Terms and concepts in ecological economics

by John M. Gowdy

Abst meaning of sustainability is the subject of intense debate among economists. e dominant school of economics in the United States, neoclassical economics, quates human welfare with the level of consumption of market goods and sees the natural world merely as an input into the economic process. To neoclassical economists, sustainability means sustaining economic output. Ecological economists take a broader view of sustainability by recognizing that essential features of the earth's life-supporting systems also must be sustained. The sustainability debate currently focuses on the ability of the economy to substitute human-created infrastructure for the services of the environment. The neoclassical concept is called "weak" sustainability, and the ecological economics concept is called "strong" sustainability. The motivation for weak sustainability is preserving an economy's capital stock, which produces economic output. Capital stock consists of human-made or "manufactured capital," the services of the environment or "natural capital," and the level of technology and training or "human capital." Weak sustainability assumes that these kinds of capital are substitutable for one another. The motivation for strong sustainability is recognizing that substitution possibilities among these different kinds of capital are limited. This paper discusses some of the terms and concepts behind the sustainability debate between neoclassical and ecological economics.

Key Words ecological economics, environmental valuation, neoclassical economics, strong sustainability, weak sustainability

ike it or not, decisions about wildlife management are dominated by economic considerations. Every corner of the world is coming under the influence of the market economy. The dominance of markets in our daily lives has given a position of privilege to economists, whose job it is to understand how markets work. Economics occupies a dominant position within the social sciences. It is a field with a cohesive, well-developed reigning paradigm (neoclassical economics) and a rigorous methodology with which to approach a variety of practical and theoretical problems. Its influence on public policy discourse is virtually unchallenged by any other discipline. Economists dominate local, national, and international bodies. Economics has earned its designation as the Queen of the Social Sciences.

But despite its acknowledged successes, the core beliefs of the economics profession are being challenged as never before. As recently as the 1960s, Paul Samuelson could claim with only a little exaggeration that anyone who did not subscribe to neoclassical economics was either a communist or a fascist. Today, a growing chorus of critics label mainstream economics as irrelevant, misleading, and out of touch with reality (Blaug 1998). The problems facing contemporary economics have been succinctly scrutinized by E. O. Wilson in his recent book *Consilience*:

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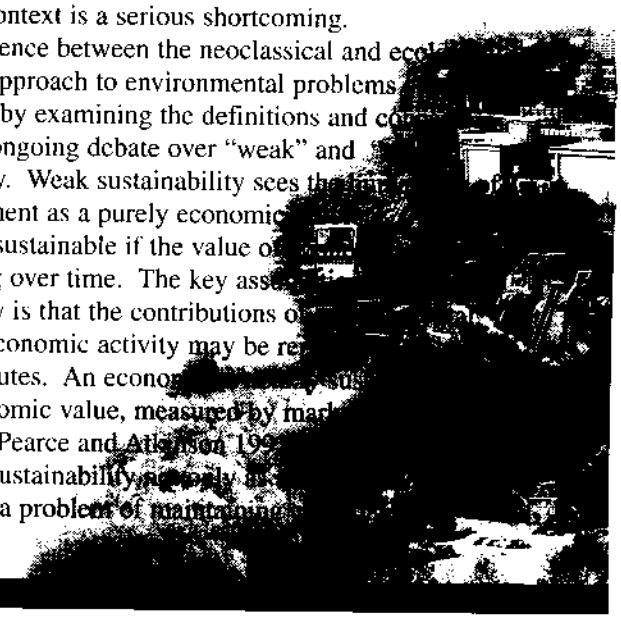
"[The weaknesses of economics] can be summarized in two labels: Newtonian and hermetic. Newtonian, because economic theorists aspire to find simple, general laws that cover all possible economic arrangements. Universality is a logical and worthy goal, except that the innate traits of human behavior ensure that only a minute set of such arrangements is probable or even possible. Just as the fundamental laws of physics cannot be used alone to build an airplane, the general constructions of equilibrium theory cannot be used alone to visualize an optimal or even stable economic order. The models also fall short because they are hermetic–that is, sealed off from the complexities of human behavior and the constraints imposed by the environment. As a result, economic theorists, despite the undoubted genius of many, have enjoyed few successes in predicting the economic future, and they have suffered many embarrassing failures." (Wilson 1998:197)

Many..."embarrassing failures" have occurred in wildlife management. The focus of most economists on markets and market solutions, to the exclusion of the behavior of actual ecosystems and actual human behavior, has been at least partially responsible for a variety of wildlife policy failures, from forestry to fisheries to the protection of endangered species.

Many of these "embarrassing failures" have occurred in wildlife management. The focus of most economists on markets and market solutions, to the exclusion of the behavior of actual ecosystems and actual human behavior, has been at least partially responsible for a variety of wildlife policy failures, from forestry to fisheries to the protection of endangered species. The environmental policy recommendations of mainstream economists have truly been hermetic—that is, uninformed by the contributions of natural science to the understanding of how actual ecosystems work.

The field of ecological economics came into existence in response to the failure of mainstream economics to bridge the gap between economics and natural science. Although the field is barely 10 years old, ecological economics has made a substantial impact among biologists and within the economics profession. The editor of the prestigious American Economic Review has referred to ecological economics as one of the 2 most important growth fields in economics (the other is the related field of behavioral economics, Holden 1993). The biologist Paul Ehrlich (1997:1) has stated that "Ecological economics is arguably the single most important academic scientific discipline today. Indeed, one of the most cheering events in the last decade or so has been the increasing cooperation of ecologists and economists, and the gradual reintegration of their disciplines." The journal *Ecological Economics* ranks as one of the most widely cited in the economics profession (Hodgson and Rothman 1999). As the field matures, there is a need to reassess the basic concepts and definitions used in ecological economics in light of theoretical developments and empirical findings in related disciplines.

Ecological economics can be seen as a more general conception of economics containing neoclassical economics as a subset. Neoclassical economics is a description of market exchange. Like any good scientific model, the neoclassical model of market exchange makes as few simplifying assumptions as possible to capture the essential features of the reality it attempts to describe. The simplification of neoclassical theory is to focus almost exclusively on the efficiency with which given amounts of resources are used to produce goods and the efficiency with which these goods are distributed among consumers. It is not concerned with where market goods ultimately originate or where these goods and the by-products of their production ultimately end up after they leave the economic system. For the elucidation of many economic problems, the neoclassical model is a good representation of the most important forces at work. For other problems, however, including wildlife conservation, the model's failure to take into account environmental and social context is a serious shortcoming.



The difference between the neoclassical and ecological economics approach to environmental problems can be seen clearly by examining the definitions and concepts used in the ongoing debate over "weak" and "strong" sustainability. Weak sustainability sees the [illegible] the environment as a purely economic [illegible]. An economy is sustainable if the value of [illegible] nondeclining over time. The key assumption of weak sustainability is that the contributions of natural capital features to economic activity may be replaced or made substitutes. An economy is sustainable as long as economic value, measured by market prices, is maintained (Pearce and Atkinson 1993). Strong sustainability sees sustainability not only as a problem but also a problem of maintaining [illegible]

replaceable, and nonsubstitutable environmental features. Strong sustainability is a basic ecological economic concept that extends the realm of economics beyond the narrow confines of market exchange (Daly 1994).

Before discussing these concepts in detail, a few definitions are in order. (Other concepts will be discussed below.) Economists use the word capital to denote economic goods used to produce economic output. Essential to the sustainability debate is the distinction between 3 kinds of capital. Manufactured capital consists of human-created machines, and human capital is the education and training embodied in the labor force. Natural capital refers to nonrenewable natural resources, such as coal and oil, and renewable resources, such as ecosystem services. The term natural capital arose in the 1990s out of the recognition that some natural resources are essential to the productive process—that is, they are complements to (used together with) human-produced inputs in production (Folke 1991, Costanza and Daly 1992). Building on the work of Nicholas Georgescu-Roegen and Kenneth Boulding, Daly (1973, 1977) introduced the term steady-state economy to describe an economy with a nongrowing throughput of natural capital—that is, a steady amount of natural resources going in and waste coming out of the economic process. Daly also stressed the importance of the scale of human activity vis-a-vis the natural world. Related to scale and the steady state is the distinction between growth and development. Growth refers to the quantitative increase in economic output, whereas development refers to an increase in the quality of output without an increase in material and energy use.

Weak sustainability: from economic man to maximizing economic output

The notion of weak sustainability is one of the most controversial ideas in the sustainable development literature. It is worth considering in some detail because it highlights the essential differences between neoclassical and ecological economics. Again, an economy is weakly sustainable if the value of economic output is nondeclining. Weak sustainability is achieved if an economy saves (and invests) at least as much as the combined depreciation of its total capital stock (Pearce and Atkinson 1993). Weak sustainability assumes that manufactured capital and natural capital are substitutable and that the goal of maintaining the level of economic output is compatible with maintaining a suitable environment for the human species. If substitution between manufactured and natural capital is possible, an economy is sustainable even if the natural environment is degraded, provided it creates enough manufactured capital to compensate for the monetary value of the loss.

At the heart of contemporary economic theory is economic man (*Homo economicus*). Economic man is naturally acquisitive, has an insatiable desire for market goods, is rationally calculating, and is devoid of social and environmental context. From the definition of economic man and the assumptions of weak sustainability, it follows that the neoclassical economic meaning of sustainability is sustaining the level of economic output or Net National Product (NNP). NNP may be seen as the rate of return on total capital stock, composed of manufactured, natural, and human capital. So weak sustainability is basically a problem of managing a nation's portfolio of capital stock. The starting point for the economic perspective on sustainability, then, is from the point of view of an individual-acting-at-a-point-in-time, nation-wide, or even planet-wide portfolio manager. Just as the flow of income from a stock of savings represents the return to investment in a savings account, so too does NNP represent the flow of income from society's level of total capital stock. Weak sustainability extends the economic problem of the individual consumer from maximizing utility subject to a budget constraint to maximizing economic output subject to the limited amount of total capital. Market-driven economic efficiency will insure that a given level of NNP will be the greatest that can be achieved given society's level of total capital investment. The assumptions and logic involved in going from economic man to maximizing NNP are:

1) *H. economicus* is an isolated individual entering an impersonal market at a particular point in time. *H. economicus* is consistently rational in an economic sense and always prefers more to less.

2) The goal of *H. economicus* is to allocate resources so as to maximize utility.

3) Utility is derived from consuming goods and services.

4) The utility derived from consuming goods and services is accurately reflected in market prices. Translating "utility" to "monetary value" enshrines the notion of universal substitutability. One dollar, one mark, or one yen is the same as any other.

5) If more is always preferred to less (nonsatiation) and if utility is equated to monetary value, then it follows that the larger is NNP, the greater is society's total utility.

6) NNP is the interest on total capital stock (natural, manufactured, and human capital)

7) Sustainability means sustaining the ability of the economy's capital stock to produce NNP.

Solow (1992:16) eloquently expresses this view:

> "Properly defined and properly calculated, this year's net national product can always be regarded as this year's interest on society's total stock of capital.

> It is absolutely essential that 'capital' be interpreted in the broadest sense to include everything, tangible and intangible, in which the economy can invest or disinvest, including knowledge. Of course this stock of capital must be evaluated at the right prices. And the interest rate that capitalizes the net national product will generally be the real discount rate implicit in the whole story. Investment and depletion decisions determine the real wealth of the economy, and each instant's NNP appears as the return to society on the wealth it has accumulated in all forms."

The neoclassical view of sustainability is illustrated by Figure 1. Sustainability means sustaining the growth rate of the economy, measured by NNP, which is the rate of return on a nation's capital stock. Given the assumption that all kinds of capital are substitutable for one another, sustainability becomes not a biological or physical problem but rather a problem in portfolio management. Again, the only criterion for weak sustainability is that the ability of the economy to produce economic output, embodied in its total capital stock measured in monetary units, must be nondecreasing.

Concepts embedded in weak sustainability

Among the many controversies surrounding the weak sustainability concept, 3 are particularly relevant to the debate between neoclassical and ecological economics. These are discounting, marginal valuation, and the commensurability of wants. Each has a direct bearing on wildlife policy. Neoclassical economists treat all goods and inputs essentially the same. In their view, ecological features are in principle no different from consumer goods bought and sold on the market.

Discounting the future. To be used in economic analysis, estimates of the future value of goods and services, including the services of nature, must be discounted. Market decisions are driven by individual decisions made at a particular point in time. It is natural that an individual, faced with pure uncertainty and a finite lifespan, should prefer something today rather than at some time in the future. This time preference is reflected in the discount rate. Suppose an individual is given a choice between receiving $1,000 now or $1,000 in one year. For numerous reasons, a rational person would choose to receive the money now. Suppose further that to make the individual indifferent between getting a sum of money now or in one year, that person would need to be offered $1,100 in a year. This would indicate a discount rate (interest rate) of 10%.

What is rational, however, for an individual acting at a particular point in time may not be rational for society as a whole. The neoclassical view is that individual preferences should be taken as the starting point for economic analysis and that these preferences can be revealed correctly in market outcomes. In this view, individuals are rational and are the best judge of what is good for them, the choices that give individuals the greatest amount of utility are those revealed in the market, and these market outcomes are sacrosanct. According to the standard approach, the principle of consumer sovereignty compels us to accept people's tastes, including their intertemporal preferences. A major problem with this position is that fundamental differences exist between the choices individuals make in the context of markets and the choices they make in a larger context as members of a community of other humans (Gowdy 1996, 1997). The shortcomings of discounting, whether it is used in private market decisions or in public policy using cost–benefit calculations, are nowhere more serious than in the case of biodiversity preservation. Economically rational decisions made in a market context by individuals at a specific point in time may collectively result in the loss of biodiversity and other resources critical to the long-term survival of the human species.

Marginal value. Central to economic theory is the concept of marginal value—that is, the change in value that results from a small increase or decrease in the item being valued. Marginal valuation is a concept so ingrained in how economists think about markets and values that it is almost impossible to appreciate its limits. When we consider the value of a species or an ecosystem, the concept of marginal value is problematic. Removing or adding one species will affect all the others in the system in largely unpredictable ways. Biodiversity is characterized by "functional transparency" (Vatn and Bromley 1994)—i.e., the contribution of one feature of an ecosystem cannot be known until it is added to or subtracted from the system. Furthermore, the effect is likely

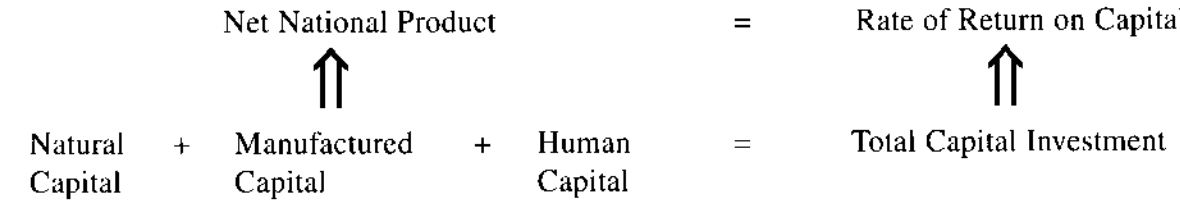


Figure 1. Net National Product as the flow from society's stock of capital investment.

to be different each time a change is made. There also are some unresolved issues in neoclassical utility theory that call into question the universal applicability of the notion of marginal value. For example, some goods and services are considered to be absolutely essential and not subject to trade (Georgescu-Roegen 1936, 1950), as empirically verified in a number of studies of consumer preferences (for example, Spash and Hanley 1995).

Georgescu-Roegen (1968) pointed out that diminishing marginal utility has no meaning without some notion of cardinality. It is not enough to be able to merely rank goods according to the utility they give. To construct a complete preference ordering, we need to be able to rank not only commodity bundles but also the difference between them. So the question "What is the marginal value of a species?" is fraught with conceptual as well as informational difficulties.

Commensurability of wants. This is an awkward term which refers to the fact that in neoclassical analysis, all the attributes of a good are reduced to a single metric. The implicit assumption is that all things that humans value can be reduced to some common denominator, "utility," or, to take it a step further, money. Once things are reduced to a common valuation metric, substitution, marginal trade-offs, and discounting seem logical and natural. Again, this may be reasonable for most market goods. The relative quality or desirability of clothing items at a department store, for example, may be reflected accurately in their relative prices. When applied to features of the natural world, however, the assumption of commensurability may not be justified. Can one imagine a single measure that could be used to make meaningful comparisons of the "values" of species or ecosystems anywhere on the planet at any time?

Once the idea of common denominator of value is accepted, it is a small step to accept the proposition that manufactured capital and natural capital are substitutes. Suppose that the discounted present value of the stream of income from the sustainable use of a rainforest is $10 million. Suppose further that you can cut down the forest, sell the timber, invest the money (in anything), and obtain a discounted income stream of $15 million. From the point of view of traditional economics, the decision is clear: cut down the forest.

Weak sustainability in practice

An instructive example of weak sustainability in practice is the small Pacific island nation of Nauru (Gowdy and McDaniel 1999, McDaniel and Gowdy 2000). In 1900, one of the world's richest phosphate deposits was discovered on Nauru, and today, as a result of just over 90 years of phosphate mining, about 80% of the island is totally devastated. It is a desert of mined-out coral pinnacles, dust, and rocks. The island was self-sufficient before phosphate mining, but now almost all food and even drinking water must be imported. The substitution of imported canned foods for local fresh products, the increased consumption of alcohol, and the adoption of other patterns of an industrialized-world lifestyle have affected adversely the health of the people of Nauru. Nearly 30% of those over 25 and about 50% of those over 50 have diabetes (Van Atta 1997). Very high rates of heart disease and hypertension also have been reported. Life expectancy at birth for males in 1985 was 49 years, substantially less than that of other Pacific Islanders except for Papua New Guinea males (Taylor and Thoma 1985). The island is biologically impoverished, chances of rehabilitation appear nil, and there is no way the island could support its current population of 10,000 or even its pre-European–contact population of about 1,200 without a steady flow of goods from the outside world.

Phosphate mining on Nauru.

At the same time, the people of Nauru have had, over the past several decades, a high per-capita income. Income from phosphate mining enabled the Nauruans to establish a trust fund estimated to be as large as $1 billion. Interest from this trust fund might have insured a substantial and steady income and thus the economic sustainability of the island. The path that Nauru took could have been weakly sustainable—that is, the population could have been economically better off than if they had preserved their island's natural environment but had fewer economic possibilities. Just because a path seems distasteful, or is environmentally unsustainable, does not mean that it is not weakly sustainable. Unfortunately, Nauru's path has proved to be weakly unsustainable because the Asian financial crisis, among other factors, has wiped out most of the trust fund. The people of Nauru now face a bleak future. Their island is biologically impoverished, and the money Nauruans traded for

their island home has vanished due to the vagaries of international finance.

The "development" of Nauru followed the logic of weak sustainability: its resource base was destroyed and converted to financial investments having a greater economic value than the undisturbed island. The Nauru case shows clearly that weak sustainability may be consistent with a situation of near-complete environmental devastation. It also shows the economic danger of a one-way substitution of money for nature.

Strong sustainability

The ecological economic concept of strong sustainability is more difficult to operationalize than weak sustainability. All of the suggested formulations of strong sustainability rules are open to criticism. The key point, however, is that strong sustainability recognizes that at least some features of the natural world are not substitutable. If we destroy the essential services nature provides, we threaten not only our economic well-being but our very existence.

In defining strong sustainability, economists usually distinguish between "renewable" and "nonrenewable" resources. Renewable resources include wildlife, water, air, and timber. Commonly proposed strong sustainability rules for using these resources are 1) rates of harvest should be kept below natural rates of regeneration, and 2) waste flows from the economy should be kept below the assimilative capacity of the environment. For nonrenewable resources such as specific minerals and fossil fuels, strong sustainability implies that the rate of use of these resources should be less than or equal to the rate of technological progress in finding substitutes or the rate of saving through conservation efforts. The basic rule of strong sustainability is that the stock of natural capital should be kept constant over time (Pearce and Turner 1990). This rule makes it clear that unlimited substitution between natural capital and manufactured capital is undesirable.

Some formulations of strong sustainability, however, are concerned only with sustaining economic activity. The point of preserving natural capital is to insure a steady supply of inputs to the productive process and to insure that the accumulation of waste does not threaten economic activity. Goodland, et al. (1993:303) make this clear:

> "Natural resources represent capital that can and should be used—or even used-up—to produce goods and services for the benefit of their owners. All natural resources need not be kept in their original state, either for our own later use or for future generations. Like other forms of capital, however, natural resources need to be maintained in order that they can continue to help the productive process."

The above conceptualization of strong sustainability is vague about the criteria for environmental sustainability because it fails to address the conflict between markets, human society, and ecosystems. In this view, as long as the question of scale is addressed, the market economy can insure the sustainability of economic output. Where does this leave the sustaining functions that are outside the realm of market valuation, or those that are impossible to quantify? A complex ecosystem, for example, could be reduced to a monoculture tree farm and as long as these trees are harvested at a low enough rate, this may be strongly sustainable in the economic sense.

Much of the confusion in the discussion of strong sustainability arises from a failure to distinguish between 2 key assumptions dividing weak and strong sustainability. The first is the assumption of substitutability between natural and manufactured capital. The second is that economic well-being "covers" all other concerns, an assumption sometimes accepted implicitly and sometimes rejected by advocates of strong sustainability. If it is accepted, then the argument between advocates of weak versus strong substitutability boils down to a purely economic debate about the degree of substitutibility and technological advance. If substituting manufactured capital for natural resources is incompatible with maintaining a suitable physical environment for the human species, then strong sustainability implies that we must step outside the conventional market framework to establish the conditions to maintain human happiness (Gowdy and McDaniel 1995).

Operationalizing strong sustainability

Many examples, past and present, show the folly of weak sustainability as a rule for resource use. Examples of strong sustainability are harder to find, but do exist. Many Pacific island societies, such as Tikopia, lived in balance with nature for millennia (McDaniel and Gowdy 2000). Others, such as Ladakh, were sustainable until they were overwhelmed by western economies (Norberg-Hodge 1992). More relevant, perhaps, are the many promising initiatives to operationalize strong sustainability. The Nature Conservancy (TNC), for example, has pioneered efforts to link the goal of biodiversity conservation with local economic development projects. TNC policies represent strong sustainability in that preserving unique ecosystems is the binding constraint, with economic development occurring only within that constraint. TNC has cooperated with the Inter-American Development Bank to start a venture capital fund to support profitable, environmentally sound businesses in Latin America, and it has worked closely with ranchers in the southwest United States (the Malpai Borderlands Group)

to restore the health of ranchland ecosystems while preserving the ranching way of life. Another promising effort is The Natural Step, an organization that promotes ecologically sustainable production. Within New York State, faculty and graduate students in Rensselaer's program in ecological economics are working to create ecologically friendly economic development initiatives in the Catskills, the Lake George region, and the Adirondacks.

Operationalizing strong sustainability should begin with a clear objective of what it is we wish to sustain. Following Georgescu-Roegen (1976), a reasonable objective is to insure the existence of the human species for as long as possible, recognizing the fact that humans, as with all species, will someday become extinct, whether we evolve into a new species or disappear altogether. With this in mind, the following steps toward strong sustainability seem reasonable:

1) Distinguish between ecological and economic sustainability and adopt a no-substitution rule between the 2. Advocates of strong sustainability argue that environmental and economic accounts should be kept separate. This accounting also should be done for ecological systems and species that have no apparent economic use or even no apparent value to humans. It has become a dangerous cliché to say that there is no conflict between human well-being and environmental protection. The conflict is clear: in the market economy we have created, humans can improve their economic well-being by destroying parts of the natural world. One of the more insidious effects of the "sustainable development" movement has been to blur the distinction between conserving nature and helping the poor. According to one member of the Brundtland Commission:

> "The great achievement of the sustainable development concept is that it broke with the old conservationist approach to natural resources and its tendency to place Earth's other species above people." (Ramphal 1992, quoted in Jamieson 1998:183)

Again, this perspective indicates a short time horizon. It is consistent with the view that it is permissible to sacrifice wild species as long as some people are temporarily better off economically. In the long run, human survival depends on protecting other species and the ecosystems they inhabit. The basic argument of ecologists is that when we trade nature for human well-being, we are destroying the life systems upon which all human life depends in order to achieve a short-run gain. In blunt terms, destroying the basis for future human survival should be no more acceptable to help the poor than to help the rich. Spash and Villena (1998) and Swaney (1987) point out that this conclusion is consistent with an anthropocentric approach despite its "biocentric" appearance. We should keep everything in the biosphere intact because it is in our long-run interest to do so. In contrast, the theoretical edifice of neoclassical theory is a justification for an extremely short-run perspective.

2) Define (or describe) ecological sustainability in terms of evolutionary potential. Life on earth depends on complex relationships and the ability to respond to changing biological and physical conditions. In ecosystems, seemingly redundant species play important roles in system resilience (Holling et al. 1995) and may assume the role of existing keystone species when environmental conditions change. Preserving humans for as long as possible necessitates preserving the biological potential to adapt to changing conditions. To ensure the survival of our species for as long as possible, we need to recognize that human culture will change; there is no reason to believe that the market economy will survive for even another 1,000 years. To ensure our survival, we need to preserve the boundary conditions under which we evolved over the last 5 million years, including the potential to adapt to change.

3) Define or describe social sustainability. What are the necessary conditions for a socially just, smoothly functioning human society that has the ability to adapt to changing environmental conditions? Just as humans evolved under rather specific environmental conditions, so too did our social systems (our varied cultures) evolve under specific biological and environmental constraints. We are only just beginning to understand the relationships between human biology and human culture.

4) Define and delineate conditions for economic sustainability. The field of economics is changing rapidly. Behind the scenes, long-held notions of sanctity of the market are changing. Spurred by massive policy failures in eastern Europe, Asia, and Latin America, economists are beginning to recognize that unregulated markets are not consistent even with economic sustainability. The current capital crisis in particular has led some prominent economists to call for restrictions on capital flows. This has far-reaching implications for weak and strong sustainability because it calls into question the assumption of the substitutability of money for natural resources.

5) Delineate the points of conflict between markets (and the neoclassical economic theory describing them) and ecosystems. A starting point is the theoretical discussion above on commensurability, nonsatiation, and economic man. These concepts translate into policy through discounting, market valuation of environmental features, and the obsession with market instruments for environmental protection.

These points call for policies that will bring the way

humans currently live in line with the biological and social requirements of long-run sustainability. This will not be easy because some of these policies will undoubtedly conflict with ideas of progress, individualism, and materialism enshrined in the fundamental belief systems of the modern world. By recognizing the conflict between human well-being based solely on market output and long-run environmental integrity, we can begin to make strong sustainability consistent with biological and physical reality. Only then can we ensure the survival of our species and the conservation of wildlife for the coming millennia.

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