingham, Richard Bishop, Michael Brody, Daniel Bromley, Edwin (Toby) Clark, William Cooper, Robert Costanza, Thomas Hale, Gregory Hayden, Stephen Kellert, Richard Norgaard, Bryan Norton, John Payne, Clifford Russell and Glenn Suter (1995), 'Issues in Ecosystem Valuation: Improving Information for Decision Making', *Ecological Economics*, **14**, 73–90 570

## PART VI INTEGRATED ECOLOGICAL ECONOMIC MODELLING AND ASSESSMENT

36. L.C. Braat and W.F.J. van Lierop (1987), 'Integrated Economic–Ecological Modeling', in L.C. Braat and W.F.J. van Lierop (eds), *Economic–Ecological Modeling*, Chapter 4, Amsterdam: North-Holland, 49–68, 287–300 and references 591
37. Robert Costanza, Fred H. Sklar and Mary L. White (1990), 'Modeling Coastal Landscape Dynamics: Process-Based Dynamic Spatial Ecosystem Simulation can Examine Long-Term Natural Changes and Human Impacts', *BioScience*, **40** (2), February, 91–107 630
38. Kimberly Anne Baker, M. Siobhan Fennessy and William J. Mitsch (1991), 'Designing Wetlands for Controlling Coal Mine Drainage: An Ecologic–Economic Modelling Approach', *Ecological Economics*, **3**, 1–24 647
39. Charles A.S. Hall and Myrna H.P. Hall (1993), 'The Efficiency of Land and Energy Use in Tropical Economies and Agriculture', *Agriculture, Ecosystems, and Environment*, **46**, 1–30 671
40. Faye Duchin and Glenn-Marie Lange (1994), 'Strategies for Environmentally Sound Economic Development', in AnnMari Jansson, Monica Hammer, Carl Folke and Robert Costanza (eds), *Investing in Natural Capital: The Ecological Economics Approach to Sustainability*, Chapter 15, Washington DC: Island Press, 250–65 701
41. H. Jack Ruitenbeek (1994), 'Modelling Economy–Ecology Linkages in Mangroves: Economic Evidence for Promoting Conservation in Bintuni Bay, Indonesia', *Ecological Economics*, **10** (3), 233–47 717
42. Jianguo Liu, Fred W. Cubbage and H. Ronald Pulliam (1994), 'Ecological and Economic Effects of Forest Landscape Structure and Rotation Length: Simulation Studies Using ECOLECON', *Ecological Economics*, **10** (3), 249–63 732
43. N. Bockstael, R. Costanza, I. Strand, W. Boynton, K. Bell and L. Wainger (1995), 'Ecological Economic Modeling and Valuation of Ecosystems', *Ecological Economics*, **14** (2), 143–59 747