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# 1

## Bringing Liquidity to Life: Markets for Ecosystem Services and the New Political Economy of Extinction

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This chapter attempts to situate the rise of market-based conservation policy, and its associated theoretical and policy frameworks such as The Economics of Biodiversity and Ecosystem Services (TEEB), within a wider history of what might be termed *financialization*. Outlining a new chapter in the long history of ontological adjustment of ecological science to dominant accounts of political economy, this chapter explores the emergence of a novel political economy of extinction. This can be analyzed in the transformations of theory: the reframing of the sixth extinction crisis within the neoliberal idiom of “natural capital” and “ecosystem services” reflects a history of the reprocessing of political and scientific ecological discourse in order to better accommodate it to reigning economic doctrines. TEEB and other articulations of market-based conservation do little to question the dominant economic theory that has licensed the financialization of social, political, and economic life and led to our current global economic crisis. As a species of power, it can also

be analyzed in the social connections of the corporate boardroom, where the professional authority, executive expertise, epistemic frameworks, and political projects of senior conservation ecologists increasingly converge with those of the world's most powerful bankers.

## Introduction

If economists continue to debate whether there is enough "global growth" in evidence to declare the Great Recession that followed the financial crisis of 2008 officially over, it may be a moot point for the multitudes living its effects in the "real economy." The vast quantities of central bank money creation that have kept financial markets liquid have had their counterpart in rising public debt, austerity, insecurity, unemployment, and declining real wages. A more ominous crisis of global growth, however, continues in the background. The biosphere is in "negative growth territory," continually being reduced in size, diversity, and complexity. In the material world of the "real economy," deforestation, land clearing, and the mining of oceanic fisheries continue apace. Greenhouse emissions continue their exponential rise, and climate change threatens to unravel abiding biotic relationships in existing refugia.

Coral reefs, "the rainforests of the sea," are so threatened by warming events and ocean acidification that some marine scientists are calling for the rapid upscaling of a raft of prophylactic ocean-engineering technologies. These range from covering vast areas of reef with giant pool covers, to capturing and re-releasing reef species after genetically engineering them to tolerate heat and acidity stress beyond the range to which they have evolved to withstand (Rau et al., 2012). Calculating rates of extinction is a dark art; biologists suggest that the consignment of species to extinction is now occurring at somewhere between 100 and 10,000 times the "normal" deep time rate, with the range of estimates for actual species extinctions being between 50 and 36,000 per year (Lawton and May, 1995; Pimm and Raven, 2000; Stork, 2010). In the deep geological time of evolutionary history, the biosphere finds itself on the precipice of the sixth mass extinction crisis since life emerged (Barnosky et al., 2011).

The biopolitical project of the "crisis discipline" of conservation biology (Soule, 1985, p. 727) once proceeded on the ethical ground of opposition

to the heedless destruction of forms of life. The ethics of intrinsic value, in which life-forms exist of themselves and for themselves independent of human meaning systems, was married to the quest for a meticulously value-free scientific account of the parts and wholes of biotic communities and ecological systems: a rigorously nonanthropocentric ethos and episteme devoted to the preservation of the extra-economic fundament of life from the depredations of "the economy." It is widely recognized that attempts to reduce the gathering pace of extinction under the aegis of the 1992 Convention on Biological Diversity (CBD) and the ethos of the protected areas paradigm have failed. While only the most naïve idealists would interpret this as a pure failure of philosophy, a sense of pragmatic inevitability has pervaded the transformation of conservation politics by the inexorable rise of the concept of "ecosystem services" to the influential heights of international policymaking over the last decade. A now familiar revolution has occurred within conservation biology and its institutional practices, a move to fully subordinate it to the *sine qua non* of anthropocentric policy languages: marginalist economics<sup>1</sup> as reconfigured by the political philosophy of neoliberalism, which elevates it to a cosmological prime Adam Smith's armchair anthropology of a constant human "propensity to barter, truck, and exchange one thing for another."

As the realization slowly dawns that ecological erosion is in lockstep with climate change, of which it is both cause and effect, and that it will fundamentally threaten the lifeworld of human populations, so too does the knowledge that it is too late for conservation alone to preserve a minimally functioning biosphere. The 10 percent of the Earth's surface inside protected areas must be complemented by a grand project of systematic restoration to reconnect eroding and isolated remnants of the relatively "wild" biosphere. Since the return to ecological pasts implied by "conservation" and "restoration" is, given the irreversibility of extinction and global warming, strictly impossible, the shift in focus becomes the ethically agnostic problem of re-engineering the resilience of the directly economic functions of undestroyed ecosystems, which have lately been discovered by conventional economic thought and reframed within it under the term "ecosystems services."

The shift in the philosophy of extinction accomplished by these developments is notable: the biosphere is no longer to be protected from the depredations of economic growth, to be allowed to "let live" in a separate, delimited space and a sphere of values, as in the protected areas

paradigm, or in the theoretically unlimited sovereign protection of the US Endangered Species Act. As Australian Environment Minister Peter Garrett put it in a speech to conservation professionals,

With 1,750 species on the threatened list it is time Australian governments began to deal with regional ecosystems rather than adopting a band-aid approach to dealing with species under stress[...]. While[...]we'll have to act in an urgent way from time to time to prevent their extinction, it won't always be effective to keep tackling them one by one. We shouldn't focus solely on the sick and dying, but should work to build the resilience of ecosystems and landscapes, to ensure, if you like, that the hospital waiting rooms are a little less full and the health care a lot more preventative. (Gray, 2009)

Perhaps nothing signifies what is at stake more clearly than the name of the CBD's new transnational scientific institute dedicated to collating, analysing, and advancing state-of-the-art scientific knowledge to inform the political community: the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES). The model organization for this is of course the Intergovernmental Panel on Climate Change (IPCC), but there is a notable difference. In its quest to communicate state-of-the-art climate science, the IPCC did not think to preemptively subordinate its scientific mission to neoliberal styles of thought by dubbing itself the "International Panel on Climate Services."

What is to be done with what remains of the "wild type" biosphere, and how to retain certain of its useful side effects? Among the list of "services," we find the "supporting services" that underwrite the very possibility of life, such as nutrient cycling, seed dispersal, pollination and primary production, and "regulating services" such as flood mitigation, climate moderation, and disease control. The biosphere is no longer to be protected *from* the market economy as a vital reserve of fundamental, priceless value; the biosphere is now to be properly evaluated through full internalization *within* the calculative apparatus of the financial markets, with all its biodiversity and ecosystem functions to be priced, privatized, securitized, and traded as "vital infrastructure assets."

The emergence of "ecosystem services" is attested to by a mushroom-cloud-shaped literature across the gray literatures of big conservation and international policy fora, and the journals of conservation biology and ecological economics where it has wide if often uneasy professional

acceptance. On the ground, private and state actors foster a host of experimental biodiversity banks, markets for ecosystem services and biodiversity "offsets," and development projects involving payments for ecosystem services. At the level of the United Nations, this has culminated in attempts to theorize and codify "The Economics of Ecosystems and Biodiversity" (TEEB) as a governmental policy language (Bishop, 2012; Sukhdev et al., 2010; ten Brink, 2011). Certainly, the problems this literature seeks to address are serious. How to re-establish habitat connectivity between the isolated islands of "biosphere reserves" across landscapes privately owned and dedicated to economic production, without a massive program of land nationalization? How to finance the maintenance of existing biosphere reserves and national parks and indeed increase their reach in the postcolonial South, given their vulnerability to the permanent fiscal crisis of the state brought on by structural adjustment, volatile capital flows, and the exhortation to export primary commodities to service debt? Who among us would not hope to witness, after a bit of microcredit and "social innovation," a flourishing of small, medium and large conservation providers, the rise of a productive sector specializing in mass ecological restoration, and long-term prudential ecological management of carbon sinks? Wouldn't it be wonderful to live in a world where it was so profitable to nurture the well-being of the biotic community that "providers" of "ecological services" could outbid coal miners for land containing coal?

In order to savor this improbable utopia, this chapter seeks to situate the rise of the "economics of biodiversity and ecosystem services" within a wider history of "financialization." Concisely, the term financialization refers to the "process whereby financial services, broadly construed, take over the dominant economic, cultural, and political role in a national economy" (Phillips, 2006, p. 268). A consequence is the penetration of global financial markets into the intimate texture of everyday life, exemplified in the securitization of household debts, and the numerous ways in which ordinary wage-earners are enjoined to manage their increasing exposure to global financial risk by becoming a kind of finance capitalist of oneself as a portfolio of precarious assets and liabilities (Martin, 2002; Martin et al., 2008). This process is coterminous with "globalization" insofar as the denationalization and liberalization of finance has been a continuous project of US foreign policy, IMF structural adjustment policies, WTO provisions, and other supranational trade treaties.

In this chapter, my account of “ecosystem services” begins with the observation that this re-translation of the problem of biosphere destruction is seamlessly adapted to the reigning mode of political economy. The essence of neoliberalism as a political philosophy is derived from the social epistemology of the Austrian economist Friedrich Hayek, who stuck fast to the view that society and nature are both so complex that market prices are the only reliable form of collective information gathering, processing, and distributing. Its inscrutable “decisions” on how to organize economic life, even if they seem irrational, cruel, and unjust, in fact always surpass the expert knowledge assembled by democratic institutions or scientific organizations, regardless of popular desires for social justice or other purposes. “Ecosystem services” offers little resistance to the Hayekian view of the market as a kind of omnisciently efficient hive mind organizing the impenetrable complexity of the world according to an inscrutably distributed epistemic vantage point that no mere individual or institution can hope to occupy. Nor does it quibble with the standard neoclassical economists view of the economy as an object modelled to mathematical perfection as a frictionless market eternally returning to timeless equilibrium—yet whose natural destiny is to “grow” constantly and infinitely increase the output of consumer products, and thereby that portion of the earth where we come across fossil-fuelled industrial technomass and its manifold side effects.

That there is a long history of conceptual exchange between the disciplines of ecology and economics is not known nearly well enough, suffice to say that ecology has always been politically subordinate, and a debtor in the relationship. In accepting “ecosystem services” as common language, the ecological scientist thus risks becoming too well attuned to the neoliberal ontology of nature, knowledge, and political morality, unwittingly enrolled in the production of a neoliberal science, and a neoliberal nature.

In Hayek’s mature philosophy, which fortified itself by drawing upon the sciences of biological complexity to which ecologists like C.S. Holling (1973) were key contributors, the market is *like* the biosphere, insofar as it is an evolving, nonlinear and complex adaptive system. It is an emergent order too complex and resilient for any centralized form of knowledge to comprehend, much less to predict or control, one that thrives spontaneously upon its own catastrophic turbulence (Walker and Cooper, 2011). For Hayek, the market is the highest level attainable of collectively organized human knowledge, inaccessible to actual humans

apart from concise price signals. And yet, because we can only know nature or society through the information distilled and distributed by our own subjective “environment” of prices, we can never really know if the biosphere is in crisis, or whether it is worth doing something about it, until it is actively traded for profit in private exchange.

The new political economy of extinction, represented by proposals for markets in ecosystem services, thus reframes the problem in the familiar neoliberal fashion as a “market failure,” traceable *not* to the inherent inappropriateness of private-profit seeking as the solution to particular collective social problems such as the sixth mass extinction, but rather a political failure of government to foster the market’s autonomous proliferation of novel market formats, property rights, and financial products (i.e., “financial innovation”) in the spirit of the Mont Pelerin Society member and Chicago School economics-law scholar Ronald Coase (1960).

The idea that our only hope to conserve and restore the biosphere is to have social interactions with nature, mediated and “self-regulated” by financial market prices, is “grounded” in the Chicago School finance theories of rational expectations and the “efficient markets hypothesis” (Fama, 1970; Lucas, 1972; Sargent, 1973). Numerous analysts have linked the EMH to the phenomena of “financialization” and thus causally to the ongoing world economic crisis. Thus, it is, on the face of it, wholly surprising that a body of financial theory that has failed so spectacularly in the sphere of finance policy should now be called upon to effect the missing transvaluation of ecological values that we so desperately need to prevent “the economy” from taking the biosphere down altogether.

## A Brief Genealogy of Ecosystem Services

The standard neoclassical model of permanent growth in equilibrium denies any direct role for natural resources in the economic process: market economies “naturally” converge upon a steady rate of growth. Responding to the “limits to growth” debate of the 1970s, mainstream economists tended to dismiss the problems of pollution and the exhaustion of natural resources (presumed to be strategic minerals in almost every case), as exciting opportunities for entrepreneurs to cash in with the next technological *substitution*. Such was the faith in a generic abstract

“technology,” that some predicted that the consequence of an inexorable depletion of minerals and fossil energy would be a miraculous future “age of infinite substitutability” (Goeller and Weinberg, 1978).

The mainstream economist’s response was to re-frame the problem as an inquiry into the market conditions conducive to “optimal growth paths” and “optimal rates of depletion” (Solow, 1974; Stiglitz, 1974a, 1974b). Reflecting the rising influence of Chicago finance theory, a common thread in these papers was the Hayekian conjecture that real economic problems were not biophysical but informational: the crisis was in fact the absence of futures markets for natural resources. As Dasgupta and Heal put it:

[M]any of the difficulties that are involved in the making of policy recommendations about the rate of depletion of exhaustible resources stem from the fact that crucial aspects of this problem are inherently uncertain, and it is not clear that an adequate class of contingent markets exists. (1974, p. 4)

Redirecting the question of the limits of “natural resources” away from an abiotic pre-occupation with strategic minerals, the term “ecosystem services” was coined by publicly engaged ecologists and conservation biologists in the 1980s as a pedagogical device to try to get across to conventional economists the point that neither human life nor “the economy” could exist without the biosphere in something resembling its present form. As Lovelock (1979) has observed, without the geo-transforming effects of the biosphere, the Earth would have an oxygen-less atmosphere of 98 percent carbon dioxide, and an annual average temperature of around 290°C.

Against orthodox techno-optimism, Ehrlich and Mooney (1983) insisted that certain “keystone” species, were vital, irreplaceable, and nonsubstitutable. Critical as partners in so many symbiotic, mutual relationships across the web of life—food, habitat, pollination, seed dispersal, soil structuring, ecological engineering—their loss could cascade in a kind of extinction multiplier effect, which could degrade and irreversibly alter ecosystems, curtailing their productivity and abundance, ultimately unravelling crucial planetary *ecosystem functions* such as temperature regulation, soil formation, and the cycling of water, nitrogen, phosphorus, and carbon. Extinction events (“losses of biodiversity”) are not atomized, discrete events, but are themselves time-delayed causes of further local, regional, and global extinctions, as recognized in the concept of “extinction debts” (Tilman et al., 1994). In one of the earliest papers

to conceptualize “ecosystem services,” published before the neologism “biodiversity” had been coined, the causal link between extinction and “human well-being” was baldly asserted:

[A]ll [ecosystem services] will be threatened if the rate of extinctions continues to increase (*italics in original*, Ehrlich and Ehrlich, 1981 cited in Maier, 2012, p. 187).

In practice, this move disclosed a knowledge problem: the precise causal relations between any particular species and its environment, between biodiversity (species richness, genetic diversity, community diversity) and the ecosystem functions that emerge from and condition biotic existence, are radically under-determined. Part of the problem is attributable to the classical division of scientific labor between the organismic perspective (of community, evolutionary and population ecology), and the abstracted biochemical and biophysical approach of systems ecology. This gulf can be attributed in part to the sheer complexity of ecological causality, given the temporal and spatial openness of real ecosystems. Conservation biologists thus argued that, in light of our ignorance of the precise causal relations between biodiversity loss and ecosystem failure, a rigorous precautionary policy was warranted toward *every particular extinction*.

The lack of clarity as to how species loss might generate changes in global ecosystems, or how biodiversity was related to global biomass “productivity” modeled by the International Biosphere–Geosphere Program, has given rise since the early 1990s to a whole new sub-discipline in ecology called biodiversity and ecosystem function (BEF) research. These studies emphasize the *functions* of species in biogeochemical or ecosystem processes and attempt to directly assess their role in ensuring the reliable function of ecosystems (Naeem et al., 2009).

Since the 1980s, ecologists have made serious efforts to work with mainstream economists. This has happened in convocations such as the Beijer Institute of Ecological Economics and in multi-authored papers that have used “ecosystem services” as a means to cobble together some common intellectual ground (Arrow et al., 1995). One widely discussed paper co-authored by leading BEF ecologists and environmental economists (Costanza et al., 1997) estimated the annual monetary value of the biosphere’s contribution to human well-being on the order of \$US33 trillion, although most of it was “outside the market.”

Ehrlich's student, Gretchen Daily, has been one of the most important popularizers of ecosystem services (Daily et al., 2002). But it was the publication of the UN Millennium Ecosystem Assessment (2005), which adopted the idiom of ecosystem services for its policy framework, that did the most to catalyze the mushroom-cloud shaped literature on "ecosystem services" across journals like *Conservation Biology* and the increasingly mainstream *Ecological Economics*, the "gray" literatures of governments and natural resource management, big environmental NGOs (ENGOs) such as The Nature Conservancy, Conservation International and World Wildlife Fund, global development institutions (UNEP, WB, etc.), and the transnational networks where scientific and policymaking coalitions are forged. Tacitly acknowledging the abandonment of scientific materialism at stake in the neoliberal conflation of "the economy" with financial markets, the UNEP Finance Initiative (UNEP-FI, 2012) undertook a quest to "demystify materiality," the better to "hardwire biodiversity and ecosystems into finance." Numerous experiments involving markets and other systems of payment for "ecosystem services" are underway. Along with various "species banks" there are also a range "offset" schemes underway such as the US market for wetlands, which in theory trades habitat loss against restoration projects under a "cap and trade" no net loss arrangement (Pawliczek and Sullivan, 2011; Robertson, 2004). Then there is the global Business and Biodiversity Offsets Program initiated by a consortium of mining and logging interests in what is claimed as voluntary "self-regulation."

Given its origins in a plea for the irreplaceability of natural species and communities, and the absolute irreversibility of extinction, it is more than a little ironic that "ecosystem services" has become a technology of security designed to increase the biosphere's "liquidity" from the point of view of financial markets. By "securitizing" ecological units and processes into financial assets that can be negotiated, exchanged, or substituted on capital markets for cash or other forms of financial capital (the "biodiversity offset," for example, which trades an act of present destruction for a promise of ongoing conservation or future restoration), "extinction debts," which are by definition strictly unpayable, can become profitable sites of financial innovation and portfolio investment. But of course it must be remembered that liquidity also presumes the possibility of instantaneous *disinvestment*. In a world where biodiversity

protection is to be mediated by global markets for ecosystem services, the process of identifying expendable species via triage becomes not so much a case of the kind of Taylorist scientific analysis of species utility, as it does in the BEF literature (Kareiva and Levin, 2003), but of rational business decisions to write off unprofitable investments, or in the larger market context, according to the speculative effect of euphoria or panic that constitutes volatile financial market sentiment.

One consequence is a shift in the site of the determination and execution (or not) of environmental policy from government corridors to the boardrooms of transnational corporations, and a privatization of an increasingly scarce ecological health.

## Financialization: A Cautionary Tale

It seems worthwhile to note that many of the key actors involved in the push to reframe ecological protection, conservation, and restoration as financially profitable business activities also have senior roles in the global investment banks at the center of the financial crisis. While the ecosystem-services literature often claims to be merely providing a means to evaluate biodiversity in land-use decisions, the logical extension of the strange idea that "nature has to pay for itself" (Daily and Ellison, 2002) is the project to transform the world's ecosystems into natural capital assets capable of yielding flows of "services" that can be privatized, securitized, and profitably traded in global financial markets (Chichilnisky and Heal, 2000). The risk of extinction and ecological meltdown is at stake in the effort to construct a global market in ecosystem services, in the transformation of the figure of the conservationist from a woolly naturalist to a consummate banking insider. This transfiguration is complete in the person of Pavan Sukhdev, the leader of the UNEP Green Economy initiative and its project to codify TEEB. An international career banker and financial "innovator," Sukhdev's credentials include having:

[W]orked with Deutsche Bank for 14 years. [...] While at Deutsche Bank in India, Pavan founded and later chaired [the] Global Markets Centre, Mumbai "[...] It is being used by Deutsche Bank's originations, derivatives structuring, trading and distribution teams in equities, credit, fixed income and foreign exchange around the globe. (TEEB, 2012)

An eloquent activist for the cause of mainstreaming biodiversity and ecosystem erosion, Sukhdev was a key figure in the successive rounds of liberalization of Indian financial markets and was instrumental in India's currency and interest rate and derivatives markets from 1993 till 1998. More recently, he has chaired the World Economic Forum's Global Agenda Council on Ecosystems & Biodiversity and currently serves on the boards of Conservation International and the Stockholm Resilience Centre. The purpose of TEEB is to internalize the economic values of nature into decision-making at all levels using market pricing (Spash and Aslasken, 2012; TEEB, 2010, pp. 3, 14). The Synthesis Report indicates that TEEB intends

creating a common language for policymakers, business and society that enables the real value of natural capital, and the flows of services it provides, to become visible and be mainstreamed in decision making. (TEEB, 2010, p. 24)

We learn about the form of this common language in *Ecological and Economic Foundations* (Pushpam, 2010), the key theoretical book in the TEEB series:

In economics, "value" is always associated with trade-offs—that is something only has (economic) value if we are willing to give up something in order to get or enjoy it. The common metric in economics is monetary valuation.

As Spash and Aslucken (2012) understand it, TEEB is congruent with a philosophy in which corporations can do no wrong.

TEEB employs the political rhetoric of "getting the price right" to allow markets to function efficiently. This involves explaining that, waste sinks have no cost for the private sector, and non-market benefits provide no reward to the market investor. In this neo-liberal framing private companies that destroy and pollute are innocent victims of a failing price system and cannot be blamed because they lack the right incentives for ecologically sustainable management. So we are told that, "Companies do not clear-cut forests out of wanton destructiveness or stupidity. On the whole, they do so because market signals [...] make it a logical and profitable thing to do." (TEEB, 2010, p. 9)

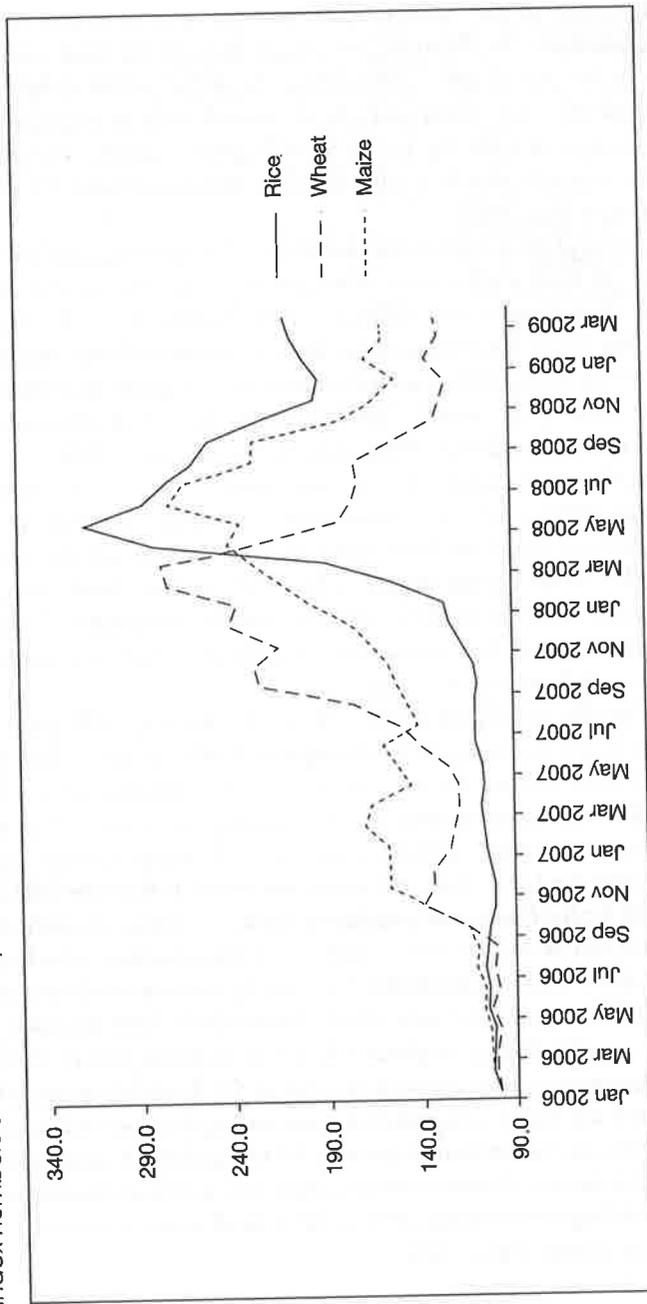
Proponent for the privatization of natural capital and the construction of new markets to finance ecosystem service provision have

not, it seems to this author, addressed the problems generated by financialization. To illustrate, we might look at the food crisis that broke in the period 2007–2008, when the global prices of basic food commodities—rice, maize and wheat—soared amid an unprecedented amplification of volatility in the world's grain markets. The price of rice, for example, almost tripled between March 2006 and the peak of the spike in May 2008.

Millions of poor, worldwide, accustomed to spending much of their income on food staples, were immediately thrust into destitution and hunger. According to one estimate, of the roughly two billion people across the world who spend more than 50 percent of their income on food, 250 million people joined the ranks of the hungry in 2008, bringing the total of the world's "food insecure" to a peak of one billion people (Kaufman, 2011). Food riots broke out from Haiti to Cairo and social unrest simmered. Northern media attention turned to the stunning collapse of Wall Street banks in September 2008 and the *Götterdämmerung* of the Bush administration bailing out the banks at the center of the roiling of global financial markets. Even after grain prices eased in world markets, prices did not fall in numerous local and national contexts in the South, restricting the poor from accessing food with varying degrees of intensity.

Noting that grain production continued to keep up with grain consumption, and that prices of local millets and other grains not traded in world futures markets did not rise, the Indian economist Jayati Ghosh isolated the seismic price shifts and the ongoing rise in food prices to the generation of a highly profitable price bubble. Seeking exposures uncorrelated with the US finance and real estate sector as the subprime crisis unfolded, hedge funds and investment banks including Deutsche Bank and Goldman Sachs, piled into staple food futures markets, which in the United States had been deregulated in 1999 by the Commodities Futures Trading Commission (Ghosh, 2010). Billion dollar bets on price rises become a self-fulfilling prophecy. Olivier De Schutter (2011), UN special rapporteur on food security, has linked the financialization of food markets to the global land grab that is driving up the price of land rights in many Southern contexts, especially Africa, pushing local farmers off the land in favour of transnational exports to countries with surplus US dollar holdings and inadequate long-term food security, such as China and Saudi Arabia (Figure 1.1).

**Figure 1.1**  
Index numbers of world trade prices of food grains



Source: Ghosh (2010, p. 76).

It is not incidental, I think, that the most influential advocates of market-based environmental policy are to be found amongst the financial elites that benefitted most from the dismantling of Depression-era banking law and public interest legislation, such as the 1933 Glass-Steagall Act, and the international restrictions placed on financial speculation in the Bretton Woods system between 1944 and 1971. Repealed under pressure from Wall Street lobbyists and neoliberal economists, these reforms had for generations, at least in the West, effectively minimized the situation J. M. Keynes had described in the *General Theory*:

Speculators may do no harm as bubbles on a steady stream of enterprise. But the position is serious when enterprise becomes the bubble on a whirlpool of speculation. When the capital development of a country becomes a by-product of the activities of a casino, the job is likely to be ill-done. (Keynes, [1936] 2009, p. 142)

Since our concern is the capital (re)development of the biosphere as such, the stakes are very high indeed. Thus it seems at best naïve to argue that the risk of species extinction should be transferred to the financial markets and managed on a for-profit basis through biodiversity derivatives (Mandel et al., 2009). It is not too difficult to imagine particular conservation investments being written down, or vulnerable species “shorted” to extinction in accordance with the ultra-short term investment horizon of speculative finance.

## Highly Connected: Complex Hierarchies in the Financial Ecosystem

Whilst bankers such as Pavan Sukhdev are conceiving of a comprehensive suite of financial markets for the risk management of ecological turbulence, there is also a coterie of senior ecologists engaged in applying cutting-edge ecological theory to the analysis of systemic financial risk. Although the two projects, which form an inverted mirror of each another, are yet to be explicitly articulated, their protagonists move in the same circles, an elite milieu in which the volatilities of a stressed biosphere and of deregulated global finance are routinely conflated.

The mainstream economics profession has tended to adopt a position of defensiveness and radical innocence with regard to its intellectual

complicity in authorizing runaway financialization (Mirowski, 2013). The post-crisis debate has nevertheless catalyzed a reappraisal of the neo-classical presumptions of perfect information, infinite foresight, instantaneous and frictionless returns to equilibrium after exogenous shocks, complete markets and risk-free financial contracts, linear predictability and the utter uniformity of the representative agent, assumptions programmed into the computable Dynamic Stochastic General Equilibrium model, which became a mainstay of government and central bank policy-making prior to the crisis. The Global Financial Crisis (GFC) has brought to the fore a movement which seeks not to provide a radically alternative policy analysis, but to rather extend and completely re-found the ontology of finance and macroeconomics away from the pale imitation of Newtonian physics, and to bring financial economics into conformity with developments in the cutting edge sciences of biological complexity.

In 2009, Andrew Haldane, the Bank of England's Executive Director of Financial Stability, argued for the integration of complex systems theory (particularly as developed in the field of ecosystems science) into the toolkit of financial regulation. Haldane's project was mentored by the veteran systems ecologist Robert May, himself an official scientific advisor to the Bank. Unfolding the logic of connectivity that is germane to complexity theory, Haldane highlighted the systemic parallels between the contagion effects of infectious disease, ecological crisis and bank failures occurring in critical nodes of the global financial markets:

Both events [the failure of Lehman Brothers and the unfolding of the SARS epidemic] were manifestations of the behavior under stress of a complex, adaptive network. Complex because these networks were a cat's-cradle of interconnections, financial and non-financial. Adaptive because behavior in these networks was driven by interactions between optimizing, but confused, agents. Seizures in the electricity grid, degradation of ecosystems, the spread of epidemics and the disintegration of the financial system each is essentially a different branch of the same network family tree. (Haldane, 2009)

Haldane went on to suggest that regulators should abandon the general equilibrium models of orthodox economics and instead "rethink the financial network as a complex adaptive system" characterized by nonlinear dynamics and susceptible to sudden changes of phase state or so-called "tipping point" during periods of stress. Shortly before he delivered his speech, a group of senior ecologists including Robert May, Simon Levin, and George Sugihara published a paper in *Nature* which outlined the

usefulness of complex systems ecology as a model for bankers during the gathering sub-prime crisis (May et al., 2008). Both financiers and ecologists emphasize that they are only drawing analogies between what they speak of as formally similar but ontologically discrete worlds of money and life in general. Yet the history-making interactions between the eroding biosphere and the financial markets is precisely what is at issue for the advocates of biodiversity derivatives and markets for ecosystem services.

The career of the marine ecologist George Sugihara personifies the epistemic and professional convergence of the conservation biologist with the figure of the financial innovator. An expert in the population modeling of plankton and fisheries as chaotic, complex systems, Sugihara was "seduced" in the mid-1990s by Deutsche Bank and spent several years in their derivatives arm working on a secret "black-box project" to develop novel instruments and trading strategies (Dalton, 2005). On his return to the Scripps Institute of Oceanography, he began work on a project to set up a market to conserve fisheries by allowing fishers to profit from trading in fish futures, options, and catch rights—an alternative to catching and selling fish. Fish markets are subject to large volatilities of price and catch volume, offering ideal conditions for derivative trading which thrives on critical events. His outlines of derivative contracts for such an exchange are, quite fittingly for the privatized knowledge technologies of financial innovation, the subject of patent applications.

The ecologist Peter Kareiva is head scientist of The Nature Conservancy (TNC), and an author of the methodology of ecosystem services valuation developed by the Natural Capital Project. The acronym "TNC" aptly symbolizes the transnational reach and corporate organization of the Big Three conservation NGOs (the other two being Conservation International and World Wildlife Fund) which since the mid-1980s, a period widely noted for the drying up of conservation funds, have come to control perhaps a half of the finance available for conservation globally (Chapin, 2010). Notably, it was during the 1980s' Third World Debt crisis, which precipitated a rapid increase in the rate of deforestation in the tropics, as IMF "structural adjustment" programs replaced import substitution with "export led development" and fiscal contraction, that conservation NGOs such as World Wildlife Fund, Conservation International and the Nature Conservancy gained international high finance experience in the form of the "debt for nature swap," buying out portions of "distressed" sovereign debt on secondary markets in exchange for commitments to fund protected areas (Reilly, 2006).

Self-described prior to the sub-prime crisis as “Nature’s Real Estate Company,” TNC eschews the environmentalist role of public policy critique in favor of the bequest and purchase of private land for conservation corridors and easements. While the effectiveness of this global effort is beyond our present concerns, TNC has been accused of not being above some environmentally questionable land speculation in a series of articles in the *New York Times*, of allowing oil drilling on donated land, and of involvement in the Bush era rewrite of the Endangered Species Act, which introduced cost-benefit criteria into the process of listing endangered species and devolved enforcement from the EPA to an assortment of local agencies. Scientists such as Kareiva and Gretchen Daily are well outnumbered on the TNC Board, which includes senior executives from the “keystone” predators of the global finance ecosystem: the hedge fund Blackstone, Barclays Bank, Goldman Sachs. The Conservancy’s current CEO, Mark Tercel, was previously the executive responsible for the Goldman Sachs Centre for Environmental Markets. And while it declines to publish the names of its hundreds of corporate donors, the advisory “Business Council” listed on the Conservancy’s website includes ExxonMobil, Dow Chemical, Duke Energy, Weyerhaeuser, Monsanto, corporations who are significant opponents of environmental law, and noted funders of neoliberal think tanks and counter-science media campaigns. As Naomi Klein (2013) has noted, Conservational International and TNC invest considerable portions of their substantial funds directly in the fossil fuel sector, which does seem something of an ethical contradiction.

For our purposes, perhaps the most illustrious political insider and figure of neoliberal conservation is the billionaire Hank Paulson, who prior to his fateful appointment by President G.W. Bush as US Secretary of Treasury, served simultaneously as CEO of Goldman Sachs and Chair of the TNC Board. It is in the latter capacity that he wrote:

It is clear that a system of market-based conservation finance is vital to the future of environmental conservation. (Levitt, 2005)

Three years later, in a move antithetical to the public neoliberal narratives of the small state and efficient markets, Paulson sought from Congress exceptional powers of sovereign debt creation and wealth transfer from taxpayers to private banks.

The Secretary is authorized to purchase, and to make and fund commitments to purchase, on such terms and conditions as determined by the Secretary, mortgage-related assets from any financial institution having its headquarters in the United States. (From the original 5 page draft of the Troubled Assets Relief Program, 2008, cited in Kolb, 2010, p. 317)

As US Federal Reserve Chair Ben Bernanke said in 2008 after Lehman’s collapse, the risk was that, without immediate, extreme intervention, “there will be no economy on Monday.” One wonders what kind of crisis would generate an immediate intervention to prevent the possibility of there being “no biosphere” for the next generation.

Prior to the GFC, explicit attempts to move economic theory beyond the unrealistic assumptions of neoclassical equilibrium had been almost exclusively directed at financial price phenomena, as “rocket scientists” with superior mathematical skills were hired to develop trading strategies for hedge funds. But in the wake of the crisis, the Hayekian vision of the market as a complex system spontaneously evolving in far-from-equilibrium conditions has arguably come into its own in the general re-founding of risk management in the terminology of resilience, “tipping points,” and epistemic limits to prediction that had already been accomplished in the spheres of adaptive environmental management, critical infrastructure security, counter-terrorism, and disaster response (Walker and Cooper, 2011).

The extraordinary resilience of neoliberalism post-crisis, I would suggest, is partly due to its metaphorical shift from outdated “balance of nature” and “equilibrium” metaphors drawn from mechanics and energy physics as the ideal image of scientific explanation, to the life sciences of biological complexity. Neoliberals cognizant of the Austrian focus on emergent processes are apt to find themselves awed by hedge funds, with their breathtaking generation of “financial biodiversity” or fancifully conflating public banks with “species” doomed to extinction (Ferguson, 2009; Lo, 2005). The lesson is clear: finance capital is not only the natural extension of the deep evolutionary history of the biosphere, but an immanent expression of its selective evolutionary filter.

Given the prevalence of such soporific memes, there was something refreshing in the study conducted by several experts in the mathematics of network topologies (Vitali et al., 2011). Their analysis of newly available cross-ownership data of 43,000 transnational corporations led them

to identify a “super-entity” of 147 supra-national finance corporations at the core of the global economy, with Barclays, Deutsche Bank, and Goldman Sachs close to the top of the list. On their analysis, these banks and funds exert a profoundly concentrated degree of control over the global network of corporations in the “real economy.” Indeed, according to their analysis, “network control ... is much more unequally distributed than wealth. In particular, the top ranked actors hold a control ten times bigger than what could be expected based on their wealth” (2011, p. 6).

The release of the report coincided with the peak of the Occupy Wall Street protests against the increasing convergence of financial and political power in the aftermath of the financial crisis. Journalists reporting on the study sought the views not, as one might expect, of economic historians or political theorists but rather of exponents of the mathematics of complexity theory. One of these was financial insider George Sugihara, who while admitting that it was “disconcerting to see how connected things really are,” nevertheless brought the gravity of complexity science to bear, arguing that the study was “strong evidence that simple rules governing TNCs give rise spontaneously to highly connected groups,” and assuring us that there is no point worrying about the increasing concentration of political power in the hands of a small band of billionaires, as “such structures are common in nature” (Coghlan and McKenzie, 2011). Sugihara was referring to “power laws,” a staple of the Santa Fe “complexity” school of financial economics. His common natural structures, however, rather trace back to the social sciences, and to one of the founding neoclassical economists, Vilfredo Pareto, who developed a logarithmic formula to describe the “natural fact” that “in all countries and at all times the extreme distribution of income and wealth follows a power law distribution” (Farmer and Geanakoplos, 2008). For Pareto, inequalities of wealth “naturally” coalesced around a distribution wherein the wealthiest 20 percent of the population control 80 percent of wealth, a distribution which, while alarming on the surface, would be something of a socialist utopia in comparison to the far more polarized wealth of contemporary financialized America (Domhoff, 2013). The “Pareto Principle” is widely cited as a prelude to the discovery of power laws, which are held to have universal application in theorizing extreme deviations from Gaussian probability in events such as earthquakes, financial crises, and tellingly for our narrative, mass extinction events (Sole and Manrubia, 1996).

## Who Will Buy My Rain?

In 2008, Canopy Capital, a London-based private equity firm, purchased the rights to market the ecosystem services of the Iwokrama nature reserve, a protected tract of rainforest in the Guyana Shield. While the firm and the government of Guyana declined to publicize the terms of their agreement, or to clarify to the forests’ indigenous owners by what sovereign power the state first exclusively possessed and then denationalized these rights, it was noted that these ecosystem services included rainfall production, water storage, and weather moderation provided by a 1,432 square mile patch of rainforest. Canopy Capital suggested it was looking at marketing “ecosystem services” through an “Ecosystem Service Certificate” attached to a 10-year tradable bond, the interest from which will pay for the maintenance of the Iwokrama forest.

On the Australian leg of his TEEB world tour in 2010, Pavan Sukhdev put up a slide that showed a relief map of the South American continent, and demonstrated the necessary dependence by farmers in the temperate crop growing regions of the continent on the rainfall generated by the tropical rainforests of the tropical north. Noting that the “Amazon Rainforest Water Pump” puts 20 billion tons of water in the atmosphere, some of which falls on the Rio Plata Basin, Sukhdev posed the rhetorical question, “What does the granary of Latin America pay for its freshwater?” As your present author, who was in attendance, happened to be puzzling through the problem of how Canopy Capital would generate the income to meet the coupon payment on its rainforest bonds necessary to attract private investment, it seemed that Sukhdev had provided the answer. When I asked him if he knew how Canopy Capital intended to exclude nonpaying farmers from rainfall, he was merely irritated and called for the next question. However, as Canopy Capital’s website darkly hints, recalling the disastrous social triage effected by the water-privatizations imposed by the IMF and the World Bank upon Bolivia, “[i]f we continue not to pay for this public eco-utility, its services will simply be cut off” (Canopy Capital, 2013).

The financialization of the biosphere is at this point but a speculative project, one that acknowledges the contribution of global financial architectures to destructive economic practices, and the desperate need for massive, long-term investment in conservation and restoration. Yet, it does this in such a way as to disarm any radical critique of corporate capitalism in its contemporary finance dominated expression. “Ecosystem services”

abandons the potentially radical point of view of earlier conservationism, which understood ecological breakdown as the result of the dominant economic model of permanent industrial growth in conditions of presumed market equilibrium. The implication that economic theory and practice would need to accept that the “economy” was a subset of the biosphere, and the recognition that this would require a reformulation of macroeconomic doctrines so that they were subordinate to ecology, no longer in flagrant contradiction with the earth sciences, has been neutralized. Something almost the reverse has happened, a process in which ecologists themselves have played an essential part. The political effects of the collapse of the distinction between markets and life may include the naturalization of global financial crisis, and the speculative financialization of extinction.

In the wake of the 2008 financial crisis, no serious reform of transnational finance has been contemplated: the socialization of the speculative losses of private banks in the form of government debt, bailouts, and austerity measures has rather furthered the concentration of wealth in finance houses at the center of the crisis, banks which are also key players in the discursive construction of markets for ecosystem services. As evidenced by the ongoing global economic crisis, a crisis which has itself undermined market-based responses to climate change, capital markets are not capable of self-regulation, much less of determining the “optimal mix” of species and ecosystems composing the biosphere. Just as the environment of national economic policy is increasingly subject to the power of private finance capital and their alumni in central banks in and through crisis, increasingly the environment of the “environment” is the financial markets.

## Note

1. Marginal utility theory refers to the currently hegemonic form of economics which takes the explanation of price formation in terms of the preferences of a representative “individual” as more or less exhausting the methodological scope of a “scientific” economics. Whilst the classical political economy of Smith, Ricardo, Mill, and Marx analyzed the production and distribution of wealth, drawing upon history, law, and the natural sciences to understand the political and material transformations wrought by industrial capitalism, the “marginalist revolution” of the 1870s, Leon Walras, William Stanley Jevons, and Carl Menger, attempted to establish a pure economics through a depoliticized analysis of market dynamics. The term includes both neoclassical and Austrian economic theory, despite their respective differences in approach.

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