Conservation Biology

Essay

Obscuring Ecosystem Function with Application of the Ecosystem Services Concept

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Abstract: *Conservationists commonly have framed ecological concerns in economic terms to garner political support for conservation and to increase public interest in preserving global biodiversity. Beginning in the early 1980s, conservation biologists adapted neoliberal economics to reframe ecosystem functions and related biodiversity as ecosystem services to humanity. Despite the economic success of programs such as the Catskill/Delaware watershed management plan in the United States and the creation of global carbon exchanges, today's marketplace often fails to adequately protect biodiversity. We used a Marxist critique to explain one reason for this failure and to suggest a possible, if partial, response. Reframing ecosystem functions as economic services does not address the political problem of commodification. Just as it obscures the labor of human workers, commodification obscures the importance of the biota (ecosystem workers) and related abiotic factors that contribute to ecosystem functions. This erasure of work done by ecosystems impedes public understanding of biodiversity. Odum and Odum's radical suggestion to use the language of ecosystems (i.e., emergy or energy memory) to describe economies, rather than using the language of economics (i.e., services) to describe ecosystems, reverses this erasure of the ecosystem worker. Considering the current dominance of economic forces, however, implementing such solutions would require social changes similar in magnitude to those that occurred during the 1960s. Niklas Luhmann argues that such substantive, yet rapid, social change requires synergy among multiple societal function systems (i.e., economy, education, law, politics, religion, science), rather than reliance on a single social sphere, such as the economy. Explicitly presenting ecosystem services as discreet and incomplete aspects of ecosystem functions not only allows potential economic and environmental benefits associated with ecosystem services, but also enables the social and political changes required to ensure valuation of ecosystem functions and related biodiversity in ways beyond their measurement on an economic scale.*

Keywords: biodiversity, commodification, conservation policy, ecosystem function, ecosystem service, emergy, neoliberal economics, social function systems, valuation

Enmascaramiento de la Función del Ecosistema con la Aplicación del Concepto de Servicios del Ecosistema

Resumen: *Los conservacionistas comúnmente han enmarcado las preocupaciones ecológicas en términos económicos para recabar apoyo político para la conservación y para incrementar el interés público en la preservación de la biodiversidad. A inicios de la década de 1980, los biólogos de la conservación adoptaron la economía neoliberal para enmarcar las funciones del ecosistema y vincularon a la biodiversidad con servicios del ecosistema para la humanidad. No obstante el éxito económico de programas como el plan de gestión de la cuenca Catskill/Delaware en los Estados Unidos y la creación de intercambios globales de carbono, el mercado actual a menudo fracasa en la protección adecuada de biodiversidad. Utilizamos una crítica Marxista para explicar una razón de este fracaso y para sugerir una posible respuesta parcial. El enmarcado de las funciones del ecosistema como servicios económicos no aborda el problema político de la mercantilización. Tal y como enmascara la labor de trabajadores humanos, la mercantilización enmascara la importancia de la biota*

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(trabajadores en el ecosistema) y de los factores abióticos que contribuyen a las funciones del ecosistema. Esta eliminación de la labor realizada por los ecosistemas impide el entendimiento de la biodiversidad por el público. Odum y su sugerencia radical de utilizar el lenguaje de los ecosistemas (i.e., emergía o memoria de energía) para describir la economía, en vez de utilizar el lenguaje de la economía (i.e., servicios) para describir los ecosistemas, revierte esta eliminación del trabajador del ecosistema. Sin embargo, considerando la actual dominancia de las fuerzas económicas, la implementación de tales soluciones requeriría de cambios sociales similares en magnitud a los que ocurrieron en la década de 1960. Niklas Luhmann argumenta que ese cambio social sustantivo, pero rápido, requiere una sinergia entre múltiples sistemas de función social (i.e., economía, educación, derecho, política, religión, ciencia), en lugar de la dependencia en una sola esfera social, como la economía. La presentación explícita de los servicios del ecosistema como aspectos discretos e incompletos de las funciones del ecosistema no solo permite beneficios ambientales y económicos potenciales asociados con los servicios del ecosistema, sino también facilita los cambios sociales y políticos requeridos para asegurar la valorización de las funciones del ecosistema y la biodiversidad relacionada más allá de su medida en una escala económica.

Palabras Clave: biodiversidad, economía neoliberal, función del ecosistema, mercantilización, políticas de conservación, servicio del ecosistema, sistemas de función social, valorización

Introduction

Since at least the 1930s, those interested in conservation and environmental protection have attempted to internalize economic externalities that lead to environmental degradation. Many of these efforts revolved around reframing ecologic concerns in economic terms in hopes of persuading target populations that conservation practices were valuable economically. For example, during the Dust Bowl in the 1930s, the U.S. Soil Conservation Service used this approach to persuade farmers that soil and water conservation resulted in greater economic profits in the long term (Worster 1979). Similarly, conservationists argued for preservation of rare species, unique landscapes, and biodiversity by reframing these ecological entities as nonmarketed commodities by applying contingent valuation and other techniques (e.g., Bowker & Stoll 1988; Moran 1994; Turpie et al. 2003). Although there certainly have been political, ecological, and economical benefits associated with reframing ecologic concerns in economic terms, there also are socioeconomic and ecologic costs and thence unintended negative consequences (Chan et al. 2007). For example, when worldwide demand for cereal grains soared during the 1970s, the promised long-term economic benefits of soil conservation paled compared to immediate economic profits, and U.S. farmers plowed up their conservation acres (Peterson 1986). Similarly, when compared with the economic value of the world oil industry, even the most charismatic endangered species or sublime landscape often come up short when quarterly or annual profits are the metric for comparison (Peterson & Peterson 1993, 1996). For example, environmental concerns regarding construction of the Trans-Alaska Pipeline System were trumped and the pipeline approved in November 1973, just 1 month after Arab members of OPEC announced an oil embargo to nations that supported Israel (Gramling & Freudenburg 1992). Similarly, persistent and ongoing efforts to allow oil extraction from the Arctic National Wildlife Refuge exemplify this pressure.

Perhaps the most comprehensive attempt to reframe ecologic concerns in economic terms to enhance environmental protection is the move to reframe ecosystem functions as ecosystem services to humanity. This was accomplished from within the neoliberal economic and political systems that have dominated industrial and postindustrial nations since the 1970s (Luhmann 1989; Aune 2001; Harvey 2005), and the ecosystem-services construct responds to these neoliberal market logics. When Ehrlich and Ehrlich (1981) coined the term *ecosystem services*, they argued that disappearance of biodiversity directly influences ecological functions that support human life. This theme was reiterated and developed for different audiences and outlets (e.g., Ehrlich & Mooney 1983; Ehrlich & Wilson 1991), but the emphasis remained largely pedagogical; the concept of ecosystem services was used to teach people that ecosystems *serve us*, thus demonstrating the value of ecosystem functions for humanity and justifying improved protection of biodiversity. This situation changed when Costanza et al. (1997) "conservatively estimated" the economic value of 17 ecosystem services for 16 biomes at US$16–54 trillion per year, with an average value of $33 trillion annually (1994 dollars).

Although Costanza et al. (1997:259) simply hoped to "give the natural capital stock that produces these services adequate weight" in decision-making processes, their article greatly intensified efforts to figure out how to cash in on potential markets worth many trillions of dollars. As economists refined valuation methods for these potential commodities, conservation biologists recognized the utilitarian appeal of merging economics and conservation (e.g., van Wilgen et al. 1998; Jansson et al. 1999; Dobson et al. 2006). Following this surge of

enthusiasm, society began developing markets for several ecosystem services. The 1997 Catskill/Delaware watershed management plan demonstrated just how cost-effective ecosystem services could be when compared with technological solutions to environmental problems (Daily & Ellison 2002; Pires 2004). Although wetland mitigation banking began in 1983, it became the U.S. Environmental Protection Agency's (EPA) preferred mechanism for offsetting unavoidable wetland impacts in 1997 (EPA 2008). In anticipation of command and control regulation, the Chicago and European Climate exchanges (launched in 2003 and 2005, respectively) established trading of all six major greenhouse gases (GHGs; Chicago Climate Exchange 2007; European Climate Exchange 2008). This market provides a vehicle for the sale or exchange of credits for a newly created ecosystem service—carbon capture and storage—to industries releasing GHGs. These, and other initiatives, demonstrate that ecosystem functions provide valuable services to humanity and that some ecosystem services lend themselves to exchange in the marketplace and, because of their economic value, justify protection.

Because of successful cases, win–win packaging, and general excitement surrounding these new commodities, it is tempting to assume that Adam Smith's invisible hand will ensure that humanity does not destroy biodiversity, ecosystem functions, and thence itself. There are serious problems with this assumption, however. First, effective markets do not exist for numerous important ecosystem functions. For example, soil, nature's engine for food production, only has economic value through its impact on vegetative productivity, which in turn affects land prices (Gardner & Barrows 1985; Rodriguez et al. 2006). Similarly, the service provided by native pollinators is valuable to humanity, but has no direct market. Because abundance of native bees has declined due to agricultural intensification and pesticide use (Kremen et al. 2002), U.S. farmers routinely rent honeybee colonies to ensure adequate crop pollination; increased U.S. agricultural yield and quality attributed to honey bees was $14.6 billion in 2000 (Morse & Calderone 2000). [Correction added after publication 29 July 2009: An error in the monetary values mentioned in the previous sentence was clarified.] Second, as Chan et al. (2007) pointed out, there are numerous cases in which commodification of nature does not result in protection of biodiversity or ecosystem functions. For example, efforts to conserve tropical forests that established markets for nontimber forest products achieved short-term conservation objectives, but the long-term impacts of these markets are unknown and under examined and may undermine the original conservation goals. Chan et al. (2007) suggest that conservation arguments that appeal primarily to anthropocentric benefits tend to overlook complex ecological and social interactions. Thus, they conclude that there are numerous situations in which conservationists should argue for conservation for biodiversity's sake alone rather than for its direct benefits to humanity.

Somehow, in all the excitement associated with reframing ecosystem functions as marketable commodities, conservationists seem to have forgotten that ecosystem services still operate within the same neoliberal legal, economic, and political institutions; and they rely on the same rationales as those used for the distribution and accumulation of material wealth. Although there is nothing wrong with benefiting financially from ecosystem services, established market logics are largely responsible for lost ecosystem functions and related biodiversity; they failed to protect these public goods (e.g., Rodriguez et al. 2006; Norton & Noonan 2007; Salzman & Thompson 2007). Thus, unqualified adoption of these same rationales via efforts to commodify ecosystem functions as ecosystem services to humanity may prove deleterious to biodiversity conservation in some cases.

When neoliberal market logics do not adequately protect ecosystem functioning and related biodiversity, conservationists must ask why this occurs. Conservationists also must evaluate why ecosystem functions and related biodiversity sometimes are lost in today's marketplaces, particularly in markets that explicitly trade ecosystem services. We argue that the sale of ecosystem services, as currently conducted, shares base calculations with the sale of human labor, and as such, any ecosystem service should be accompanied by an analysis of the ecological "worker" that produced it. We also examine the next round of policy ideals that ecosystem services may be used within and suggest a more discreet presentation of the natural world that appeals to, but is not limited to, economic functions (Luhmann 1989); perhaps a presentation more aligned with the original hopes of those who introduced the ecosystem service concept.

From Ecosystem Function to Ecosystem Service

In most western nations, statutes, regulations, and executive orders require that environmental decisions be made within the framework of cost–benefit analysis (Salzman & Thompson 2007). Thus, environmental policy has evolved within terminologies and logics relevant to this dominant economic framework. Not surprisingly, cost–benefit analyses rarely emphasize biotic and abiotic entities that create ecosystem services, and markets commonly fail to protect ecosystem functions and related biodiversity adequately. Similarly, many social critics have decried failure of market forces to protect the safety, health, and welfare of human workers (e.g., Horkheimer 1947; Marcuse 1966; Adorno 1991). These critiques, grounded in the economic and political theory of Karl Marx, help explain the limitations of using ecosystem services to protect ecosystem functions and biodiversity. Marx's (1867/1906) analyses of the labor process and the

creation of commodities are just as relevant to understanding why market forces often fail to protect ecosystem functions and related biodiversity as they are to why market forces often fail to protect the welfare of human workers.

Since the industrial revolution (i.e., mid-to-late 18th century), workers have been hired in a labor marketplace. Workers meet a financier and agree to sell their labor and/or time to the financier for a wage sufficient to entice them to invest their time and energy in work (Marx 1867/1906). As a part of the wage agreement, the worker's labor and/or time is purchased and thus contractually owned by the employer, where it is used to produce some thing. The worker then uses her or his body to transform raw materials (e.g., minerals, fibers, energy, nutrients) by way of instruments (e.g., hands, tools, technology) into a product that becomes a commodity when offered for sale at a price in the marketplace. The commodity is simultaneously valued economically as the material *use value* (the sum of raw goods, instruments, and labor) and the abstract *exchange value* as expressed in the monetary price. Commodities are valued in terms of a universal equivalent—money (Lefebvre 1968:47), an intercessory symbol that makes exchange possible. Marx argues that to sell the commodity for profit, it must be distanced from the raw material, energy, tool, instrumentation, and labor costs so that alternative values to the exchange price cannot be readily calculated. Thence, the market price for the product conceals the contributions of the laborer and other resources used to manufacture and ship the product.

When products "assume this money-shape, commodities strip off every trace of their natural use-value, and of the particular kind of labour to which they owe their creation, in order to transform themselves into the uniform, socially recognized incarnation of homogeneous human labour" (Marx 1867/1906:123). A number of mechanisms help accomplish this transformation. Time of commodity production and product sale are separated, as are time of employee labor and employee payment. Similarly, modern marketing compartmentalizes material use value and abstract exchange value. For example, the top 100 advertisers worldwide spent $97 billion in 2006 to obtain as high an abstract value as possible for their commodities (e.g., expensive designer clothes made in Asian sweatshops; Wentz 2007). This estrangement of the material and symbolic aspects of commodities results in giving money—the exchange medium—precedence over both the natural world and human work because these entities are hidden from view in the monetary price (Marx 1867/1906). For these reasons, when consumers purchase commodities, they typically focus on the price of the commodity and their desire for it as influenced by marketing, not on the labor, energy, raw material, or other environmental costs associated with its production and shipment.

When ecosystem services to humanity become commodities, the biotic components of ecosystems become the workforce whose labor and energy is purchased. We use the phrase *ecosystem worker* as shorthand for the organisms that produce services in an ecosystem service marketplace. Ecosystem services are offered as a proxy for the labor required to produce commodities (Boyd & Banzhaf 2007). Thus, any discussion of an ecosystem-service market should include discussion of the biota providing the service, or the ecosystem workers. The ecosystem worker sustains itself by transforming raw materials (e.g., minerals, fibers, energy, nutrients) into tissues so it can survive and replicate, thus producing a commodity desired by humanity, or an ecosystem service. As with other commodities traded in the marketplace, production logics tend to erase every trace of the ecosystem workers (biotic components of the ecosystem) and raw materials (abiotic components of the ecosystem) from the marketed commodity (an ecosystem service to humanity). This erasure of the ecosystem worker, and its replacement with money, contradicts the original purpose for reframing ecosystem functions and related biodiversity as ecosystem services, which was to increase public consciousness of the importance of biodiversity (e.g., Ehrlich & Ehrlich 1981; Ehrlich & Mooney 1983; Ehrlich & Wilson 1991). Thus, the attempt to demonstrate human dependence on local and global ecosystems risks erasing these very ecosystems from public consciousness.

Marx's (1867/1906) analysis of commodification reminds us that market price is not the only, let alone the ultimate, assessor of value (Peterson & Peterson 1993, 1996). Instead, worth is derived from biophysically grounded relations among the ecosystem worker, the capitalist financier, and the human beneficiaries of ecosystem functioning. Furthermore, it is derived in part from the quality of life of the ecosystem worker as measured by ecological relations among organisms and the ecosystems they inhabit. Marx (1867/1906:588) argued that

> Labour is the substance, and the immanent measure of value, but *has itself no value*. In the expression 'value of labour,' the idea of value is not only completely obliterated, but completely reversed. It is an expression as imaginary as the value of the earth. These imaginary expressions arise, however, from the relations of production themselves. They are categories for the phenomenal forms of essential relations. That in their appearance, things often represent themselves in inverted form is pretty well known in every science except political economy.

Any expression of a commodity's price trivializes the value of the laborer and important facets of the laborer's life (e.g., sustenance, health, offspring) because, in price, value becomes to some degree an imaginary expression.

For most people, even those who are highly educated, ecosystem functions and biodiversity are surreal concepts. This fact was the impetus for using ecosystem services to humanity as a pedagogical tool in the first place. To Marx the imaginary nature of Earth's economic value was so much a given that he used it to point out the imaginary economic value of human labor. Awareness that certain ecosystem services are worth considerable money does not necessarily translate into understanding why specific ecosystem functions and related biodiversity should be conserved. When we commodify an ecosystem function by reframing it as an ecosystem service, we obscure the value of the ecosystem worker and its persistence through time. For example, because of the high demand for carbon offsets, monoculture plantations for CO_2 storage are taking precedence over more biologically diverse systems that absorb less carbon, but benefit more species (Hunt 2008). This illustrates how commodification erases or at least obscures the ecosystem worker and related abiotic factors that made the ecosystem service to humanity possible, thus contributing to the publics' already limited likelihood of focusing on ecosystem functions and biodiversity.

Conclusions and Conservation Implications

We support the intent of conservation biologists who attempted to raise awareness of the importance of biodiversity by reframing ecosystem functions and related biodiversity as ecosystem services to humanity. As it has been applied through the process of commodification, however, the concept of ecosystem services has decoupled function from service sufficiently that many people may be aware of the economic value of a given ecosystem service without recognizing human dependence on local and global ecosystems. Not surprisingly, then, there are numerous instances in which commodification of nature has not resulted in conservation of biodiversity (Chan et al. 2007). What, then, should be done?

The genie of ecosystem services cannot be put back into the bottle, and we do not think it should be. Instead, conservationists must reverse the erasure of the ecosystem worker (biotic components of the ecosystem) and related abiotic factors that accompanied the commodification of ecosystem functions. Odum and Odum (2000:21) offered a radical approach to conservation when they argued that

> [e]fforts by economists and others have been made in the last two decades to "internalize the externalities" or to modify market valuation to give more consideration to ecosystems. What is needed is the reverse: to "externalize the internalities" to put the contributions of the economy on the same basis as the work of the environment. We suggest that the best way to do this is to use one kind of energy [emergy] as the common denominator.

Measuring the work of the economy on the same basis as the work of ecosystems, while retaining money as the medium of exchange, certainly would reverse the erasure of the ecosystem worker that has accompanied the commodification of biodiversity and ecosystem functioning into ecosystem services. For example, the amount of solar energy required to produce a product, transport it to its destination, operate and repair it for its lifetime, and recycle or otherwise dispose of it once it becomes useless would reframe the product in terms relevant to ecosystem function and would almost certainly lead to more effective environmental protection. Exactly how humanity could implement such a radical solution given the economic hegemony currently characterizing human society is less obvious.

Luhmann's (1989) social theory suggests an approach that appeals to, but does not limit itself to, economic functions. In this context, ecosystem functions and related biodiversity appear as discreet entities that are separate from, yet related to, ecosystem service commodities. His social theory also explains how societal changes that would reverse erasure of the biodiversity and related abiotic components of ecosystems could be catalyzed. He argued that human society structures itself by communication within and between function systems and that all communication is constrained by these subsystems. He identified the economy, law, science, politics, religion, and education as the most important function systems in late modern society. Although Luhmann (1989:51) admitted that "among society's many function systems the economy deserves first consideration," he claimed that any attempt to derive the near-totality of other social phenomenon from any one sphere is hopelessly reductionistic. Indeed, any substantive social change requires simultaneous resonance, or synergy, among these social systems. If we hope "to put the economy on the same basis as the work of the environment," as Odum & Odum (2000:22) suggest, we must retain ecosystem *services* within the economic function system, and simultaneously expand the importance of ecosystem *functions* and related biodiversity into terms recognizable by other important societal systems (e.g., law, science, politics) so that the requisite social changes can occur.

Regardless of whether society decides to put the work of the economy on the same basis as the work of the environment, as suggested by Odum and Odum (2000), Luhmann's (1989) social theory still provides an approach for mitigating erasure of the ecosystem worker that accompanies commodification of ecosystem functions as ecosystem services. Global efforts to confront climate change provide a timely example of the requisite resonance among social function systems (Luhmann 1989). To control GHG emissions, the United Nations Framework Convention on Climate Change (UNFCCC) drafted the Kyoto Protocol, which combined the use of scientific data, new legal frameworks, and market systems to

lower global emissions of GHGs (United Nations 1998). Specifically, the UNFCCC devised three strategies for providing a framework for future emission-reduction efforts: the clean development mechanism, joint implementation, and emissions trading. Emissions trading, in particular, provided a vehicle for the sale or exchange of credits for a newly created ecosystem service (i.e., carbon capture and storage) to industries releasing GHGs. Creative implementation by signatory nations and innovations by industry and the marketplace allow demand for these commodities to be assessed, valued, supplied, and traded. Monitoring of GHG emissions and explicit integration of carbon capture and storage by biotic systems renders it difficult to ignore the plants and other photosynthetic organisms (ecosystem workers) and systems responsible for this ecosystem service to humanity. In this case, the service provided to humanity is identified as an economic component of the ecosystem's biodiversity and ecosystem functions. Thus, Luhmann offers a framework for more careful use of the ecosystem-services construct by discretely labeling its partiality.

Honadle (1999) concluded that successful market-associated approaches for avoiding or solving environmental problems generally require reorganization of existing political, legal, and economic infrastructure and the likely addition of new organizations and institutions. After all, "for markets to work effectively, neither the legal tapestry nor the social fabric can stand in overt opposition to market dynamics" (Honadle 1999:20). Historically, periods when humanity made substantive progress toward environmental protection coincided with times when humanity dealt with environmental concerns via multiple societal function systems simultaneously. During the 1960s, for example, Carson's (1962) *Silent Spring* catalyzed synergy among nearly all of society's function systems across much of the Western world. This ultimately led to far greater environmental protection in the United States and elsewhere (Waddell 2000) and even altered how ecology and environmental science textbooks were written (Peterson & Peterson 2000). This synergy among multiple function systems led U.S. society to elect environmentally oriented politicians who passed nearly every environmentally groundbreaking statute now on the books in the United States. Similar changes also occurred in many other nations during this period. Ecology became part of the everyday lexicon, the Green Party became a major political force in Europe, and the public in the western world demonstrated its willingness to pay for environmental protection. Similarly, convergence of societal function systems led to important environmental changes in the United States during the early 20th century under the leadership of Theodore Roosevelt, Gifford Pinchot, John Muir, and others.

Perceiving ecosystem functions from within neoliberal economic perspectives alone tends to obfuscate the ecosystem functions and biodiversity required for ecosystem services to humanity. Turning our emphasis from the product (ecosystem service) to the producer (ecosystem worker) shifts the conversation surrounding biodiversity and ecosystem function from one focused on profit, investors, yields, and prices to one that includes biodiversity protection, status of public goods, the role of various segments of human society, and other material relations.

Odum and Odum's (2000) proposal for reframing the economy from an ecological perspective likely would reverse the erasure of the ecosystem worker that currently accompanies commodification of ecosystem functions as services to humanity. This change does not require reforming the political economy so much as it requires reframing biodiversity and ecosystem functions to resonate fully across all of society's function systems (Luhmann 1989). For example, public outrage regarding how ecosystem workers (i.e., biodiversity) are treated could be productively translated into changes in who is in or out of political office, which in turn may lead to statutes and regulations more conducive to legally protecting ecosystem functions and related biodiversity as well as badly needed conservation science. The educational system could integrate the results of scientific research, which in turn could feed back into the political, legal, and scientific function systems. This synergy among societal function systems is required to help humanity transcend currently detrimental perspectives toward the natural world. Defining the ecosystem worker as a discreet entity, separate from, yet related to, the services it provides, not only allows the economic and environmental benefits associated with ecosystem services, but also may enable the social and political changes required to ensure valuation of ecosystem functions and related biodiversity in ways beyond measurement on an economic scale.

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