



Promoting the Science of Ecology

Perspectives on Economics and Ecology

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PERSPECTIVES ON ECONOMICS AND ECOLOGY^{1,2}

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Abstract. This paper was prepared as concluding remarks presented at a symposium, "Ecological economics: building a new paradigm for sustainability," organized by R. Costanza and R. V. O'Neill and held at the 7–11 August 1994 annual meeting of the Ecological Society of America.

Key words: ecology and economics, merger of; economic ecology; economics as part of global ecosystem; human impacts; input–output systems; pollution control and economic incentives; population control, human; scales of impact; sustainability.

INTRODUCTION

As we move toward the 21st century, the overlap and synergism between economics and ecology demands our scientific attention. But in the intellectual excitement of seeing this new field emerge, we must not lose sight of the underlying global dynamics that are driving the pending merger. Simply stated: the population bomb has not been defused. The media and ecologists have simply fatigued of repeating the obvious.

The combination of human population growth and increasing per-capita impact is placing irreconcilable demands on the global biotic system. We can reduce per-capita demands with technology and recycling. But such strategies simply delay the inevitable unless the human population asymptotes.

Of course, the population *will* reach a limit. The choice is between a series of global crises and a reasoned plan for the future. But for global sustainability to avoid becoming a cruel and unattainable fantasy, plans must include human population control and economics.

A FEW WORDS ON SCALE

One of the most compelling aspects of the environmental problem has been the rapid expansion of the scale of impact. The expanding scale has led ecologists on a merry chase. In a few decades, our emphasis has moved from populations to ecosystems, watersheds, landscapes, regions, and the globe. Today, a PhD candidate must have the word "scale" in the thesis title just to get a job.

The expanding scale has changed our view of effective action. Recycling plastic milk cartons can make the world safe for local landfills, but cannot address the fundamental issues. L. W. Barnhouse (*personal communication*) has pointed out that we can no longer regulate pollution by individual license and permit. Ef-

fective control at larger scales requires economic incentives.

The expanding scale has changed our perception of the problems. We are now concerned with nonpoint-source pollution, habitat fragmentation, global climate change, ozone depletion, loss of tropical forests, and reductions in biodiversity. To deal with problems at these scales, economics will and must become part of ecology.

A FEW WORDS TO ECONOMISTS

The first thing that economists must realize is that they will meet resistance from many ecologists. We mightily resisted the introduction of mathematical modeling for a decade or more. Botanists still pretend no one is eating the plants. Ecologists, with some notable exceptions, perpetuate the fantasy of a "natural world" where human society can be ignored. Even applied ecologists fall victim to this fantasy. Human society and its economic activity are seen as an external driver that perturbs the natural world, not as another dynamic entity within the ecosystem itself.

You can also expect resistance to general equilibrium models. We tried that. Remember that our historical perspective is very long. Pollen records show that forests turn into deserts, and global climate changes. We no longer pretend that equilibria and linear dynamics can handle the load.

Of course, equilibrium assumptions suffice over some time/space scales. The assumptions certainly facilitate dealing with a large number of interacting components. But ultimately, at the scale of global sustainability, the assumptions are blatantly false. And face it, *you* [economists] can't predict the bond market any better than *we* [ecologists] can predict ecosystem responses. So it probably will not be fruitful to insist on an inadequate modeling structure as the necessary condition for uniting ecology and economics.

Economists can also expect resistance to an overly simple application of the concept of valuation. Valuation sometimes sounds like: "Tell me the damage cost and then go away so I can plug the number into my model." You can expect ecologists to set their heels in

¹ Manuscript received 20 December 1994; revised 16 November 1995; accepted 17 November 1995.

² For reprints of this group of papers, see footnote 1 on p. 975.

reaction to such a one-sided partnership. We have tried this before, and biotic systems will not squeeze into simplistic models using dollars any better than they fit into simplistic models using calories. The biotic system is not a parameter but a complex set of interactions that must be built into the dynamic structure of the model.

The crucial message to the economist brings us back to scale: the global system is closed. At smaller scales, it suffices to abstract economics as an open system. The rest of the biotic world is external. Resources are input and wastes are output. All feedbacks are within the economic system.

But human population growth and impact force the scale upward. As the scale increases toward global questions, the system closes. Outputs now change the climate, deplete the ozone layer, and create new feedback loops. The economic system can no longer be abstracted and dynamic interactions can no longer be ignored. The economic system and the ecological system are now parts of a closed dynamic unit. This leads to fundamental changes in our paradigms, and is the key force driving the marriage of economics and ecology. The time is upon us when neither discipline in isolation can be viewed as a complete world view or a sufficient explanatory paradigm.

A FEW WORDS TO ECOLOGISTS

The phenomenon of closure at large scales is equally critical to the ecologist. Global climate change should already have driven the point home. At smaller scales, we do not model the hurricane, we consider it an external perturbation. At the global scale, ocean, atmosphere, and biota interact and feedback cannot be externalized.

So the ecologist should be well prepared for the observation that the economic system can no longer be viewed as an external driver. Solving problems of ozone depletion, acid precipitation, and tropical deforestation requires a marriage of ecological and economic insights. Ecologists may resist the incursion, but be warned. Your students are going to start asking questions about sectors and international trade and van Thunen models, just like they started asking questions about models and scale a few years ago.

Human population growth continues and, therefore, the scale of ecological problems is unlikely to shrink. We already know that larger scales produce closure. The momentum seems inevitable, and human society must be considered part of the ecological system. Do not expect economic ecology to go away anytime soon. This is not a fad, this is a consequence of the structure of the global system.

As economics and ecology begin to merge, interactions between the marriage partners can be expected to heat up. I mention this because ecologists often want to preach to economists. The homily usually deals with complexity and interactions and feedbacks. Now econ-

omists aren't nearly as hot-headed as ecologists are, but eventually they are going to protest.

The protest will come on two fronts. First, economists are quite familiar with complex systems dynamics. They have actively participated in the conceptual development of many of the fundamental systems methodologies that we use in ecology. We are preaching to the converted. Second, ecologists might better direct the preaching within their own discipline. Reading the table of contents of any major journal in ecology raises questions about how well ecologists themselves have learned the lessons of complexity.

But the most important message to the ecologist comes from our own basic concept of dominance. You cannot get through a basic course in ecology without learning that a single species often dominates a community or ecosystem. The dominant tree forms a closed canopy and constrains the growth of other species by controlling light availability. In such cases, you simply cannot understand the dynamics of the system unless you understand the dynamics of the dominant species.

Simply stated: *Homo sapiens* is a dominant. The proposition is true at most scales, but is undeniable when you consider the globe. As with any ecological system, you cannot understand system dynamics unless you understand the dynamics of the dominant. And economics captures one important dynamics of this dominant. Therefore, at the global scale, we are once again driven to the merger of economics and ecology.

A FEW WORDS TO ECONOMIC ECOLOGISTS

To the pioneering economic ecologist falls the lot of referee or, better, marriage counselor. The most important chore will be maintaining equality. Economic ecology must develop as an interdisciplinary field. We must not allow either side to swallow the other. Both have unique insights vital to the union. Neither reduces to the other's world view and neither should be mutilated so that it fits within the other's paradigm. Economic ecology is truly a new intellectual challenge.

We should remain optimistic in our prognosis about the union. Language barriers aside, both fields deal with similar subject matter, i.e., interactions in a complex system. They also share a common rubric in modeling. They have both gone through the same discussion of parameterization and validation. On a number of occasions they have simultaneously announced the discovery of the same wheel. Given their common cultural background, there will be much to fall back on when things get tough.

We must remain diligent as the merger develops. In particular, we should not allow economic ecology to become an esoteric discipline at the margins of the parent sciences. As a separate entity, it may develop its own agenda, talk only to itself at its own meetings and in its own journals. Such offshoots tend to be ignored within the mainstream of the science.

We can all applaud the pioneering labors of Robert

Costanza, Herman Daly, and colleagues to get the ball rolling. But as momentum increases, we should try to steer back toward the parent sciences. The merger is far too important to the fundamental paradigms of both ecology and economics to allow for long-term isolation.

We should be delighted that the Ecological Society of America has sponsored this symposium. Hopefully, economic ecology will be welcomed and encouraged in future meetings of both parent sciences. Eventually, traditional journals may find it relevant to include interdisciplinary papers as part of their mission to communicate.

At a fundamental level, the interdisciplinary merger of economics and ecology is essential as human activities take on a global dimension. Progress can only occur if ecologists and economists both begin to adopt an interdisciplinary paradigm. Allowing economic ecology to develop in isolation may become a dangerous procrastination.

A FEW WORDS IN CLOSING

We are moving toward a common goal of global sustainability. At a fundamental level, we seek a theory of the stable dynamics of local, regional, national and global systems—systems composed of a complex environment *and* the human society operating in that environment. To achieve the goal, we must stop the artificial abstraction of two isolated systems. As the impacts force us to move to larger scales, closure occurs and the separate disciplines must merge.

It is difficult to guess whether the merger will be harder on economists or ecologists. But I am sure that ecologists will chafe when they learn that they must give up their favorite fiction: the “natural” world. The “natural” world, isolated from large-scale human impacts, exists only in our imaginations. We have already altered the atmosphere, exterminated or shuffled species, and broken migration routes so nowhere on the planet is truly natural.

It remains critical to set aside and conserve areas that are relatively buffered from small-scale human impacts. We must preserve our options for controlled experiments. But we must accept that we can only control some human impacts, largely at a local scale. *Homo sapiens* is the dominant and its dynamics are an integral part of every ecosystem we study.

To end where I began, any consideration of global sustainability contains the same major assumption: human population growth will be controlled. Focusing on how each of us can have less impact is simply procrastination. As economists and ecologists we must continue to raise this issue. Otherwise, economic ecology is just another chess game, another intellectual pacifier to while away the time, waiting for the famine or the Second Coming, whichever arrives first.

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