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TOWARD AN ECOLOGICAL ECONOMICS

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ABSTRACT

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Integrating ecology and economics is increasingly important as humanity's impact on the natural world increases. Current paradigms in both fields are too narrow (and seem to be getting narrower). This paper introduces and summarizes this special issue of *Ecological Modeling* devoted to ecological economics. There are eleven papers (including this one) that cover most of the important theoretical issues involved (applied papers are left for a future volume). These issues are: (1) sustainability; (2) inter- and intra-species distribution of wealth; (3) discounting and intergenerational justice; and (4) dealing with non-monetized values, imprecision, and uncertainty. This collection is seen as a hopeful first step toward a true synthesis of ecology and economics that could lead to better management of renewable and non-renewable natural resources and a sustainable future.

NEED FOR AN ECOLOGICAL ECONOMICS

The main impetus for this special issue is the hypothesis (some would say observation) that current economic paradigms have some serious shortcomings when it comes to dealing with natural resources. The relevant word here is serious. No economic system or body of ideas to analyze and control it can be perfect. But many economists believe that the remaining imperfections need not be cause for concern. Free marketeers believe that externalities are unimportant and that the system can be improved by giving the market an even more free (but still invisible) hand. Hard-line Marxists contend that better planning and political education will solve any remaining (minor) problems.

A second impetus is the observation that ecological paradigms tend to ignore human cultural behavior as an object of direct study. Ecologists are

generally concerned with predicting the impacts of human activity *on* natural ecosystems, but not with understanding and predicting human behavior in the context of natural ecosystems.

The authors in this volume share the view that the remaining problems are *very* serious, and that fairly elaborate modifications to existing paradigms are necessary to address them. They cover a wide spectrum as to exactly what the major issues and problems are, however, and how we might go about rectifying them.

In this introduction we summarize the common threads running through the papers and put them in a larger context. We also mention a few additional topics that do not appear in any of the papers. We title this chapter: 'Toward an ecological economics' because the strongest thread linking these wide-ranging papers is the idea that a certain broadening of boundaries and perspectives needs to occur. Ultimately, we think this means that ecology and economics must be more fully integrated if either is to deal adequately with man's use of natural resources. This special issue is a hopeful step toward that synthesis.

MAJOR ISSUES, PROBLEMS, AND SOLUTIONS

Concern about natural resources has a long history in economics, but it has gotten short shrift in the 20th century as economists turned their attention to other topics. The classical economists of the 18th century were much more concerned with man's dependence on and interaction with nature than their contemporary counterparts. In this special issue of *Ecological Modelling*, CLEVELAND gives an historical account of ecological/biophysical models from the classical economists to the present. There is much here that is useful to remember and reiterate, and modern energy analysts can be seen as proposing a more technically sophisticated revival of many of these early ideas. CHRISTENSEN concentrates on the parallels and contrasts between the classical economists, modern Marxist economists and modern energy analysts.

The problems that result from ignoring man's interdependence with the natural world can be defined in many ways. The sections below summarize the major themes of the papers and provide some additional perspectives.

Sustainability: maintaining our life support system

The most obvious danger of ignoring nature in economics is that nature is the economy's life support system, and by ignoring it we may inadvertently damage it beyond repair. Several authors stress the fact that current economic systems do not inherently incorporate any concern about the sus-

tainability of our natural life support system and the economies which depend on it. PEARCE discusses the reasons for the inability of existing forms of economic organization (free market, mixed, planned) to guarantee sustainability. He then lays out what he views as the necessary conditions for a sustainable, "ecologically bounded" economy. In his view the issue of sustainability is intimately connected with the issue of justice (both within species, between species, and between present and future generations) since justice in this context ultimately implies sustainability. HUETING attempts to apply some of these principles in order to quantify their economic implications. He concludes that saving the environment is not only economically possible, but also necessary for ensuring sustainability.

Intra- and inter-species distribution of wealth

Wealth is ultimately the capacity to support life and the enjoyment thereof. Therefore it is not really fanciful to think of sharing wealth in this sense with other species or with future beings. In animal populations all members have roughly the same 'standard of living' or level of per-capita resource use. Nor does that use rate change over time. Of course there exists territoriality and dominance hierarchies, so animal populations are not totally egalitarian. But they are not divided into social classes in which some have vastly more access to resources than others. For animals, respecting carrying capacity is mainly a matter of limiting population, with per-capita resource consumption levels remaining relatively constant and uniform. Of course for humans per-capita resource use varies greatly among social classes and is not constant over time. Consequently the issue of sustainability is not simply a matter of controlling numbers (although that cannot be omitted), but also includes the issues of sufficiency and equity of distribution. Staying within carrying capacity for humans involves not only population control, but also consumption control and distribution control. None of these are 'automatically' handled by free markets, nor are they popular topics. Modern economics has little to say about justice and even less about sufficiency, as PEARCE points out. HUETING considers the implications of scenarios that give explicit priority to the environment and to long-term considerations and shows them to be both practical and necessary. In general, however, our authors only scratch the surface of these important issues.

Turning from intra- to inter-species distribution of 'wealth' or carrying capacity, it is clear that modern economics has declared that our species should get an ever increasing share. This presumption leads to problems in that it ignores the instrumental value of other species to us in maintaining life support systems, and it ignores the intrinsic value of other species. The

issue of instrumental value of other species arises frequently in these papers. Energy analysts calculate a form of intrinsic value based on the 'degree of organization' or embodied energy of things (including living things). There are practical and theoretical problems with this sort of calculation but the idea that things can have some value *independent of human perception* of that value is foreign to modern economics. To the average economist if a tree falls in the forest, it not only makes no sound, but it has no value unless there's a market in which consumers can reveal their preferences for timber. While the market can be a powerful and useful tool for allocating resources, one can think of many examples where humans have misperceived the value of natural resources (i.e. wetlands) until it was almost too late. Some notion of intrinsic value must therefore be introduced as a check on human perceptions and to allow us to study the economies of nature which do not include humans.

Discounting, intergenerational justice, and the time delay trap

Intergenerational justice is a strong motivating force in many of the papers. Its close connection to sustainability has already been noted. Often the present vs. future issue is thought to be objectively decided by discounting. But discounting at best only reflects the value of the future (all species in the future) to the presently existing members of one species, ours. The value of future life to the future beings themselves does not enter the calculation at all. GOODLAND and LEDEC, and PEARCE, examine some of the anomalies associated with discounting. It is worth emphasizing here that discounting is simply a numerical way to operationalize the value judgment that: (a) the near future is worth more than the distant future, and (b) beyond some point the worth of the future is negligible.

Most economists tend to treat discounting as rational, optimizing behavior based on people's inherent preferences for current over future consumption. However, there is evidence that discounting behavior may be symptomatic of a kind of semi-rational, suboptimizing behavior known as a 'social trap'. A social trap is any situation in which the short-run, local reinforcements guiding individual behavior are inconsistent with the long-run, global best interest of the individual and society (Platt, 1973; Cross and Guyer, 1980; Costanza, 1987). We go through life making decisions about which path to take based largely on the 'road signs', the short-run, local, reinforcements that we perceive most directly. These short-run reinforcements can include monetary incentives, social acceptance or admonishment, and physical pleasure or pain. Problems arise, however, when the road signs are inaccurate or misleading. In these cases we can be trapped into following a path that is ultimately detrimental because of our reliance on the

road signs. Discounting allows us to give too little weight to the future (or other species, other groups or classes of humans, etc.) and thus helps to set the trap. Both economists and ecologists tend to fall into the trap of assuming that individuals are optimizing and then interpreting *all* observed behavior as optimal (since it is exhibited by optimizing individuals). By this reasoning discounting the future must be optimal because humans do it and they are optimizing individuals. The psychological evidence indicates, however, that humans have problems responding to reinforcements that are not immediate (in time and space), and can be led into disastrous situations *because* they discount too much.

Discounting future value by the rate of interest also provides an extremely tight link between ecological destruction and macroeconomic policy. Any exploited species whose natural rate of population growth is less than the rate of interest is under threat of extinction, even in the absence of common property problems. It is a bit far-fetched to imagine Paul Volker and the FED worrying about the effect of U.S. interest rate policy on deforestation in the Amazon, but that is simply evidence of the unwarranted isolation of economics from ecology, because such links really do exist.

Non-monetized values and the partial quantification trap

There is a limit to what we can do with numbers, just as there is a limit to what we can do without them. Not all values can be quantified in monetary terms at the same level of precision. Comparing non-monetized values with each other and with monetized values is difficult but obviously not impossible since we do it all the time. In an age of number crunchers, however, there is a danger that the more precisely expressible values will dominate the less precisely expressible values simply because their numerical character makes them easier to fit into models. Against this 'unfair' advantage of precise numbers, however, must be balanced an 'unfair' advantage of the poorly-measurable. If something can be precisely measured it is hard to exaggerate its magnitude. It is what it is. But imprecise values can be exaggerated, and exposing the exaggeration is not always easy.

One approach is to try to quantify all values in a common metric, on the grounds that any decision trade-off between the priced and the non-priced implies some shadow price implicitly given to what was not priced. That may be true, but it is the order of causation that is crucial. The fact that *after the fact* such a decision implies some shadow price does not mean that *before the fact* we have any means of calculating that price independently in order to use it as the basis of the decision.

The only solution to the partial quantification trap is to recognize and deal with the range of imprecision inherent in any decision. This means

looking at the full range of possible outcomes, given the level of precision of our models and data, and making decisions in that context. It is seductive to try to obtain a precise, decisive, answer by using as input to precise mathematical models *only* that which we can measure precisely. But it is extremely dangerous to do so. As Albert Einstein once said; "the laws of mathematics, as far as they refer to reality, are not certain, and as far as they are certain, do not refer to reality."

Integration vs. cross fertilization

Some writers aim at full integration of economics and ecology. Others, more modestly, seek only cross fertilization by borrowing constructs from one discipline and applying them in the other. In this volume several strategies of integration are attempted. VAN DER PLOEG et al. summarize a broader range of attempts at various forms of integration and cross fertilization (what they call "stretching") that have thus far been made. VERTINSKY uses the concepts of diversity, stability and resilience from ecology to illuminate the functioning of the Japanese style of management and economic decision-making. Many ecologists have imported the economic model of input–output economics into ecology. Perhaps this particular borrowing is really the repayment of an old debt that economics owes to the life sciences, since the input–output model derives from Quesney's 'tableau economique' which was suggested to Quesney (a physician) by the analogy of the circulation of blood in the body to the circulation of income among social classes in the body politic.

Extending classical, neoclassical, and marxist analysis

The papers that do aim at a new integrative synthesis take several different starting points. GOODLAND and LEDEC, and PEARCE, attempt to expand the boundaries and concepts of neoclassical economics so as to embrace the important economic development issues of sustainability and carrying capacity, yet within an overall neoclassical framework of comparing costs and benefits at the margin.

CHRISTENSEN offers the notion that the extension of classical economics may offer greater possibilities of integrating ecology and economics than does neoclassical economics, and casts modern energy analysis as a form of classical revival. Similarly, KAUFMANN wonders if Marxist economics might not offer the best starting point for the development of integration, which he also sees as being exhibited in its early stages by modern energy analysts.

Systems ecology and energy analysis

The systems ecology approach exhibited by CLEVELAND and by NORGAARD seeks to envelop economics in an overall ecological framework: NORGAARD takes coevolution as the key concept, while CLEVELAND and other energy analysts take energy flows as the dominant integrating principle.

Both disciplines have been cross-fertilized, and indeed to a degree integrated, by borrowing from a third discipline, thermodynamics. The laws of thermodynamics set the basic conditions of usefulness of matter–energy, whether for metabolism or production, and define the way in which both economies and organisms live off the environment by "sucking low entropy from it" as Erwin Schroedinger put it, and as was seen by Frederick Soddy even earlier. Several of the papers incorporate this fundamental tenet in various forms. LAITNER looks explicitly at the implications of considering resource constraints (particularly energy) in constructing economic development strategies.

TOWARD A TRUE SYNTHESIS

To effect a true synthesis of economics and ecology is the second most important task of our generation, next to avoiding nuclear war. Without such an integration we will gradually despoil the capacity of the earth to support life. Gradual despoilation is certainly preferable to destroying it all at once in a nuclear war, but is still an unhappy prospect. The importance of the topic is more than sufficient justification for this special issue. It would be pleasant to report that the integration of economics and ecology has reached its full perfection in this volume. The truth, however, it that we are just a few steps beyond the beginning. We know this problem will increasingly attract the efforts of scientists and scholars in the future, and hope that this collection may in some way encourage and facilitate that important work.

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