15. The unfinished journey of ecological economics: toward an ethic of ecological citizenship

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> 'Use' as our primary relationship with the planet must be abandoned . . . Intimacy with . . . its wonder and the full depth of its meaning is what enables an integral human relationship with the planet to function. It is the only possibility for humans to attain their true flourishing while honoring the other modes of earthly being. The fulfillment of the Earth community is to be caught up in the grandeur of existence itself and in admiration of those mysterious powers whence all this has emerged.
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> Berry (2000, p. xi)

15.1 INTRODUCTION

The fundamental insight of ecological economics is to insist that the human economy must be seen as embedded in the Earth's biophysical systems. An essential property of those systems is that they are open to energy from the sun, but closed to matter – that for all practical purposes nothing ever leaves or arrives on the Earth. This perspective dates from the work of economists Kenneth Boulding in the 1960s and Nicholas Georgescu-Roegen in the 1970s and has been developed in the work of Herman Daly whose life and work we celebrate here. Further advances have been secured by Robert Costanza and many others educated in physics, biology and ecology.[1] This profound paradigm shift is still relatively new. It is determinedly unrecognized by mainstream economists who simply do not know what to do about a finite world. Indeed, in many contexts, mainstream economics has been able to mount a counter attack under the rubric of 'environmental economics' – a phrasing that may seem to be synonymous with ecological economics.[2] The epistemic shift propounded by ecological economics is founded in our understanding of the relationship between the human economy and its host planet. It is of fundamental importance in securing the future of life's long sojourn on Earth. To those who have pioneered this field, all Earth-bound living beings now, and in the future, owe a debt of gratitude.

Yet, the paradigm is incomplete in important ways, and thus the task of reaching a new worldview remains to be completed. There are two main limitations of the current theory that I discuss here – but the larger task ahead is to formulate the foundations of an ecological political economy. First, ecological economists insist that the economy be seen as embedded in the biosphere, but retain, for the most part, the valuing system of the economic paradigm they seek to overturn. At this time the field contains a variety of points of view about its ethical foundations. In the main these are very similar to the neoclassical point of view they seek to escape, but there are those who wish to emphasize respect for nature. This lack of consensus makes it difficult for ecological economists to escape from other assumptions of that worldview they seek to overturn. Second, this also has the effect of retarding the development of new terms of discourse – the vocabulary we have to discuss ideas like money, cost, efficiency and the like. These two factors account, in part, for the 'tar baby effect'[3] that afflicts this discipline at the stage of its maturation it remains attached to the thing it is trying to escape. It will get free and 'into the briar patch' – to continue the metaphor – only when it develops an embedded ethics, and terms of discourse derived from that ethical system. By an 'embedded ethics' I mean an ethics that is fully informed and shaped by, but not reduced to, the findings of contemporary science. Since ecological economics has insisted on seeing the economy in the context of thermodynamics it is especially germane to trace some of the implications of these laws for ethics. This, of course, only begins the vast task of constructing a scientifically informed ethics – a task well beyond the scope of this chapter, but essential for enabling a human presence on a flourishing Earth.

Accordingly, in this brief chapter my aim is four fold. First, it is to show how the journey of ecological economics remains unfinished; second, to suggest some of the characteristics of an embedded ethics; and third, to describe some of the effects of this repositioning on the ways we discuss what is at stake. Lastly, I briefly discuss the idea of an ecological political economy as an essential element in completing the journey.

15.2 THE UNFINISHED JOURNEY FROM ONE WORLDVIEW TO ANOTHER

For the last 150 years Western culture has been in the throes of a great dispute about the nature of the world and our place in it. On the one hand, there is the Thomistic-Enlightenment Synthesis (TES), which includes

Deism and Newtonian mechanics. On the other hand, there is the Scientific Evolutionary Paradigm (SEP) emphasizing thermodynamics, evolution and emergence; beginning in the early part of the nineteenth century with the fields of geology and thermodynamics. Darwin's *On the Origins of Species* published in 1859 (Darwin, 1859) is, of course, a centerpiece of this worldview.

15.2.1 A God and Human Centered Worldview

The TES synthesis was masterfully constructed in the thirteenth century of Thomas Aquinas out of the Old and New Testaments, and the works of Aristotle rediscovered in the West after being kept and studied by Muslim scholars. Essential elements of this amalgamated paradigm are at least three fold. First, there is the idea of Creator God who gives form to an initial chaos and who subsequently stands largely apart from it, but at the same time is nevertheless able to intervene in history, at least in most versions of this worldview. God is thus both immanent and transcendent. Second, another crucial element is the idea of human superiority – humanity is seen as created in the image of God and standing above and apart from nature. In the Old Testament narrative nature itself is degraded from its perfect state due to the fall of man. Third, there are thus fundamental dualisms built into this narrative from the beginning: God apart from both humanity and nature; and mankind apart from the rest of nature. These separations are less prominent in certain strands of Judeo-Christian theology than others. Aquinas also harvests a dualistic feature from Aristotle who emphasized that man was the uniquely rational animal.

The scientific revolution undertaken by Copernicus (1473–1545), Galileo (1564–1642), Kepler (1571–1630) and Newton (1642–1727) kept much of the basic underlying structures of this paradigm, but undertook to explain the world in material terms with God relegated to the role of initiator of the process. In this conception God is often referred to as a clock maker – who starts the universe on its way, but does not intervene thereafter, and could not, given the lawful nature of the universe described by scientists like Isaac Newton. In this era a major purpose of scientific discovery was understood to be the power over and control of nature; as contrasted to Aristotle's goal of understanding. And a core method of science within this understanding is analytical: the aim is to conceptually, and where possible literally, break things down into parts to better understand them. Its epistemological atomism thus precedes scientific atomism of the nineteenth century. It is within this conceptual womb that contemporary economics was nurtured and given birth in the work of Adam Smith, particularly in *The Wealth of Nations* published in 1776

(Smith, 1776). Smith took over the Deist assumptions of the paradigm and argued that economics was the study of the lawful behavior pre-ordained by the clockwork God. To attempt to interfere with the natural operations of the market was to interfere with God's plan – and hence could not avoid making things worse.

Now what is truly astonishing in the whole matter is that neoclassical economics of the twentieth and twenty-first centuries has not rejected or even examined its eighteenth-century assumptions. As Robert Nadeau has pointed out, 'the creators of neo-classical economics disguised the scientific and metaphysical foundations of Smith's natural laws of economics under a guise of mathematical formalism borrowed wholesale from the equations of a badly conceived and soon to be outmoded mid-nineteenth century physical theory' (Nadeau, 2006, p. 100). The scientific study of evolution, quantum physics, complexity theory, ecology and its relation to far from equilibrium thermodynamics were and are simply ignored, or given marginal attention at the very best. Economists have forgotten their roots and ignored or misunderstood scientific developments of the nineteenth and twentieth centuries and so have not questioned this dimension of their basic theories.

15.2.2 An Evolution Centered Worldview

While it grew out of the TES the evolutionary paradigm (SEP) takes strong exception to two of its dimensions: (1) the view that the world was created at a particular time in a final form and (2) the dualisms that sets humanity (and God) apart from nature. With regard to the first, the current consensus within this view is that the current universe began some 13.8 billion years ago in what is called the 'big bang.' (What, if anything, existed before then is unknown.) Since the beginning of the current universe there has been a long process of evolution characterized by emergent entities and processes (Chaisson, 2006). An emergent entity or system has characteristics where the whole has properties beyond those of the parts that make it up. A molecule of water has physical and chemical properties that the hydrogen or oxygen atoms that make it up do not possess, nor even suggest might occur. Living beings like butterflies have properties that neither the atoms nor the molecules that make them up have. The upshot is that the whole may be surprisingly different than its parts suggest.

Second, the idea of emergence helps to explain the phenomena that the idea of dualism tries to characterize. At the same time it helps to reframe the issue in more informative terms. Butterflies are different than the molecules that make them up – but they are not completely different. Humans have a much more complex form of consciousness than butterflies – so we are different, but not wholly different. Human consciousness is not a special creation of the universe, but rather, though emergent from it, nevertheless embedded in it. Our evolutionary heritage is inscribed in our flesh, bone, brain and mind. We are not only in the world, but of the world (Lakoff and Johnson, 1999).

In the first half of the twentieth century it was unclear how the fundamental theory of biology – evolution – was compatible with the second law of thermodynamics – a fundamental descriptor of the universe. This law holds that all things tend toward simplicity, chaos or lack of complex structure; while the theory of evolution is an account of life's growing diversification and complexity. At least two ideas from thermodynamics are essential to reconciling these two apparently diverse perspectives. The first is to distinguish between isolated, closed and open energy systems. Isolated systems exchange neither energy nor matter, closed systems receive energy but not matter, and open systems receive both. The universe is isolated, and as a whole is characterized by increases in entropy overall.

But within the universe there are systems closed to matter, but which receive energy from the outside. The Earth is one of these. Living things, like human beings and snakes, are open to both matter and energy since they, to use Schrodinger's famous phrase, 'suck orderliness' from their surroundings. People take in new energy and matter in the form of things such as sandwiches and milkshakes. They allow us to maintain our bodies in what is called 'a far from equilibrium condition' characterized by body temperatures of around 37 degrees centigrade, which is generally higher than the background temperature of the ambient environment. The idea of using external energy to create complexity explains macroscopically how far from equilibrium conditions can be maintained. But how are sandwiches and milkshakes possible? In answering this question the role of plants is crucial.

Photosynthesizing organisms, for instance, green plants, take in certain highly selected wavelengths of light. Plants use light in several ways. Some of the light is absorbed into the plant and surrounding air and degrades to heat. The heat evaporates water from the leaves and helps to draw more water up from the ground through the roots and stems of the tree to the leaves. However, certain wavelengths of light are used by the photosynthetic apparatus in the leaves of the plant, to break one oxygen atom from water so that the remainder can interact with carbon dioxide from the atmosphere. Through a process that is complex in itself, the water and carbon dioxide combine to form simple sugars retained by the plant, and oxygen is released into the atmosphere. While the energy stored in the new sugar molecule is less than the photic and heat energy that went into its making, the sugar molecule can be utilized and stored in many ways, and forms the basic energy source for much of the rest of metabolism on Earth. Some forms of the stored energy are so stable that they can become fossilized and stored below ground as coal, oil and natural gas, for millions of years. By using this transient light energy a more stable energy is created that can easily be said to retard the sometimes slow, sometimes fast, process of increasing disorder. The whole of biology depends on slowing the tumble toward disorder. The energy stored is always less than the energy input, but the transformation has permitted the abundant flourishing of life on Earth and the development of all its marvelous complexity at scales from sub-cellular organelles to the functioning of the ecosphere. The slowing of disorder through the capture of energy by the process of photosynthesis and its subsequent storage and utilization by complex life systems is one part of the very definition of life.[4]

But how are far from equilibrium conditions possible to begin with? Why isn't everything like everything else? Why do complex systems like you and me exist? The universe is characterized by profound differences in temperature – and in accordance with the second law of thermodynamics it is 'trying' to reach thermal equilibrium. It seeks ways to be as cool as it can be (Schneider and Sagan, 2005). To do this it needs mechanisms to reduce temperature gradients – to get rid of heat. Here the idea of 'dissipative structures' plays a key role, an idea coined by Prigogine (Schneider and Sagan, 2005, p. 81). When we boil water on a stove, as the water reaches the boiling point little bubbles form. As it passes the boiling point, these bubbles become larger as it reaches what we call a rolling boil. These bubbles are dissipative structures – ways to get cool. Macro equalizing processes on Earth are wind and ocean currents – attempts to cool, respectively. the air and ocean water, which are hotter at the equator than at the poles because of the angle at which the sun's rays strike the Earth. Another earthly heat dissipater is life itself. Life on Earth, including plant life, takes in high grade energy from photosynthesis and degrades it, resulting in a net cooling. Complex ecosystems are efficient heat dissipaters, which, if left unperturbed, do the 'best they can under the circumstances' to degrade the exogenous radiant energy they receive from the sun (Schneider and Kay, 1995). Both cosmic and biological evolution are macro dissipative processes. However, complex ecosystems retard the dissipation of some energy by storing it in complex carbon compounds for longer or shorter durations, though overall they accelerate energy dissipation.

As noted above, mainstream economics remains isolated not only from the implications of thermodynamics, but also from the idea of evolution, complex systems theory and the science of ecology to name just a few. It is a conceptual framework with no systematic integration of biological and physical processes that govern the planet and is thus at odds with the science of the last 200 plus years. With the vast expansion of the human population and even far vaster expansion of economic output the world's macroeconomic system endeavors to rule the world without even trying to understand it. The sciences may offer interesting analogies or metaphors for thinking about economic processes, but this is not the point I am making here. I am arguing that the economic system and finance must be understood as a fully integrated part of the Earth's biophysical systems. Until we ground macroeconomics and finance in science and an Earth-respecting ethics we can only expect increasing carnage and mayhem.

15.2.3 The Location of Our Knowledge Systems

One way to characterize what we think we know about the world is to look at how universities have organized it. This is typically done in departments and faculties – a way of dividing up our understanding of the world that will likely prove to be a major factor in our undoing. Imagine that we took a pair of scissors and cut out the names of these units, magnetized them and put them in a jar. Then we placed two relatively powerful magnets on a table – one standing for the TES paradigm, the other for SEP. If we then shake all the magnetized slips of paper out of the jar many of the bits will be drawn to the SEP – generally the sciences with other fields such as psychology falling – at least provisionally – somewhere in the middle, though edging toward SEP as it becomes more and more informed and shaped by neuroscience. But some of the slips will head straight for, and be stuck hard to, or remain in the field of, the TES magnet. These are the bits with the names neoclassical economics, finance, ethics, much of philosophy and theology, law and politics on them to name just a few.

Looked at in this way, ecological economics is an attempt to get from one paradigm to the other – to escape from the magnetic field of TES and fall into the field of the SEP. This is the main feature of the paradigm shift from a vision of the economy in standard economics textbooks as a closed, circular flow to one that is embedded in the Earth's biophysical systems, and accordingly subject to the laws of and the limitations imposed by thermodynamics and other laws as played out on this lively planet. This is a beginning of the crucial journey, but it is not its end. Ecological economics is suspended in between – pulled toward SEP by its embrace of thermodynamics and the idea of an economics embedded in the Earth, and pulled toward TES by an ethics (and theology, politics and often philosophy) that belongs to the TES.

15.3 THE ETHICS OF ECOLOGICAL ECONOMICS

In this section I will (1) show that the current ethics used by most ecological economists is firmly rooted in the TES paradigm that they seek to escape; (2) discuss a different point of departure found in the work of Aldo Leopold; and (3) illustrate some of the implications of an embedded ethics for how we think about the human place in Earth's systems and in the universe.

15.3.1 The Tar Baby Problem

Ecological economics is bonded to what it is trying to escape from. In *Ecological Economics: Principles and Applications* Herman Daly and Josh Farley state: 'Although we shrink from trying to define the ultimate end, . . . we suggest a working definition of the penultimate end for the ecological economy: the maintenance of ecological life support systems far from the edge of collapse . . . and healthy, satisfied human populations free to work together in the pursuit and clarification of a still vague ultimate end – for a long, long time' (Daly and Farley, 2003, p. 57). The principle of penultimate value continues to be use of the world in support of (sustainable) consumption, and key terms like 'natural capital' and 'ecosystem services' reveal that many of its premises are still derived from the TES framework. This language signals that ecological economics remains committed to dualism, anthropocentrism and a kind of materialism that views the world as a collection of objects to be used for human satisfaction.

Yet, the dualism is eroding. Josh Farley points out that 'one could hold that humans are one of many species, with no special rights to the low entropy generated by ecosystems. This view explicitly recognizes that humans are a part of nature, and as natural systems unravel, human survival is compromised. It can easily acknowledge that we do not understand ecosystems adequately to state authoritatively that any individual element is expendable, and therefore even for anthropocentric reasons must act as if life were sacred.'[5] From this point of view, 'ecosystem services' is simply a name we use to point out our interdependence; but it still hovers close to the idea that the world is property. To Farley, the phrase 'ecosystem services' refers to specific physical characteristics rather than values. Ecosystem services are fund-fluxes in nature. On this view the ecosystem fund is not transformed into what it produces, services are produced at a fixed rate over time, cannot be stockpiled and so on. Some fund services can be non-rival, in which case their value in terms of human use is maximized at a price of zero. They fall completely outside the transaction dimension of the market model, though it is still important to allocate resources toward their conservation and restoration. This is in distinct contrast to ecosystem goods, which are stock-flow (funds) in nature and always rival. The idea of ecosystem services is discussed in Daly and Farley (2003, pp. 103–10). But fortunately they do not take the next step of trying to assign prices to these 'services.' Nevertheless, their vocabulary on this topic is largely within the neoclassical framework.

In terms of completing its journey from one worldview to another a highly regrettable development has been the current frenzy to assign dollar values to these 'ecosystem services,' a term and way of thinking made popular and legitimated by Costanza et al. (1997).[6] The point of view enshrined in this article still lives in the disenchanted world of the Enlightenment that sees humans as distanced from the world, or better within a fantastical enchantment with the alleged vast power of humans to subordinate the world for our benefit. This is a step back toward environmental economics – a branch of neoclassical economics that tries to analyse the economy-nature relationship primarily through the ideas of 'externalities' and 'public goods.' Tragically, this framework also underpinned much of the work of the Millennium Ecosystem Assessment – an empirical tour de force in terms of understanding the current and evolving, and deteriorating, state of the Earth's life support systems. But it is also a metaphysical and theological disaster in terms of relying, without apparent recognition, on the premises of the TES worldview. (And these questionable but unstated assumptions are independent of the methodological conundrums that often plague these estimates such as 'willingness to pay,' 'existence value,' or to the fact that market valuation's 'one dollar, one vote' assigns much more weight to the values of the rich than to anyone else.) Ironically, some of the world's best ecologists embraced a way of thinking that imperils the very thing to which they have devoted their life studies, and about which many, if not most of them, care about deeply. By embracing 'ecosystem services' many ecological economists cannot get free of the tar baby of concepts from mainstream.

There are six reasons why this way of practicing ecological economics puts the world ecological systems at grave and irreversible risk. For this reason they could undercut Daly and Farley's goal of maintaining ecological life support systems. The root problem is that as in a French restaurant, we may want nature services à la carte – perhaps we don't want the whole meal. Rather than order the whole menu – table d'hôte – let's just have the soup and desert. Here are four ways our 'ordering' could help dismember natural structures. First, the value of services will depend in large part on the price assigned to it by the market. So we value bees for their pollination services of a coffee plantation and we value the copse where the bees have their hives for giving the bees a place to live. But when world coffee prices plummet and the coffee trees are cut down, then the 'services' of the copses lose their value.

Second, technical innovation may render nature's services less valuable or even irrelevant. It may be 'cheaper' in dollar terms to build a water filtration plant, thus replacing the 'services' of a forest that is protecting a reservoir than to forego the profits from clearing the forest for timber and replacing it with houses and shopping malls. Third, we can improve on what nature has to offer. For example, in the rush for bio-fuels we plant fast growth eucalyptus trees by cutting down the 'inefficient' old growth forest that is in the way. Or, as done in Lake Victoria, we improve nature by introducing the commercially more attractive Nile perch that extirpated a vast number of smaller native fish species. Fourth, nature not only offers gifts, she is also full of menaces – poisonous snakes, deadly viruses like AIDS, trees with rotten tops that kill us when we try to cut them – what foresters call 'widow makers.' The ecosystem services approach suggests that in adding up nature's services we should subtract all the bad things and see where the net value is. And once we have determined what and where bad things are, we get rid of them – if there is a net benefit to some humans, to do so (McCauley, 2006). We may value what a forest does in terms of water filtration and erosion control, but feel menaced by the fact that the woods are also homes to coyotes who control the deer population but also feed on small household pets. And it is this control that keeps the woods diverse and adaptive to begin with since too many deer often retard regrowth and diversity.

Sixth, and in summary, the idea of 'ecosystem services' flies in the face of what is perhaps the core insight of ecology – that everything is connected. The world is not severable into parts in the way this idea suggests. Put another way, ecosystem services in the neoclassical framework are not valued for the myriad, interconnected interactions that the ecosystem provides for itself so it remains in – or striving toward – a stable state far away from equilibrium. Nature – left to her own devices – is already thermodynamically efficient. Yet, in the name of economic efficiency we dismember nature's older and wiser efficiency without having any agreed on standard to judge what we should and should not do. The reason that ecological economics will fail if it does not complete its journey is that it is an economics of humans and not of the human-planet interdependent interface. The best thing that can be said about the idea of ecosystem services is that it is an interim step on the journey toward recognizing the depth of human/nature interdependence. But it is a very dangerous move for it extends the reach of what it is trying to escape.

15.3.2 Finding a Footing

Why has ecological economics failed to develop an ethics consistent with its own best intentions? Part of the answer is to be found in the disciplinary background of the people who have been its pioneers. They come from the biological and physical sciences or from economics itself. In addition, there have not been many attempts to build a bridge between the relatively new field of environmental ethics and ecological economics.

But there is also great public and professional resistance to the necessary rethinking. A fundamental issue of our era is the relationship between ethics and evolution. Yet, it is one that is seldom addressed head on[7] and is often thought to be too incendiary to tackle. It is hard to know where we should be going without recognizing where we have come from. Along with Albert Schweitzer, who wrote on ethics in the second, third and fourth decades of the twentieth century, Aldo Leopold was one of the leading figures in the first half of the twentieth century to try to systematically address this question (Leopold, 1949).[8] Both rejected the mainstream utilitarian and Kantian traditions of their upbringing; Leopold setting aside Gifford Pinchot's human centered utilitarianism; and Schweitzer the German traditions that tried to rest ethics on the idea of the rational person (Schweitzer, 1949). Since they wrote, much happened, particularly regarding Leopold's beliefs, to ratify and extend his thinking.

I propose using Leopold as the principal reference point for an adequate environmental ethic. For many years he was an employee of the US Forest Service, and was the founder of the field of wildlife management – a way of managing 'wild' populations principally for human benefit, such as hunting. Toward the end of his career he was a professor at the University of Wisconsin. While there he bought and began the restoration of a run-down farm. It was that farm that inspired what is most likely the most influential work in the English language concerning the human relationship to the rest of nature in the twentieth century: *A Sand County Almanac*, published shortly after Leopold's death in 1948 (Leopold, 1949). In that work he wrote:

> Conservation is getting nowhere because it is incompatible with our Abrahamic concept of the land. We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect. There is no other way for land to survive the impact of mechanized man, nor for us to reap from it the esthetic harvest it is capable, under science, of contributing to culture . . . That land is a community is the basic concept of ecology, but that land is to be loved and respected is an extension of ethics. That land yields a cultural harvest is a fact long known, but latterly often forgotten. These essays attempt to weld these three concepts. (Leopold, 1949, pp. viii–ix)

For Leopold the fundamental principle of ethics is summarized as follows: 'A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise'

(Leopold, 1949, p. 224). In reading the often lyrical account of Leopold's time on his farm one senses his deep respect for 'the land,' and that he laments in a most profound sense that he lives in a society that has lost touch with the fundamental reciprocity that must govern the human-Earth relationship.

Leopold's work helps illuminate an age old question: how do we go about justifying one ethic while rejecting another? What processes of reflection will allow us to assent to one view, and will fail to affirm another? A way to begin answering this question is: we should accept those ethical views that most accord with our other considered and well-grounded beliefs. This can be broken down into four parts following Daniels (1979): (1) what is the ethical principle or disposition in question? (2) how does it accord with other concepts such as our theoretical views about the nature of the universe, persons, society, evolution, God, the state, the family and the like? (3) how does it accord with our moral intuitions about fairness, duty, liberty and so on? and (4) are all these ideas taken together feasible? Can we do what they suggest? Taken together these four steps should be used reflexively – so that our beliefs reach an equilibrium where all elements are in accord. In this way it incorporates and adjusts our intuitions, but does not assign them more weight than the other elements. This is how it escapes the trap of intuitionism where each person simply insists that his or hers are authoritative.

In a mature, or rather maturing person, this is not a one-time event, but rather an open-ended process of adjustment, insight and self-expansion. The connection between ethics and science is both integral and extensive, particularly in reference to numbers 2 and 4. In a healthy, adaptive society this discourse is also a public process by which society reflects on its own values. In this process science can and should play a key role for it influences our views about matters such as the nature of the universe, the divine, the characteristics of the person, the earth. It also helps us understand what can and cannot be done; what resources there are and how long they are likely to last, what medical interventions are likely to work, how to design an airplane and ways to run our farms and economies.

Understanding how our beliefs can be justified also helps us understand how they are undermined and sometimes collapse. The unraveling of the TES narrative has been a lengthy process stretching over centuries. In the nineteenth and twentieth centuries we have seen the reconstruction of another, especially since the 1940s. It is changing the story from created to creative – the thermodynamic account of how creation happens. It undermines the idea of human dominion, and the two dualisms that separate the self from 'the environment' and the sacred from nature. For ecological economics to be part of the worldview toward which it wishes to travel a standard of respect for nature must inform both its theories and practices.

Since Leopold wrote, many scientific developments have helped put his scientific and ethical insights into larger contexts by connecting them to chemistry and physics; thus providing them with important, but not conclusive, support. Of course, Science is not the sole determinant of our ethical beliefs, but it is not irrelevant either. The significance of the developments in physics, chemistry, and molecular and evolutionary biology since the 1940s, when Leopold wrote, is that they 'fill in' much of the background needed to support, understand and operationalize Leopold's 'land ethic.' A wonderful, and to me beautiful, coherence appears on the horizon, in which our moral, scientific, political and theological views, like a geodesic (Buckminster) Fuller dome, support and strengthen each other. The ethical and policy implications of these discoveries are fundamental but nearly wholly unexplored. Therefore, we must begin afresh. A few ideas follow.

15.3.3 Toward a Value System for Ecological Economics

A new beginning will be based on understanding what we can about the origins and evolution of the cosmos, the place of the Earth in this epic, life's emergence on Earth, the biophysical functioning of the planet, and human origins, capacities and institutions. Any contemporary ethic would be incomplete without including an ethic of atonement and reconciliation for the enthusiastic carnage our 'civilization' has wrought on the natural world. Ideas of penance and the like, of course, have deep roots in the Judeo-Christian and many other religious traditions and fit well into a Leopoldian framework.

Ironically, ecological economics itself calls attention to a place to begin reconstructing our understanding of ourselves and our place in the world, though for reasons we have discussed it makes little or no use of this perspective in rethinking its value premises or many of its key ideas. The basic insight that for all practical purposes Earth is a system of systems closed to matter and open to energy has profound implications for ethics (Daly, 1996, pp. 27–30). As a way to begin, let's look at the implications of these two points – closed to matter and open to energy – in turn from the perspective of Leopold's ethic.

15.3.4 What Goes Around Stays Around

15.3.4.1 Closed to matter

Judged by mass and frequency hardly anything arrives here – small amounts of cosmic dust and an occasional meteor, and very little ever leaves – a rocket now and again. According to the first law of thermodynamics – the conservation of energy and matter – this means that whatever is done here stays here in one form or another. There is no such thing as production as orthodox economics would have us understand this idea, only transformation (Faber et al., 1996, p. 218). If we had an economics connected to the idea of the planet closed to matter, climate change would not be seen as an inconvenient truth (Gore, 2006), but as a necessary and fully foreseeable consequence of a carbon based economy. Destabilized climate is just one example of our failure to integrate economics with how the Earth works. The vast dead zones in coastal waters, fish loaded with mercury, flame retardants in the flesh of living beings, PCBs (polychlorinated biphenyls) in the breast milk of women living in the Arctic are the predictable consequences of the systems *we* have designed and promulgated globally as the 'best' way to live.

We must recognize at least three sources of these dangers to understand what we are doing. One is the societal concentration in the ecosphere of elements found in the lithosphere typically in very dilute concentrations – such as lead we use in our batteries. Another is the dispersion of such heavy metals and other toxic natural elements that persist in the ecosphere even after their primary use is terminated – such as lead in batteries; or from the release of elements as a side-effect – such as in the burning of coal containing mercury. Third, the processes of chemical engineering that lie at the foundations of industrial society also often constitute assaults on the Earth's living systems and the plants, and human and other animals that make them up. This results from introducing compounds to which life has little or no opportunity to adapt. These same three phenomena threaten human rights around the globe due to the toxic effects of these elements and compounds on human health (Pimentel et al., 2000).

From both a Leopoldian and human rights point of view we should favor those chemical and physical transformations that are respectful of ecosystems, and avoid those that impede their functioning and resilience. Building society around ideas like 'green chemistry' and certain understandings of industrial ecology are mandatory from the point of ethics of respect and reciprocity. These ideas have to include, at a minimum, careful imagination of potential side-effects, exhaustive testing and observation over appropriately long terms, continued alertness to unexpected side-effects and a willingness to say 'No' to proposed chemicals. All approvals should be tentative, preserving the option to stop production, distribution and use should this be required. An adequate value system for ecological economics has to build in from respect for Earth's life support systems, not out from human desires and satisfactions. Ecological economics must seek to be embedded in a conceptual revolution that constructs an ecological political economy.

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It is essential to distinguish between the 'operating ethics' of an economy – what actually motivates peoples' behavior – and the overall goals toward which the economy strives. For example, Keynesian economics is an attempt to design an economy that achieves social stability by dampening the business cycle, but relies on stimulating people's propensity to consume to reach this goal during economic downturns. Tragically, contemporary macroeconomics has partially lost sight of Keynes's counter cyclical goals and now seeks growth in consumption all the time. An adequate ethic for ecological economics would build on Keynes's ideas by taking social and ecological stability, or better a resilience respectful of a flourishing Earth, as its goal and design its institutions accordingly.

Keynesian economics could not be thought through without ideas like the 'liquidity trap' and 'aggregate demand.' Similarly, ecological economics needs to build a vocabulary that begins where it does – with the fundamental processes that govern Earth's life support systems. Ideas like 'public goods' and 'externalities' will likely be retained in such a system but they will not be the key conceptual points of intersection between the economy and Earth's systems. Rather, like a smaller 'Russian doll' in a set, they will be part of a nested system that begins with the characteristics of the Earth's ecosystems. A step toward designing such a system will require a rethinking of our vocabulary – a preliminary step in this direction is taken in Section 15.4 below. Once we have a new and more functional vocabulary we will need to design new institutions and policies, as Keynes did in the development of macroeconomics.

15.3.4.2 Open to energy

Open to energy is also critical in understanding and enhancing life's prospects. On Earth there is substantial negative entropy – the capacity to enhance complexity due to free energy from the sun. The sun also powers Earth's ability to process the waste generated by human activity and all other life forms. Put in its simplest form, almost all of Earth's complex life is made possible by photosynthesis' success in temporarily slowing the conversion of light energy to heat. The current levels of the human population and consumption are simply taking the natural world apart faster, and increasingly far faster, than sunlight and photosynthesis can put it back together again. Humans now appropriate a substantial percentage of the Earth's terrestrial life support budget (Haberl et al., 2008; Vitousek et al., 1986). From a Leopoldian perspective this trend is a, likely *the*, paramount injustice – the confiscation of more and more of the Earth's life support budget. This is why we must reconceptualize what it means to budget, and bring the whole ecosphere and its flourishing into consideration.

Understanding, metering and carefully regulating (by reference to physical quantities, not prices alone – which are means to alter behavior) the Earth's 'complexity-support-budget' (that is, photosynthesis and all that it supports) is more fundamental and vastly more intricate and meaningful than doing the same things for the money supply. The ecosphere budget is the fount of wealth on which all other wealth depends. An ethic that sees humans as members of the natural community rather than its masters is led in the direction of compassionate retreat from the global project of human domination of Earth (Brown and Schmidt, 2010, p. 278). As Thomas Berry has stated, 'our own special role, which we will hand on to our children, is that of managing the arduous transition from the terminal Cenozoic to the emerging Ecozoic, the period when humans will be present to the planet as participating members of the comprehensive Earth community' (Berry, 2000, pp. 7–8).

Any satisfactory value system for ecological economics will have to come to terms with issues of fairness in the use of Earth's life support budget, and the fact that by any account the human population is already much too large. These equity issues pertain to shares among living persons, between generations of people and between people of all generations and other species. In the Western tradition issues of fairness are thought of primarily, even exclusively, as matters between persons. Here again a reinvention of our vocabulary is essential to think through these issues. Current macroeconomics has a vocabulary for thinking about the money supply in support of growth, such as M1 and M2. Ecological economics urgently needs to develop a vocabulary that systematically connects economic management to a fair and flourishing Earth.

But we can go beyond these initial insights stimulated by understanding the Earth as both a closed and open system. Overall, there should be an isomorphism between ethics and a holistic science of nature. This is only the very simple point that responsible community membership requires knowing the characteristics of the community in which you are a member; for instance, being Amish requires knowing the rules and expectations of their community. We need an ethics that reflects the evolutionary paradigm with regard to the characteristics of the complex system in which we live. As Robert Costanza has noted, some of these characteristics include at a minimum: (a) path dependence; (b) recognition of multiple equilibria – there is no one best way; (c) optima are seldom achieved and are always unstable; and (d) lock-in – which Costanza characterizes as 'path dependence, multiple equilibria and sub-optimal efficiency [must] be the rule rather than the exception in economic and ecological systems' (Costanza et al., 1993, p. 550).

Here are some of the ways ethics and complex systems theory relate to each other. Path dependence suggests that any ethical framework will have to take into account how the present situation came to be; for example, history matters. What makes sense for the forest of the future is heavily influenced by the soil conditions laid down by the forest of the past. What we can and should do will be substantially influenced by antecedent conditions. Historical trajectories produce complex interdependent systems at scales from the sub-cellular to the ecosphere. The capitalist system that dominates in the Anglophile countries has rewarded and hence reinforced behaviors that have contributed to the rapid decline in life's prospects. Yet, this is a fact with which we must work at this point as we try to set a new, more responsible course. The idea of multiple equilibria suggests that there is no one best state of affairs toward which to aspire; but multiple ways of flourishing that are themselves path dependent. It is akin to the idea of tolerance in political liberalism, which suggests that there are multiple ways of understanding and living 'the good life.' But, also akin to political liberalism, there are boundary conditions such as an 'equal liberty for all' – as John Rawls put it (Rawls, 1999). We should seek individual and ecosystem flourishing that supports and enhances the flourishing of others. The erosion from a clear cut on my property can impede the flourishing of my neighbor's woodlot. But this is an inter-human example; we must now purposefully extend the principle of care for the flourishing of others to all of nature with all its interdependent participants, including humans. The concept of rare and fragile optima should help us understand that any optimization project, such as gross national product (GNP) maximization, will bring ruin in a world of complex interdependent systems. Lastly, lock-in should help us recognize that the road not taken is often the road that cannot be retaken. If we take a wrong turn in traffic we can usually retrace our steps and come out where we intended. But this is typically not the case in complex biophysical systems. Once the top predator from an ecosystem is eliminated, the system will head off in a new direction even if that predator is restored. The massive soil erosion following tropical storms in the Philippines strips the land of its fertility, and the resulting silt destroys the inshore fishery in ways that are not restorable in historic time.

15.4 RETHINKING HOW WE THINK

If ecological economics is to complete or at least approach the shore toward which it so boldly set sail in the second half of the twentieth century it will require new terms of discourse that reconsider and reposition ideas like 'ecosystem services' and 'natural capital.' In an embedded ethic some common economic terms take on new meaning that reflects how the economy relates to the biosphere. This is what I call a 'whole earth economy' (Brown and Garver, 2009). Here are some of the core ideas.

15.4.1 Wealth

Wealth, which we now tend to think of in terms of money and what it can buy, takes on a fundamental new sense. Wealth in a whole earth economy is not monetary wealth. Low entropy stocks are wealth; and flows are income. Photosynthesis is a flow while biomass and stored carbon are stocks created from that flow. Fundamentally, fairness is the share of photosynthesis rightly available to each species (or individual), a share of the Earth's life and what supports it and keeps it going. Thus, for humans as community members in Leopold's sense, wealth can only be conceived and held as a trust.

15.4.2 Budgets

Normally, a budget refers to a flow of money – it is a record and often a projection of income and expenses. In a whole earth economy, the primary income is sunlight. Spending is a matter of using up life and other matter and energy. It's important to remember that the Earth's capacity to support life, in part made possible by life itself, is limited but not fixed. We need to develop indicators for measuring the health of the Earth and its living systems. Photosynthesis is the primary agent of transformation in support of life, and the primary limiting factors on it are: (1) the ability to capture sunlight that is used to create the food that plants and animals (for example, humans) consume, and to absorb or process the wastes we throw back into the environment and (2) toxins, which, if allowed to build up in the ecosystem, will affect the ability of plants to survive and perform photosynthesis; and/or the destruction of the land that allows plants and animals to live. Over the course of life's earthly evolution, some 3.8 billion years, the budget of complexity-creating capacity has, for the most part, been in surplus. That means that life has been able to create more apples, more wildebeests or more sardines than are needed for a species to survive; the surplus is available for feeding other life forms and for evolutionary change. There are substantial deficits from time to time, however, such as the mass extinctions we humans are now causing.

15.4.3 Absolute Advantage

Absolute advantage in a whole earth economy is a country's or region's ability to transform and consume material and energy with the lowest draw on the Earth's capacity to create and maintain complexity (the complexity budget). That would mean that a country that produces goods to sell on the global market at the lowest cost to life's budgets, not the lowest cost in terms of money, would become the one with lowest absolute cost. Countries could pursue comparative advantage, producing for trade the goods with the lowest draw relative to other goods they produce. For example, Brazil might be able to produce both aluminum and timber with a lower draw on Earth's reproductive capacity than Canada, but if it can produce timber with a much lower draw and aluminum with only a slightly lower draw, then by trading timber for aluminum, the total draw could be reduced.

15.4.4 Cost

In a whole earth economy, the cost of something is how much of the integrity, resilience and beauty of Earth's life support systems must be exchanged to get it. The idea of costs and prices reflects the full cost to life, as grossly measured by the use of Net Photosynthetic Productivity (NPP), or other such measures of Earth's life support capacities. The gross measure must be further refined to reflect enormous geographic variation in NPP and the robustness or fragility of ecosystems in specific places.

15.4.5 The Relativity of 'Opportunity Cost'

From the neoclassical point of view if we do not cut a forest that we own there are opportunity costs in foregone income and consumption. But from the point of view of ecological citizenship this can be a benefit because the citizen looks at the effect on life's abundance. In complete contrast to the neoclassical viewpoint, to cut the forest is to forego something, not to gain it. The meaning of opportunity cost is relative to the conception of the self who is making the choice. The self can be understood narrowly in terms of interests, or broadly in terms of identification with the widening community or ecosystem, up to and including the commonwealth of all life. And the universe itself.

15.4.6 (Re)Distribution

Claims on shares of Earth's budget(s) in a whole earth economy are not limited to persons, but can be made by and on behalf of life generally. Distributive justice in terms of distributing stocks and flows (wealth and income) concerns shares of the capacity to build, sustain and enhance the entire commonwealth of life. Fair distribution in our time is often a question of limiting people's or species' ability to take for themselves more of Earth's complexity and assimilation capacity than they deserve.

15.4.7 Money

In a whole earth economy, money, and its many surrogates like credit, is a socially sanctioned right to intervene, now or in the future, in the Earth's life support complexity budget – in essence, a license to exert an influence on the local or global ecology. It may count as a cost because it uses up complexity or produces wastes and toxins. It may count as investment by acting to maintain or build up the complexity producing capacity of the ecosystem. Inequalities in income and wealth give people different power over the Earth's complexity.

15.4.8 Production/Transformation

Production and transformation normally describe processes of manufacturing or growing something that is useful. In a whole earth economy, there is no actual production of matter, only transformation. All transformations are net entropic – which means that they convert useful energy to dissipated heat and increase the disorder, or loss of complexity. The concept of 'goods' is a partial illusion. All consumption causes a net increase in entropy and decrease in usefulness to humans, though some high entropy wastes may still be rich resources for other parts of the ecosystem.

15.4.9 Resources

What we know as natural resources all have a role in natural systems that human use alters. For example, logging a tree removes habitat and changes ecosystem function; mining metals or tar sands uses up energy and contaminates the environment with substances previously held safely at some depth beneath the Earth's surface. Humanity is a product of evolution and cosmological processes but not their goal, and hence does not have any special privilege with respect to any aspect of the natural system, living or non-living. The Earth and all life on it should be looked at as the commonwealth of life – as the result of biological and cosmic evolution.

15.4.10 Waste

From the point of view of a whole earth economy, industrial processes have to be analysed with a view to their effects on the whole commonwealth of life. Every time something is made there is a waste stream, and the energy used in the process always declines in its ability to do work. Thus, industrial processes and waste must be reconceptualized because there is no production as normally understood; only transformation. The key to applying this principle is to think of costs in terms of elimination of self-organizational capacity or the interference with recovery – as with toxins that impede life's resilience. The final waste is heat at too low an energy level to do any more work, to maintain self-organizational capacity.

15.5 SOME STEPS TOWARD AN ECOLOGICAL POLITICAL ECONOMY

To bring these ideas of an ethic for ecological economics and its terms of discourse into a broader context we must begin the construction of an ecological political economy. In my view there are six questions that are essential to answer in furthering the journey begun by Herman Daly and the other pioneers of the twentieth century. Beginning with a scientific understanding of the world we need to rethink:

1. Who we are.
2. What we know about what we know, and what we do not know.
3. What we should do.
4. What we should measure.
5. An economics for the anthropocene; and a politics informed by an Earth systems point of view.
6. The place of religion and spirituality in light of our answers to these questions.

Though many will fear that the SEP is a threat to religion this need not be so. What this perspective tells us is that we are in the presence of, and also are a part of, a vast evolving, learning system (of which consciousness is one manifestation) that is far older and more powerful than we are. It has a scale, a beauty and a glory that cannot be fully grasped. Wisdom is to be found in respect and reverence for all that is. And achieving a state of self-transcendence, however temporary, allows us to return to a question nearly forgotten in our frantic and tragic age: what is civilization for? Here is my tentative answer: civilization is for the cultivation and elevation of the mind and spirit of the human animal who lives respectfully on the Earth with reverence for life and the sources of its being. 'Citizenship' should be understood as the dimension of human self-conception that takes the long view. Ecological citizenship is to recognize our role as co-celebrants in the evolution of life and the world in an entropic universe.

To me, this is the challenge and gift that my dear friend Herman has set before me and us.

NOTES

1. I have worked on the ethical dimension of such a shift in some of my earlier works (Brown, 2007; Brown and Garver, 2009), and I am indebted to my colleagues and co-authors for many of the ideas herein.
2. I am indebted to Brendan Mackey for reminding me of this point.
3. The *Brer Rabbit Story* is a tale of a rabbit who gets stuck to a scarecrow made of tar and covered with straw. When Brer Fox captures the trapped rabbit, the rabbit begs the fox not to throw him into the 'briar patch' where he would be safe. Finally, not understanding the ruse, the fox frees the rabbit by throwing him into the briars.
4. I am indebted to Paul Heltne for assistance in drafting this paragraph.
5. Personal correspondence.
6. A thorough discussion of the case for 'ecosystem services' is contained in Ruhl et al. (2007). It documents how, in the United States, law, policy and social norms all fail to protect natural systems. Regrettably, the overall framework of this book remains neoclassical.
7. Wilson (1975) is an exception to this, though it is unfortunately very reductionist.
8. Parts of my discussion of Leopold draw on Brown (2009).

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