Chapter 5

Can We Put a Price on Nature's Services?

In 1962, the Drifters, a popular rock 'n' roll group, sang:

> At night the stars put on a show for free,
> And darling, you can share it all with me . . .
> Up on the roof . . .

Nature provides many products and services that we, like the Drifters, enjoy for free. But, as Thomas Paine said about liberty, "What we obtain too cheap, we esteem too lightly." Ecologists point out that "the goods and services that nature provides in support of an economy – such as the cycling of nutrients for the production of renewable resources (like fish and forest products), the pollination of flowering plants, and the regulation of climate – are free."[1] We may therefore esteem them too lightly.

Many ecologists and ecologically minded economists suggest that we would appreciate and protect nature more if we attached market prices to the products and services it provides.[2] According to one prominent ecologist, "Moral arguments are not enough – we have to make nature a regular column in our spreadsheets and cost-benefit analyses, so that natural assets are properly valued in our decisions."[3]

THE ARGUMENT OF THIS CHAPTER

In later chapters, I shall try to show that moral, aesthetic, cultural, and spiritual arguments are enough; they provide compelling reasons to preserve the magnificent aspects of the natural world. In this chapter, I shall defend two theses. First, I shall discuss large-scale atmospheric or biospheric processes or forces of nature. Planetary atmospheric systems are what economists sometimes call "lumpy" goods, that is, goods that

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cannot be provided incrementally, divided in pieces, or sold in units. Either we protect (or "buy") the whole system or forgo it; there is no way to trade in marginal amounts. Accordingly, political will and legal institutions may be required to transit industry away from technologies that threaten to destabilize the planetary climate. To be sure, the most effective policies to reduce or limit "greenhouse" gases will rely on market forces and incentives; nevertheless, there is no meaningful way to "price" units of the global climate incrementally or at the margin.

Second, I shall discuss those goods – such as arable land – that are or can be sold in incremental amounts and therefore do trade in markets and thus do receive competitive prices. The productive services of nature, such as the ability of fertile soil to grow crops, receive low market prices not because markets fail or because a resource such as fertile soil is a "public good" but because the resource, in this example good cropland, is quite abundant relative to effective demand. This is the case generally. Even when one takes a service for granted – the wind that pollinates cereal crops, for example – one may pay the full market price for it, even if it is zero, because the supply is adequate and free.

I shall begin this chapter by introducing the theory that led John Locke at the end of the seventeenth century to conclude that nature has little if any economic value as he understood that concept. I shall use the context of the labor theory of value – from Locke to Marx – to discuss the prices nature or its products or services command or could command in a competitive market. As I have argued in earlier chapters, price coordinates economic activity in ways that lead to prosperity by providing information about such conditions as scarcity relative to demand. I shall argue that market exchange generally succeeds in setting prices for goods associated with ecosystems, such as farmland, timber, and water. Absent well-known distortions caused by governmental subsidies, markets work well for these commodities, and their prices represent how willing buyers and sellers trade marginal or incremental units of these goods.

In this chapter I ask whether any ecosystem product or service that does not now trade between willing buyers and sellers could do so – that is, if it could receive a competitive market price – if property rights were established or some impediment to exchange were removed. Is there any ecosystem product or service that does not already receive a more or less objective market price – and thus which should receive a "shadow" or imputed price in our spreadsheets and cost-benefit analyses? This

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chapter asks, to quote law professor Barton Thompson, "whether there is a more robust and direct role for markets in preserving the environment."[4]

This essay will argue that nature and its services are either (1) of such general and broad importance, such as global atmospheric systems, or so related to pollution (a form or coercion) that the the concept of "marginal utility" or "competitive market price" does not apply to them; (2) actually priced by extant markets; or (3) too plentiful to command a price at the margin ("too cheap to meter"). In other words, I shall argue that the attempt to attach hypothetical market prices to ecological services will fail because these services – if they can be sold in incremental units – have competitive market prices, even if because of the abundance of supply relative to demand, the prices are negligible.

Of course, we depend completely on nature's largess. The appropriate response to dependency, however, is gratitude. You do not respect a gift by inquiring about its price. It is not as if God markets nature to us. This is especially true if nature's services are so plentiful (as they generally are) that they overwhelm demand and are free to all. What would price tell us about plenty? I will argue that it is hard to find instances in which markets would establish prices for environmental goods or services but for "ignorance, institutional inadequacy, and the problems inherent in public goods."[5] By "putting a price on it" we regard nature as a resource to exploit rather than a heritage and an endowment to maintain. This is the most self-defeating path environmentalists can take.[6]

ECOSYSTEM SERVICES AT THE GLOBAL SCALE

Consider first ecosystem services at the global scale. I believe these should often be analogized not to economic goods to which prices may be attached but to the conditions – like liberty, property rights, the enforcement of contract, and so on – that make production possible. No one suggests that liberty should be "priced" though everyone knows it must be protected. To ask how a market would settle prices on legal, political, and social institutions is to pose a foolish question since no market could function without them. It is the same with biospheric processes on which life depends.

Once a political authority has "capped" or limited the amount of pollution that can be emitted and has established initial "allowances" among polluters – a very tall order in itself – these allowances could

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trade to encourage their efficient use. Such a regulatory market, if it could ever exist, would not represent voluntary exchange between willing buyers and sellers of ecosystem services. Regulatory markets represent command-and-control regulation made more consumer-friendly.[7] Barton Thompson has written, "Governments superimpose market structures onto these regulatory systems primarily to ensure that the limited rights to pollute, develop wetlands, and divert water are used efficiently, thus minimizing the cost of regulation to the economy."[8]

Governments may create "regulatory markets" – sulfur dioxide under the Clean Air Act provides the usual example – to make command-and-control regulations more cost effective. Thompson comments, "Beyond the odd anecdote, unfortunately, the actual value of pure regulatory markets to environmental preservation remains questionable."[9] So far, experience with attempts to "cap" carbon and trade "allowances" have been fraught with corruption as each player has insisted on having a supersized initial endowment. It would be one thing if carbon "allowances" were sold to the highest bidders and the money invested in clean technologies. It is another thing that the "allowances" are constructed from political whole cloth and allocated accordingly.

Those who propose a "cap-and-trade" policy for carbon emissions might be analogized to the mice in Aesop's fable. In their Council, one mouse proposed "that a small bell be procured, and attached by a ribbon round the neck of the Cat. By this means we should always know when she was about, and could easily retire while she was in the neighbourhood." When a wise old mouse inquired, "But which of us shall bell the cat?" no one had an answer. The old mouse declared, "It is easy to propose impossible remedies." In the same vein, a commentator has observed of carbon "markets," "The problem . . . is that it is anyone's guess whether such trading can work on a global scale."[10]

The principal difficulty that defeats efforts to impose a regulatory market on "greenhouse" emissions lies in finding a suitable, meaningful, and acceptable principle for setting initial allowances.[11] It is now apparent that nations in the European Union emissions "market," for example, gave themselves such huge initial entitlements (the technical term is "hot air") that they have had difficulty enforcing limits. As a result, the supply of "carbon emission rights" exceeds the demand, and as I write this chapter, the price of a one-ton unit plummeted from 30 to 8 euros in two or three days.[12] Economists "assume the can-opener" if they suppose that interested parties can agree on a formula to establish a "cap" and allocate initial allowances.[13]

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LOCKE ON THE ECONOMIC VALUE OF NATURE

At the time Europeans began to colonize the New World, John Locke compared land values in Great Britain to land values in America.

> An acre of land that bears here twenty bushels of wheat, and another in America, which, with the same husbandry, would do the like, are, without doubt, of the same natural, intrinsic value. But yet the benefit mankind receives from one in a year is worth five pounds, and the other possibly not worth a penny.[14]

Ecologically minded economists today describe as "ecosystem services" or as "natural capital" what Locke called the "natural, intrinsic value" of land. In 1997, a group of ecological economists estimated the economic value of ecosystem services and related natural capital at between $16 and $54 trillion per year.[15] Locke reasoned on the contrary that the labor accounts for nearly all the benefit land yields. "Labour makes the far greatest part of the value of things we enjoy in this world: And the ground which produces the materials is scarce to be reckoned in, as any, as any, or at most, but a very small part of it."[16] Locke suggested that labor accounts for the economic value of agriculture, while what we call ecosystem services are "possibly not worth a penny."

Locke supported his conclusion in part by defending a labor theory of economic value. For Locke, labor functioned as an essential ingredient that turned otherwise useless materials into useful goods. He wrote, "Land which is wholly left to Nature, that hath no improvement of Pasturage, Tillage, or Planting, is called, as indeed it is, *waste*; and we shall find the benefit of it amount to little more than nothing."[17] Economists following Locke, including Ricardo and Marx, endorsed the idea that the amount of labor inherent in an object determines its economic value. Because Karl Marx saw economic value as an inherent or intrinsic quantity and located it in the contribution of labor, he like Locke concluded that natural materials obtain value only when mixed with labor. "The purely natural material in which human labor is objectified . . . has no value."[18]

It would be hard to find an economist today – especially an environmental economist – who endorses a labor theory of economic value. Environmental and ecological economists, however, generally accept the idea that economic value represents or refers to an intrinsic or inherent essence. They may adopt one of two different conceptions of the normative factor that makes one good more valuable economically than another. The welfare economists I criticize in this book hold that the

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satisfaction of preference ranked by willingness to pay (WTP) is inherently or intrinsically valuable, that is, "preferences do contain their own normative content."[19] Ecological economists, in contrast, locate the source or nexus of value in the natural world, for example, in free energy, net primary productivity, emergy, exergy, or some other factor thought to be essential to production.

Ecological economists might follow Nicholas Georgescu-Roegen in arguing that the essential value-giving limit on production has to do with the fund-flow of low-entropy resources;[20] they might agree with Paul Ehrlich and others that net primary productivity (the product of photosynthesis) constrains economic growth;[21] or they may refer to various forms of "natural capital."[22] It makes no difference, however, whether you agree with Locke or Marx that labor is the normative element, with welfare economists who equate "benefit" with preference or WTP, or with ecological economists who develop concepts such as emergy to define what is intrinsically economically valuable. What is important is not how these positions differ but what they have in common, that is, a commitment to the idea that economic value is a measurable quantity – whether physiological (labor), psychological (WTP), or material (low entropy resource flows).

In this book, I have argued that nature has no economic value. The reason is not that nature does not benefit us in every way – of course it does – but that nothing has economic value. I have argued that the phrase "economic value" has no reference. Economists from Locke to Marx thought the term referred to the input of labor, but it is hard to find anyone who propounds this view seriously today. Ecological economists use the term to refer to a construct, such as "emergy," "low entropy resource flows," or something of that sort I do not presume to understand. (It probably took a lot of emergy to write this book, for example, but this is unlikely to affect its sales.) Welfare economists equate "economic value" with WTP – but as I have argued, WTP is not normative and refers to nothing of value. The term "economic value" has no tenable, defensible, normative definition.[23]

Nothing (including ecosystem services) has any economic value because the term "economic value" cannot be made meaningful – defined in terms of an essence, ether, or entity that has normative content. As an intrinsic value WTP has no standing. References to proxy terms such as "benefit," "well-offness," or "welfare" make definitional circles back to WTP itself. Invocations of WTP do not connect the concept "economic

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value" with any goal or objective society as a whole has a reason to pursue. The concept of WTP connects with nothing but itself or to ostensibly normative concepts, such as "well-being," arbitrarily defined in terms of it. The economist, therefore, has no role to play in "valuing" goods, whether in terms of surplus labor, consumer surplus, exergy surplus, or what-have-you surplus. The concept of "economic value" or "valuation" is empty, arbitrary, or oxymoronic and refers to nothing that has value in itself or from a social point of view.

I agree, then, with the Austrian school of thought that believes economists should focus on two concerns. The first is to explain the nuances of Smith's Invisible Hand, in other words, "how within a specific set of institutional arrangements the power of self-interest can spontaneously generate patterns of social order that simultaneously achieve individual autonomy, generalized prosperity, and social peace."[24] To understand the Invisible Hand is to recognize that goods do not exist in fixed or static amounts to be allocated to and consumed by those who "value" them most. Instead, in the appropriate competitive conditions – conditions in which price signals convey information about such things as scarcity – economic activity is creative and dynamic. The second task is to throw cold water on utopian schemes by reminding their partisans of how feckless, horrid, recalcitrant, truculent, exasperating, and depressing human nature truly is.

LOCKE AND THE PRICE OF LAND

Even though Locke adopted a labor theory of value, he was sensible to the role of prices in allocating resources. Simply as a matter of accounting for profits and losses in terms of prices paid and received, Locke found that natural materials traded at very small amounts relative to the price of labor and technology. He pointed out that excellent cropland was free for the taking in many places in the world, such as in regions of Spain (at the time) and in the "inland vacant places of America."[25] Locke wrote of land in America that one cannot "acquire to himself a property to the prejudice of his neighbour, who would still have room for as good and as large a possession (after the other had taken out his) as before it was appropriated."[26]

Land was so plentiful relative to demand that the price of the marginal acre was minimal. Starting in 1863 under the Homestead Act, the U.S. government gave a quarter-section (160 acres) free to anyone who would

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farm it for five years. Labor commanded a scarcity price; land was free. By 1900, about 600,000 farmers obtained about 80 million acres of land under the act.

According to Locke, if the price of fertile land is negligible, as it was in America, the economic value of food "must all be charged on the account of labour, and received as an effect of that."[27] Locke reasoned that of the prices we associate with agricultural commodities, "nine-tenths are the effects of labour. Nay, if we . . . cast up the several expenses about them . . . we shall find that in most of them ninety-nine hundredths are wholly to be put on the account of labour."[28] In the production of commodities, "Nature and the earth furnished only the almost worthless materials as in themselves."[29]

The price structure of agriculture has changed little since Locke's time. "The cost of labor is the biggest part of the total food marketing bill," the U.S. Department of Agriculture (USDA) has reported year after year.[30] According to a 2004 USDA publication, "Nineteen cents of every dollar spent on U.S.-grown food goes to the farmer for the raw food inputs, while the other 81 cents covers the cost of transforming these inputs into food products."[31] Of the 19 cents, land – the rent on the natural resource – represents perhaps one or two pennies.

In 2004, a typical acre of fertile soil in the American heartland sold at the average price of $1,780, at least a quarter of which can be attributed to the distorting effect of subsidies, according to USDA figures.[32] Farmers who are paid – as a way to control surplus – not to grow crops bid up the price of land where not to grow them. Without these distortions, the prices of (or rentals for) cropland land in the United States would constitute about one-tenth of the farmer's expenses and thus less than 2 percent of the price of food. This is consistent with Locke's calculation that only one part in a hundred of the prices of agricultural products can be credited to the natural properties of the land, while 99 percent must be credited to labor and the tools it applies.

In *The Curse of American Agricultural Abundance* (2003), Willard Cochrane, a leading agricultural economist, argues that it would be more economical and efficient if the government stopped paying tens of billions in subsidies every year to prop up cropland values. Land would then revert back to prairie in the American West much as it has returned to forest in the East.[33] Cochrane suggests that "large parts of the Great Plains should be converted into a fenceless 'buffalo commons.'"[34] In the absence of government subsidies, farmland in the United States will continue its return to the natural condition and the negligible economic

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value it had in Locke's time. Locke was right. Because of its abundance relative to demand, fertile cropland continues to furnish only "almost worthless materials as in themselves," which can be obtained for almost nothing.

Every real estate broker can recite the three factors that control the price of an acre of land: location, location, and location. In 1840, Johann Von Thuenen showed that land values – or the "rents" farmers can extract from they land they farm – are higher the closer the land is located to cities even if the uses of the land are the same.[35] Transportation costs will diminish the economic value of land, however fertile, that is far away from markets. Nothing has changed in 250 years since Von Thuenen wrote. The price of land (as Henry George noticed) has a lot to do with where the railroad (or metro) is built. The economic value of land still depends on its location, that is, on its convenience to highways, schools, restaurants, theaters, and society generally – its proximity to the amenity of urban living as opposed to what Karl Marx called the idiocy of rural life.[36]

Today, an acre of farmland commands the very highest price if it can be taken out of row crops and planted instead to shopping malls and condominiums. According to the USDA, "survey data indicated that agricultural land with a potential for immediate development (expected land use if sold) was valued at more than $5,700 per acre."[37] To rent a ten-by-five foot parking space in Manhattan, New York, you must pay more than you would pay to rent a hundred acres of good farmland near Manhattan, Kansas.[38] Economic returns to nature from agriculture are negligible, just as Locke thought.

In recent years, prices for land have risen somewhat in response to huge subsidies the government is now beginning to pour into the production of ethanol to be used to supplement petroleum in combustion engines. At this time, as much or nearly as much fossil fuel is required to produce and ship an equivalent amount of energy in the form of ethanol. Accordingly, subsidies to ethanol production buy few returns to the environment.[39] The prospect of genetically engineered microbes capable of converting cellulosic biomass introduces the possibility of converting huge landscapes, now forested, into fast-growing poplar plantations, switchgrass operations, and other novel crops. If agriculture turns from producing comestibles to producing combustibles, the outcome for the environment is anyone's guess.

"Truly *sustainable* agriculture in America's future," an agronomist has written, "will include only the very few forms of agriculture that

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are compatible with urban life," such as nurseries and turf farms.[40] This may also include the production of fuels useful for transportation. In 1928, humorist Will Rogers recommended another strategy for making farming sustainable. "I tell you turning your land into a golf course is the salvation of the farmer," he said. "The only thing to do with land now is just to play golf on it. Sell your land and caddie."[41]

THE LAUDERDALE PARADOX

In 1819, James Maitland, Lord Lauderdale, reasoned that any good that nature provides plentifully and freely, no one has any reason to purchase. It cannot fetch a price in a competitive market, even where markets for it exist, and so it has no exchange value – this is, no one can get anything in exchange for it. The result is a paradox. The more freely and lavishly nature benefits us, the lower the price the "marginal" unit of a natural product or service will fetch or, to say the same thing in other words, the less exchange value nature will possess.[42]

Manna from Heaven illustrates Lauderdale's paradox. According to Scripture, enough manna fell from Heaven during the Exodus to provide the Israelites with plenty of bread. Accordingly, no one had a reason to gather or hoard more manna than he or she could consume. The Israelites, the Bible tells us, stored up manna to eat on the Sabbath since none fell on that day. Since everyone could easily acquire as much as he wished without charge, the marginal unit of manna could not command a market price. Manna had no economic value (in the sense of a market price or exchange value) except perhaps on the Sabbath when it did not fall from Heaven (Exodus 16: 23–26).

The principal condition for production, exchange, and therefore economic value, Lauderdale argued, is scarcity. He defended two principles:

1. That things [with desirable qualities] are alone valuable in consequence of . . . existing in a certain degree of scarcity.
2. That the degree of value which every commodity possesses, depends upon the proportion betwixt the quantity of it and the demand for it.[43]

For Lauderdale, "economic value" should be understood in terms of what Adam Smith called "value in exchange" or what can be obtained in exchange for that good. Lauderdale thought that value thus defined can be located at the intersection of supply and demand for the

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incremental unit of that good, that is, at its price in a competitive market. Economic theory suggests that competition drives consumer prices down to producer costs. Goods that cost the least to produce – no matter how beneficial they may be to the consumer – will fetch the lowest prices, especially if supply vastly exceeds demand.

Market price or "value in exchange" does not correlate with benefit – however one understands that concept. That you inhaled a lot of air yesterday, for example, does not make the air you breathe any less beneficial today. As long as the air you breathe is abundant and free, however, its price is zero. It lacks value in exchange; that it is beneficial, even exigent, does not determine its price. Benefit does not correlate with price but may even vary inversely with it: for example, the best things in life are free.

Advances in technology, by driving down the production costs of a good, lower its competitive market price. The consumer pays less for his or her next purchase but may obtain the same or a greater benefit. Any phone call may soon be free – the Internet already allows this – and thus it will have no market price. The benefit of a call to 911, to your bookie, or to your broker remains the same. When the antibiotic Cipro lost its patent, generic equivalents appeared at a tenth of the price. The "next" prescription may do just as much good even if it costs ten times less.

Today the music industry is full of fear and loathing because potential consumers are ripping and burning songs for free for which they paid big bucks a few years ago. The entire industry, which once earned billions, may go bankrupt because no one will buy what he or she can acquire gratis. People enjoy the music – now on their iPods – more than ever, but they use the money they spent on music to purchase other things. The price the music fetches in a competitive market is zero; the "value in exchange" is zero; but the benefit is as great as ever. The music industry, of course, cannot stay in business if its product cannot fetch a price – if everyone gets as much as he or she wants for free. Nature can benefit everyone freely, however, without worrying about creating scarcity by policing intellectual and other property rights. It has no operating costs.

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THE SUPPLY OF FRESH WATER

Consider a scenario in which Heaven rains manna in huge quantities but does not distribute it in equal amounts everywhere. The price of

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manna would vary with its distance from the deposits. This is consistent with the Von Thuenen model in which location is everything. What has value – what is scarce relative to demand – is not the manna, which is superabundant, but either (1) residential real estate close to the sources of manna or (2) the labor and technology needed to transport manna to where it is consumed.

Fresh water is a resource that nature provides through the hydrological cycle in vaster quantities than humanity can use. The sun evaporates water from the oceans, the wind moves the clouds to land, and the distilled water precipitates like manna over the Earth, but in some places more than in others. Overall, humanity uses about 2,100 km^3 of fresh water a year – one-fiftieth of the amount that precipitates over land. The runoff from rain that is accessible – rainwater that is collected behind dams or in lakes, rivers, or aquifers near large human populations – equals slightly more than one-tenth of the total rainfall on land or 12,500 km^3 annually. This provides ten times more water than the average European and three times as much as the average American consumes.[44]

For the residents of New York City, like those of many municipalities, abundant, pure, clean rain water falls like manna from Heaven; it has little "exchange" value. City residents must pay, however, for expensive dams, reservoirs, pipes, and tunnels, in other words, capital improvements, to gather and deliver the water from upstate sources, primarily the Catskill watershed. People who live in the watershed are required (and subsidized) to build septic systems because nature will not treat sewage for them. Since the 1920s, the city has chlorinated its water in part to kill fecal bacteria and other pathogens associated with the fecal wastes produced by 350 vertebrate species that thrive in the Catskill region, including huge populations of deer, beaver, and waterfowl. In the reservoirs, "the background contamination from wildlife populations is apparent."[45]

Let us suppose for a moment that over time the Catskill watershed ecosystem

> became overwhelmed by sewage, industrial and agricultural runoff to the point that the water quality in the city fell below EPA drinking water standards. An economic analysis provided costs of two alternatives for restoring water quality. The cost of purchasing and restoring the watershed so that it could continue to provide the service of purification and filtration was calculated to be $1 billion. The cost of building and maintaining a water purification and filtration plant

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was $6–8 billion in capital costs, plus annual operating expenses of $300 million. The City has opted to buy and restore the watershed, i.e., to let nature work for people.[46]

According to this suburban legend, New York City authorities determined that "preserving habitat in the watershed and letting the ecosystem do the work of cleansing the water" was worth the price of buying up land and development rights in the watershed.[47] Accordingly, the city floated a bond issue to "use the proceeds to restore the functioning of the watershed ecosystems responsible for water purification."[48]

If any of this had actually happened, it could offer an example of a willing buyer (New York City) who purchased land or development rights and thus put a market price on an ecosystem service, namely, on the ability of natural habitat and biodiversity to disinfect and purify water.[49] The story is constantly invoked because it provides a clear and compelling example of an economic "return" to nature. That the story represents a fiction or fabrication does not matter because it demonstrates the "correct" academic theory.[50] Thompson has correctly cautioned that the hope that the downstream users of watersheds would bargain to keep those landscapes undeveloped may easily be overestimated. "One should have a healthy dose of skepticism regarding how often water companies, local governments, and other entities will find it worthwhile to preserve watershed lands."[51]

FISH AND FIBER

What about fish captured in the wild? Economists use the concept of resource rent, developed by Ricardo in 1817, to measure the value of fisheries. The rent on a natural resource is the amount left over when the costs of exploiting a resource are deducted from the revenues it brings. In theory, the resource rent approximates the maximum the owner of the resource could charge for its use.[52]

To estimate the resource rent of wild populations of diverse kinds of fish, resource economists typically begin with a model that relates the total costs of exploiting the resource, including a normal return on investment, to the total revenue computed as the dockside price of fish per pound times the number of pounds of fish caught.[53] In this model, the difference between the costs paid and revenue obtained represents the economic value or rent on the resource. When the fishing industry attains profitable levels of effort, new boats will be attracted to the

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resource, quickly moving the industry beyond the sustainable yield of the fishery. At this "open access equilibrium point," the total cost coincides with the total revenue and resource rents are dissipated. Governmental financial transfers to the fishing industry (subsidies) push the fishing effort even beyond the open access equilibrium and thus boost the total costs of fishing farther out beyond the point where the catch is worth more than the cost. The point where the costs stand today.

Fisheries experts often lament that "the main problem is that in the process of the expansion of fishing effort, resource rent has been completely dissipated. It has gone to finance the overexpansion of the fishery."[54] At fault are subsidies paid by many nations to support their fishing fleets in competition with the fleets of other nations. In 1999, a representative year, Organization for Economic Cooperation and Development (OECD) countries alone paid about $6 billion to subsidize their commercial fishing fleets. Some nations, such as Finland, paid far more in subsidies than the fish it sold brought in revenues; other countries, such as the United States, paid subsidies in excess of 25 percent of the total revenues.[55] Under these distorted conditions, capture fishing operates at a deficit supported by taxpayers. Potential resource rents are more than dissipated; the natural capital or ecosystem service realizes an economic loss.[56]

Even if the capture fishing industry optimized its effort, whatever resource rent it earned would be ephemeral. Capture fisheries must compete with aquaculture, which offers lower costs, reliable year-round supplies at huge volumes, uniform and consistent quality, just-in-time delivery, traceability, proximity to markets, and virtually every other competitive advantage imaginable. "By the year 2030," according to the Food and Agriculture Organization, "aquaculture will dominate fish supplies and less than half of the fish consumed is likely to originate in capture fisheries."[57] Aquaculture accounts for over a third of the fish humans consume, and over the next two decades, according to the *Washington Post*, fish farming will largely "replace the last commercial food-gathering system based on hunting wild animals."[58]

The future of the fish industry lies with transgenic fish genetically engineered for rapid growth, disease resistance, inexpensive feeds, and table appeal.[59] Genetically engineered varieties are now in development for at least thirty-five commercial species.[60] The next few decades will see a rapid decline in capture fishing as the large fleets of the past are replaced by intensive, biotechnology based, vertically integrated,

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closed-system, highly capitalized industrial aquaculture, controlled – as the hog and poultry industries are controlled – by a few multinational corporations. It is hard to see how capture fisheries, already subsidy dependent, can survive competition from aquaculture except in special cases, as when for aesthetic or spiritual reasons people prefer "wild-caught" rather than farmed fish. Where ecosystem services and wild stocks are inexpensive and superabundant, the economic return to nature is negligible. Where they are not, technology quickly develops to capture economic rent by making cheap and inexpensive resource flows, such as genetic information and plentiful organic matter, do the work of more expensive ones.

The transition from hunting and gathering in the wild to plantation-based industry, expected to occur in fisheries over the next two decades, has largely taken place in forestry. According to a report in *Issues in Science and Technology*, "The United States today finds itself in a world of timber surpluses and increasing competition." Industrial tree plantations are rapidly underpricing and out-producing wild forests. "Particularly important has been the expanded use of intensively cultivated, short-rotation tree plantations in temperate and subtropical regions of the Southern Hemisphere. These 'fiber farms' have proved to be extraordinarily productive."[61]

When farming declined, the region east of the Mississippi reforested. In a fine article, nature writer Bill McKibben celebrates the resurrection of the Eastern forests to their pre-Columbian expanse. He quotes a Forest Service official who wrote that the forest of the East and South "has come full circle. By the 1960s and 1970s, the pattern of forest, fields, and pastures was similar to that prior to 1800, its appearance much like it must have been prior to the American Revolution."[62] A survey of fifty nations in the boreal and temperate world found results similar to those of the eastern United States. In the 1990s, the forest biomass in every one of these countries increased.[63]

So much timberland now exists in the United States and so much inexpensive pulp and paper can be shipped in from South America – a 10 percent tariff followed by stiff quotas has reduced the glut of lumber easily imported from Canada – that big firms are selling off their forest holdings to conservation groups, speculators, developers, and individuals. The firms may invest some of the proceeds in high-technology plantation operations in Brazil and other southern nations, where trees can be genetically engineered for quality and growth. In 2004, International

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Paper announced its decision to sell off 5.1 million acres of timberland in the United States, an area larger than Massachusetts. In separate deals arranged by the Nature Conservancy and the Conservation Fund, the company sold a million acres for aesthetic preservation.

The demand for forests as objects of love and appreciation seems more robust than the demand for them as sources of timber. "Based on market components," said David Liebetreu, International Paper's vice president for forest resources, ''our forestlands are worth a lot more to other people than they are to us.''[64] According to a newspaper account, urbanites "are looking for play forests and country home sites."[65] The aesthetic properties of a forest make it desirable. A forest appraiser involved in these land transfers opined, "It used to be that timber production was the primary objective for someone buying timberland, but today, recreation and investment is their main motive."[66]

The transition we are seeing from capture fishing to aquaculture and forestry to silviculture is unsurprising. Environmental economists such as John Krutilla had noted decades ago that advancing technology has "compensated quite adequately for the depletion of the higher quality natural resource stocks."[67] If an ecosystem service – such as the provision of wild turkeys – becomes scarce, advances in technology supply substitutes and drive prices down. A hundred million turkeys appear on dining tables on Thanksgiving without anyone firing a shot. It is hard to think of a renewable resource the price of which has increased over the past decades. Krutilla observed that "the traditional concerns of conservation economics – the husbanding of natural resource stocks for the use of future generations – may now be outmoded by advances in technology."[68]

Biotechnology can even create better products at lower prices – wood, for example – than intact natural ecosystems. Transgenic trees offer the same advantages – fast growth, cold-hardiness, uniform and predictable quality, disease resistance – as transgenic fish. According to Roger Sedjo, "High-yield plantation forestry has the potential to meet the world's industrial wood needs while simultaneously protecting existing natural forests and thereby conserving their environmental values."[69]

INSECTS

In his famous "Canticle of the Creatures," St. Francis of Assisis praises God for the work of "Father Sun" and "Sister Moon." One might ask if praising God for the diurnal rotation of the Earth properly "values" this

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gift to us. Why not put a "price" on the work of the sun and the moon; why not compute our WTP for the force of gravity that keeps us all from floating off into space? In "St. Louis Blues," Bessie Smith wailed, "I hate to see the evening sun go down." Maybe she did. We would be willing to pay a lot, however, not to see it coming up.

One could not imagine a more fatuous, deluded, and irrelevant pastime than to try to compute the losses that would occur if gravity dwindled in power, the moon no longer lit the night, or the sun refused to shine. Since none of these scarcities is in the cards, it is a waste of time to worry about them. I want to argue that this is generally true of the ecological services to which many environmentalists seek to attach economic values. It serves as little purpose to consider what losses would occur in the absence of the labor of insects, for example, as what losses would occur in the absence of the force of gravity, the sun, microbes, photosynthesis, and so on and on.

Everyone recognizes the "vital ecological services provided by insects."[70] The important or relevant question is whether any of these services is scarce enough – whether the demand for it so exceeds the free supply – that it could conceivably generate a competitive market price.

Consider, first, the pollination of crops, which "is perhaps the best-known ecosystem service performed by insects."[71] To associate an economic value with this service we could try to estimate the price that an incremental unit of it would fetch in a competitive market. To see how this could be done, consider the basic cereal crops: wheat, rice, and maize or corn. These are all wind pollinated. If you take bellows to Kansas and offer to blow pollen around the fields, you will not be hired. There is no demand for additional wind. In this example, pollination has a zero price because there is so much of it anyone can have all he wants for nothing. One cannot overestimate our dependence on the wind – an instance of solar energy – in carrying pollen between plants. The economic value of this service in the sense of competitive market price, however, equals what you could earn with your bellows – nothing.

The same analysis applies to insect pollinators if they function as ubiquitously and freely as the wind. One could as meaningfully try to estimate what society would pay – or how much it would lose – if it had to find some substitute for insects (in insect-pollinated crops) as for wind (in wind-pollinated crops). In a study of the economic value of the ecological services provided by insects, John Losey and Mace Vaughan have written, "We base our estimations of the value of each service on

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projections of losses that would accrue if insects were not functioning at their current level."[72] To show how price is relevant, however, one must demonstrate the prospect of scarcity – in other words, the prospect that someone might be interested in purchasing the next or incremental unit of the service. Instead, ecological economists tend to associate value with benefit – and by ignoring the question of scarcity, they abandon any meaningful relation to price.

A good way to determine whether agricultural production is ever limited by the human-caused decline of pollinators is to find out if beekeepers are hired to employ their hives to provide pollination services nature once supplied. The prices beekeepers receive for the pollination services of their bees could be ascribed to the loss of a natural service if, indeed, native or natural pollinator populations had declined. It is extremely difficult to get data, however, that tell what rents may be paid to apiarists to make up for a lost ecosystem service rather than to provide a service nature never supplied.[73] The leading paper in the field notes that even when the local decline of a pollinator has affected production (of blueberries in New Brunswick, for example), "it did not affect the overall market price for blueberries because that was set elsewhere by broader, regional effects." The essay observes bleakly that "the economic impacts of pollinator declines have not been well recorded" and pleads for more data.[74]

Losey and Vaughan point out that dung beetles decompose (often by burying) the waste produced by cattle on the range, "resulting in significant economic value for the cattle industry."[75] They estimate this "economic value" as the losses the industry would incur in the absence of dung beetle activity. No one suggests, however, that dung beetles are becoming scarce. If you set up a stand on a highway in Texas advertising "Dung Beetles for Sale," it is doubtful that anyone would stop but the police. You would do as well with your beetle business in Texas as with your bellows business in Kansas.

In fact, if you permit me to anthropomorphize, I would suggest that the cattle industry pays the beetle for its work. Indeed, the cattle industry has created dung beetle Heaven. Any rancher within the natural range of the beetle can acquire as many as he or she wants or can use by making a direct exchange with the beetle itself. The beetle works for dung. The farmer provides the dung; the beetle provides the decomposition. What's not to like – if you are a dung beetle? You can have a big family. It's the same with the pollinating insects who visit the flowers of fruits, nuts, and vegetables to acquire the nectar or pollen or whatever

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it is they seek. They are paid for their work – and supported in vast numbers by the farmer's compensatory planting of crops. Indeed, one could argue that the farmer is just the pollinator's way of making another pollinator.

Ecological economists view the work of the insectivorous classes (along with that of nature's other servitors) as Marxist economists regard the work of the laboring classes. Both the insect worker and the human worker, on this general approach, produce the "surplus" value captured by the agriculturalist or the capitalist, respectively. What is a dollop of dung, a *nosh* of nectar, or a worker's wage in comparison to the value these laborers add to the product of capitalism – the surplus value that accrues to the capitalist but is truly earned by the laboring masses (in this instance, of insects)? The sentimentally appealing but intellectually empty effort to ascribe economic value to nature's services may at bottom constitute little more than the labor theory of value *redivivus*. Marx had a recommendation: the workers of the world should unite to throw off their chains. What recommendation do ecological economists offer the laboring insectivorous classes?

BIODIVERSITY

What about the economic value of biodiversity? Biodiversity represents nature's greatest largess or excess since species appear nearly as numerous as the stars the Drifters admired, except that "scientists have a better understanding of how many stars there are in the galaxy than how many species there are on Earth."[76] Worldwide the variety of biodiversity is effectively infinite; the myriad species of plants and animals, not to mention microbes that are probably more important, apparently exceed our ability to count or identify them. The "next" or "incremental" thousand species taken at random would not fetch a market price because another thousand are immediately available, and another thousand after that. No one has suggested an economic application, moreover, for any of the thousand species listed as threatened in the United States.[77] To defend these species – or the next thousand or the thousand after that – on economic grounds is to trade convincing spiritual, aesthetic, and ethical arguments for bogus, pretextual, and disingenuous economic ones.[78] As David Ehrenfeld has written,

We do not know how many [plant] species are needed to keep the planet green and healthy, but it seems very unlikely to be anywhere near the more than

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quarter of a million we have now. Even a mighty dominant like the American chestnut, extending over half a continent, all but disappeared without bringing the eastern deciduous forest down with it. And if we turn to the invertebrates, the source of nearly all biological diversity, what biologist is willing to find a value – conventional or ecological – for all 600,000-plus species of beetles?[79]

The disappearance in the wild even of agriculturally useful species appears to have no effect on production. The last wild aurochs, the progenitor of dairy and beef cattle, went extinct in Poland in 1742, yet no one believes the beef industry is threatened. The genetic material of crop species is contained in tens of thousands of landraces and cultivars in use – rice is an example – and does not depend on the persistence of wild ancestral types. Genetic engineering can introduce DNA from virtually any species into virtually any other – which allows for the unlimited creation of biodiversity.

A neighbor of mine has collected about 4,000 different species of insects on his two-acre property in Silver Spring, Maryland. These include 500 kinds of Lepidoptera (mostly moths) – half the number another entomologist found at his residence.[80] When you factor in plants and animals, the amount of "backyard biodiversity" in suburbs is astounding and far greater than you can imagine.[81] Biodiversity has no value "at the margin" because nature provides far more of it than anyone could possibly administer. If one kind of moth flies off, you can easily attract hundreds of others.

The price of a building lot in suburban Maryland, where I live, is a function of its proximity to good schools and to Washington, D.C. The thousands of kinds of insects, weeds, and microbes that nature lavishes on the typical suburban lot do not increase its price. No one wants to invest to see if any of these creatures contains a cancer-curing drug, although a raccoon in my attic did test positive for rabies.[82] No one thinks that property values are a function of biodiversity; no one could suppose that a scarcity of critters looms that might create a competitive advantage for housing lots that are more generously endowed with deer, opossums, muskrats, raccoons, birds, or beavers. (A neighbor who has a swimming pool plays unwilling host to a beaver who at night jumps off the diving board into the pool, swims around, and jumps out again.) The astronomical variety of biodiversity is thrown in with every residential acre. Buy an acre or two, and an immense amount of biodiversity is yours for nothing.

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OBJECTIONS

To suggest that ecosystem services possess only a negligible "exchange value" or market price is to invite at least the following four objections. First, one may earnestly assert that ecosystems "act to purify air and water, regulate the climate and recycle nutrients and wastes. Without these and many other ecosystem goods and services, life as we know it would not be possible."[83] The team that pegged nature's services at tens of trillions wrote, "The services of ecological systems and the natural capital stocks that produce them are critical to the functioning of the Earth's life-support system."[84] Bromides such as these, however edifying, tell us nothing about competitive price or exchange value, which is a measure of scarcity not dependency.

I understand, of course, that when economic development changes a landscape, for example, when a university such as Stanford takes the place of a savanna, some of the ecosystem services the landscape once provided will be lost. No one would suggest, however, that in view of the diminished ecosystem services, the landscape be restored and the offending university removed. What is needed is an example of an ecosystem service that is worth more in market terms than the privately built housing, schools, hospitals, and farms because of which that service diminished or declined.[85]

For example, one could speculate that downstream towns vulnerable to flooding – New Orleans is an example – could conceivably pay farmers upstream to let their lands flood during the rainy season (thus delaying or forgoing planting their crop) to approximate the ecosystem service – in this instance, retaining water – the forests, fields, or wetlands once supplied. This sort of brokering might be worthwhile to attempt at least as an experiment. Researchers have found instances in which towns have purchased land in flood plains to mitigate flooding,[86] although on inspection, these examples may be dubious, in part because of huge financial incentives from the federal government and in part because flooding occurred anyway that might have been prevented by infrastructure such as levees. The literature cites examples, but when one follows the footnotes, one often finds much less there than one might hope.[87]

Consider a second objection to my argument. The Nature Conservancy and other groups raise and spend enormous amounts to acquire and retire for aesthetic and ethical reasons "the last great places," as

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the Conservancy calls them. The appreciation of the spiritual, moral, and aesthetic aspects of nature – an obligation to protect undeveloped places – is exactly the kind of commitment environmentalists share and should act on. Aesthetic and moral value, however, is not to be confused with economic value, even though it requires funding. It would be a mistake to say that natural areas have value because people are willing to pay to preserve them – as if WTP were the locus or source of value. Rather, people contribute to organizations like the Conservancy because they recognize the beauty and glory inherent in nature and a duty to protect the aesthetic, moral, historical, and religious value of particular places.

A third objection is obvious. Nothing has been said here about minerals, such as diamonds and gold, which are obviously scarce relative to demand and thus have a high value in exchange. These goods, however, are priced competitively, more or less, and there is little need for government officials to second-guess these markets. The argument here would not apply to diamonds and other minerals, in any case, but to goods associated with the functioning of today's ecosystems, such as clean water. It would not apply to petroleum since it is not supplied by living ecosystems.

Fourth, one may object that the argument presented here extends only to exchange value, competitive market price, or the intersection of supply and demand. If ecosystem services are plentiful and free (like manna) they will have little value at the margin. No way of conceiving "economic value" other than in terms of competitive market price, however, allows one to compare the "marginal utility" of ecosystem services with that of ordinary consumer goods, which are "valued" at competitive market prices. A group of ecological economists has wisely written that the real test "of whether an ecosystem service will facilitate conservation is not whether academics can valuate it, but whether someone – or some organization – is able and willing to do what is necessary to secure it."[88]

Everyone agrees, of course, with platitudes about how dependent we are on Nature's lavish beneficence. Everyone imagines the wonderful time the Drifters enjoyed up on the roof and under the boardwalk down by the sea. Nature plentifully and freely sustains us, comforts us, and inspires us. We recognize that the preservation of the beauty, complexity, and integrity of the natural world represents an aesthetic opportunity, a spiritual duty, and a moral obligation. Large-scale atmospheric

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systems, such as those that regulate climate, demand political will for their protection. They cannot be marketed or "priced" at the margin any more than liberty. From the perspective of economic value in the sense of a competitive market price, however, Locke was right. "Nature and the Earth furnished only the almost worthless materials as in themselves."

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