LETTERS

We welcome letters from readers, particularly commentaries that reflect upon or take issue with material we have published. The writer's name, affiliation, address, and telephone number should be included. Because of space limitations, letters are subject to abridgment.

VALUING ECOSYSTEM SERVICES: A RESPONSE

Professor V. Kerry Smith raises a number of questions in his perspective, "Mispriced Planet" (*Regulation*, Summer 1997) with regard to our estimates of the aggregate annual value of the world's ecosystem services (Costanza et al. 1997). His critique appears to contain three fundamental claims: (1) Willingness to pay (WTP) is an inappropriate measure of value since it is a "measure defined for a change in something." (2) Using WTP yields a value estimate grossly in excess of peoples' ability to pay for world ecosystem services since the estimate "is about 1.8 times the authors' world GNP estimate." Logically, according to Smith, actual value would have to be "less than world GNP, only because there is nothing left to give" or pay beyond that. (3) We use a "linear aggregation rule" which ignores ecological feedbacks. Smith concludes from those observations that our "analysis seems to combine bad economics with bad ecological science." Smith's highly negative conclusions are, however, insupportable and deserve rebuttal.

The short answers are: (1) Although WTP is admittedly flawed and incomplete, it can and has been used to estimate much more than "a change in something", including existence, option, bequest and other use and "non-use" values. (2) GNP picks up only marketed goods and services. We argue clearly in our paper that ecosystems provide *real* income (contributions to human welfare) much of which never enters any market. The point of our paper was to estimate that income, which has no direct relationship with current, incomplete, GNP. If that income *were* to be internalized (via eco-taxes for example) the structure (and probably the total amount) of GNP would be very different, as we also clearly state in the paper, and ecosystem services would be a component of the revised GNP. (3) While we appreciate the importance of feedbacks and nonlinearities in ecological systems, our first-cut analysis merely followed the convention used in almost all economic analyses of assuming a linear aggregation rule. If that invalidates our study then it invalidates almost all other economic analyses as well.

We agree strongly with Smith that WTP measures of economic value have major conceptual and measurement flaws. There is a long list of recognized problems including those associated with completeness, accuracy, incentive compatibility, incomplete or nonexistent markets, context, transactions costs, definition of the "object of choice," and joint products, to identify just a few. Unfortunately, economic science has not yet evolved sufficiently to solve all of those problems adequately at the microscale, let alone at the global scale addressed in our paper. In addition, while work is in progress on developing alternatives to WTP (Gregory et al. 1993, Bingham et al. 1995, Costanza and Folke 1997) most of the past research that we synthesized for our study relied on WTP-based measures.

The best current estimate of marginal WTP is price in well-organized markets, which we used whenever possible. Where market prices were not available, we used pseudomarket-based WTP measures. Where those were unavailable, we used "replacement cost" measures of value (which can also assess WTP in certain situations). If marginal WTP equals market price in all final goods markets, then there is a direct link between WTP and world GNP. The sum of marginal WTP times quantities in all final goods markets equals world GNP. But the point is, that linkage does not exist for nonmarket final goods or services such as the world's ecosystem services since they are not priced or inadequately priced in current markets (all that is captured in current GNP). The linkage would exist only if the world's ecosystem services were priced in well-functioning markets. We believe it is better to estimate the linkage (even if imprecisely) than to continue implicitly pricing ecosystem services at zero or some extremely large but indefinite number. Smith appears to be opting for the vagaries of zero prices or prices approaching infinity which, in fact, guarantee the "mispriced planet" that he argues against. While WTP certainly has problems (and several researchers are actively working on alternatives) it is still the most commonly used measure and one that must be included in any broad-based synthesis like ours, even given Smith's (and our own) reservations.

Smith's second point is that logically, payment for the world's ecosystem services can never exceed world GNP. We would agree with that if GNP were a true full accounting measure. A global community can never pay more than it produces plus accumulated wealth less minimal consumption. If it did, it would not survive. But, the key point is that current GNP misses a lot of real income. An adequately revised GNP would count ecosystem services. We estimated the value of those services, much of which is outside the current market. If prices were actually charged for ecosystem services based on their value, most other prices in the global economy would be radically different, as would earnings of other factors of production. Prices of commodities that utilize

ecosystems intensively would rise relative to commodities utilizing ecosystem services less intensively. Products that could be produced with less ecosystem services would be. Factors of production which are substitutes for ecosystem services would increase in relative value. The ultimate structure and configuration of the global economy in the new situation is difficult to predict. We did not try to do it in our paper. Our more limited conclusion was that the economic value of ecosystems, at existing prices, was substantial and those services could not be safely ignored as a minor factor of production with minimal price distortions on the global economy. That is not a logical flaw, but a robust conclusion based on the relative magnitude of the contribution that the world's ecosystems make to the global economy. We could not pay for their contribution at existing prices, but would never have to. Prices and the commodity composition of global production would adjust to accommodate payments for ecosystem services if in fact they were adequately internalized.

Another way of assessing whether the magnitude of our estimate demonstrates the existence of a logical flaw is to think of two planets. The two planets are identical except the first planet ingeniously prices all of its resources inclusive of ecosystem services at their marginal value to the global economy. All externalities, common property resource problems, etc., have been solved with infinitesimal transactions costs. The second planet prices all of their ecosystem services at zero thus inducing inefficient prices throughout its economy. The first planet is obviously more efficient in terms of basic economic principles, but unfortunately, we currently live on something more approximating the second planet. Our analysis estimates the value to the global economy of ecosystem services on the second planet. It turns out to exceed the second planet's GNP at existing prices. That is not surprising given the distorted price structure on planet 2. However, that result does not in any way interfere with the logical existence (and preferability) of the first planet. If the second planet charged the same ecosystem prices as the first, it would become identical to the first. Therefore, Smith's allegation of a logical flaw is not correct. Smith mistakenly alleges that the value of ecosystem services on the second planet cannot exceed the incomplete and distorted GNP on the second planet, when in fact it is the more comprehensive and efficient GNP on the first planet that cannot be exceeded by the value of ecosystem services.

Smith also criticizes our estimates for utilizing a "linear aggregation rule" on ecological systems and thereby ignoring feedback cycles, assuming homogeneity within ecosystem categories, and ignoring that "social systems and institutions are just as 'essential' or even more so for the global economy." His criticisms are valid. In our paper, we clearly acknowledged that, because of those (and other) simplifying assumptions, our estimate was only a starting point, and probably represented a low estimate. However, such assumptions are standard boilerplate in most economic studies (and many ecological studies) of the environment, and his criticism is applicable to almost all other current economic research studies on the environment, including many of Smith's own studies. Does that imply that no such studies "should be used in any form," including Smith's own? We clearly acknowledge in our paper that we have only scratched the surface and there is much need for additional research that relaxes the simplifying assumptions which both we and Smith point out (several of us are, in fact, working on such research). But if the assumptions invalidate our research then all economics that deals with the environment will have to start over.

In summary, Smith suggests our results "should not be used in any form" because they are "seriously flawed." But Smith's allegations of logical flaws turn out to be seriously flawed and incorrect themselves. He also criticizes us for making ecologically unrealistic simplifying assumptions. But all research must make simplifying assumptions and those same assumptions are also made by almost all other economic analyses (including many of Smith's own). While we wholeheartedly support ongoing efforts to do more sophisticated research that relaxes those assumptions, we do not believe that relying on them renders current (and past) research useless. Failing to confront the issues our paper addressed means continuing to accept a zero price for many ecosystem services; and that is the worst kind of economics and the worst kind of ecology. We think our modest attempt to take the first steps away from that fallacy is an important and useful improvement.

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CLEARING ECOSYSTEMS MISUNDERSTANDINGS

In the May 1997 issue of *Nature* Robert Costanza and several colleagues place a value on the services of the world's ecosystems. Economist V. Kerry Smith

(Regulation, Summer 1997), finds Costanza et al.'s results "seriously flawed" and notes that they "should not be used in any form." He writes that the overall effort combines "bad economics with bad ecological science." While Smith's analysis concentrates on the work's economic shortcomings, I will focus my comments on two of the Costanza groups' misunderstandings of ecosystems that render the analysis valueless for public policy purposes.

First, the benefits Costanza et al. see as services provided to humans by ecosystems (as organized, knowable, and discrete entities on the surface of the Earth) are, in essence, the serendipitous byproducts of individual living organisms seeking to survive and nonliving things following fundamental laws of physics and chemistry. For instance, they claim that pollination is a benefit humans derive from the actions of ecosystems; yet ecosystems do not pollinate anything. Individual food-seeking insects, birds, and other biota that move from flower to flower in normal pursuit of their species' lifestyle are responsible for pollination. Costanza and his colleagues make a huge leap when they attribute to ecosystems the fruits of insect labor.

They make similar errors in asserting that ecosystems provide such services as climate control and water management. Researchers have long known that plants can impact climate; they both absorb and reflect incoming solar radiation, they alter the mix of atmospheric gases, and they can modify ground level circulation of the atmosphere. But they do so as individual plants, not as participants in some union of life forms intent on altering the atmosphere. Likewise, ecosystems do not manage or regulate water. The fate of individual water molecules falling as rain, for example, is determined by physical forces like gravity, not the edicts of ecosystems. So it is that some of those molecules are bound up in the soil, others percolate downward to gather in aquifers, and still others eventually reach lakes and oceans. To be sure, the presence or absence of vegetation, vegetation composition, soil make-up, topography, and other factors influence those happenings. But that is by no means evidence of the existence of a higher level entity called an ecosystem orchestrating the behavior of the water molecules to provide a service for humans or for itself.

The second and more fundamental flaw in their analysis is the assumption that ecosystems are tangible objects that actually exist on the surface of the Earth. Ecosystems are mental constructs, heuristic devises, rather than real entities that Mother Nature placed on the landscape to await discovery by scientists who apply theory and/or agreed upon methodologies and protocols. Indeed, no such methods or protocols exist. Consequently, in nothing more than a geographic free-for-all, researchers are able to fix the location, shape, and size of the geographic unit they call an ecosystem using whatever variables and means suit the project at hand. That is why, for example, federal agencies strongly disagree on how a map of the nation's ecosystems should look. Such a laissez faire approach allows scientists to declare that an ecosystem is a dung pile, a whale carcass, a watershed, the entire planet, or any other bit of the Earth's surface that is convenient for the moment.

In their article, Costanza et al. demonstrate the arbitrary and artificial nature of ecosystems. They simply declare that sixteen ecosystems blanket the Earth. Their ecosystems are different from those proposed by other scholars and the Costanza group offers no meaningful explanation of why they settled on sixteen ecosystems or on how they established their locations. They fail to grasp that the ecosystems they claim are providing services to humans are just figments of their imagination. Ecosystems may be valuable tools in aiding research but from a public policy perspective, it is difficult to see how anyone can seriously claim that ecosystems-that exist only in the minds of their authors-provide services to humans. But Costanza et al. make just such a claim by proposing that their ecosystems are providing services to humans at an average rate of $33 trillion per year. They want policymakers to incorporate their analysis into government regulatory actions and tax policy in order to improve decisionmaking.

Their type of analysis adds confusion not clarity to the decisionmaking process because it is based on flawed assumptions about the nature of ecosystems. To interject it into public policymaking is to infuse the process with nebulous ideas and meaningless numbers to the detriment of sound decisionmaking.

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CORRECTING REMEDIAL MEASURES

Fred L. Smith Jr.'s excellent column in the Summer 1997 issue of *Regulation* ("Caution: Precautionary Principle Ahead") highlights a much overlooked aspect of environmental regulation and of public policy in general. That is, that all remedial measures—no matter how laudable their intentions—have consequences. Mr. Smith demonstrates that those consequences often outweigh a measure's supposed benefits.

In a different context, the famed antifederalist Melancton Smith said in 1787: "It is natural for men who wish to hasten the adoption of a measure to tell us, now is the crisis—now is the critical moment which must be seized, or all will be lost: and to shut the door against free inquiry, whenever conscious the thing presented has defects in it, which time and investigation will probably discover. This has been the custom of tyrants and their dependents in all ages." The value of time and investigation is certainly absent from today's global warming debate.

Smith recounted a "much heated discussion" he had with global warming advocate Dr. Stephen H. Schneider, in which Dr. Schneider accused him of being willing to "run an uncontrolled experiment on the only planet we have." But suppose we followed Dr. Schneider's advice. Not his advice of today, but his

advice of almost twenty-seven years ago, when he wrote in *Science* magazine: "[I]t is projected that man's potential to pollute will increase six-fold to eight-fold in the next fifty years. If this increased rate of injection . . . should raise the present background opacity by a factor of 4, our calculations suggest a decrease in global temperature by as much as 3.5 degrees C. Such a large decrease in the average temperature of Earth, sustained over a period of few years, is believed to be sufficient to trigger an ice age."

What if the industrialized nations had jumped on the global cooling bandwagon in 1971 with as much alacrity as Dr. Schneider? Establishing a vast government regulatory mechanism is a lot easier than dismantling an unnecessary or harmful one.

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LESSONS FROM THE LAB

In his article "Market Masked Regulation" (Summer 1997), Timothy Cason makes a point worth repeating—the laboratory of experimental economics can help guide environmental regulation. If a proposed regulatory tool is worth pursuing in the wilds, the lab is well-suited to address the details. Exploring the interaction of institutions and behavior has been the purpose of the economics lab for nearly four decades. By choosing the phenomena to explore, the institution to evaluate, the theory to test, and the response to measure, a policymaker can construct the environment and the rules of exchange that create incentives and thus affect behavior. A failure to meet the expectations of institutional efficiency and rational behavior will trigger more experiments in order to better understand what design features create unintended, but influential signals that undermine efficiency.

Cason's work revealed a fundamental flaw in the original design of the Environmental Protection Agency's auction of permits in their Acid Rain emission trading program. And while the EPA should be given credit for accepting an idea that had been floating around since Thomas Crocker first suggested tradable permits in 1966, the lab results showed the efficiency of the auction could be improved by changing the process of permit allocation. Originally, buyers and sellers submitted bids for emission permits, and the EPA set the market price discriminatively off the demand curve by matching the seller with the lowest offer to the buyer with the highest bid. The matching then continued with the second lowest offer going to the second highest bid, and so on, until the equilibrium quantity was reached. Rational sellers quickly saw through the auction, and began capturing rents by understating their true offer so as to be matched with a high bidder. The lab results confirmed the intuition—sellers undercut each other to get into the high end of the market. The end result was an inefficient auction. That the EPA actually changed to the more efficient uniform price auction clearly indicates that lessons from the lab are profitable.

But lessons should not be learned after the regulatory tool is already in place and resources are wasted because of inefficient design features. That is especially true for global climate change policy—an environmental question mark that dwarfs acid rain in scope and impact. In October, President Clinton formally announced that in Kyoto he would ask for binding targets to be back on target with 1990 emission levels by 2008-2012, a $5 billion program of tax cuts and R&D for new technologies, and the participation of developing countries. And given the perceived success of the SO_2 emissions trading program, the President also supports a broad-based domestic and international greenhouse gas emissions trading system. An idealized emissions trading program could substantially reduce the cost of carbon reduction—perhaps halving the costs of meeting the President's emissions target.

What is curious about carbon emissions trading, however, is that its biggest supporters have come more from environmental NGOs; they have not been economists. The environmental community prefers emissions trading programs over carbon taxes because the quantity of carbon flowing into the atmosphere is fixed, thereby shifting risk to the economy in the form of price uncertainty. But many economists have questioned the feasibility of carbon trading because the international market is likely to be thin; most nations have indicated inaudible interest in the system, and the costs of monitoring and enforcing the system are likely to be high.

Given those potential impediments, the lab can be used to explore how an emission trading system might draw new buyers and sellers, or how a trade might be self-enforcing given different penalty schemes. The lab is well-suited for finding alternative exchange institutions that would increase the ability to buy and sell the low-cost carbon emission reductions from around the globe. Researchers can examine the conditions necessary for creating and evaluating the performance of either a domestic or international emission trading system or both. The lab provides the control, repetition, and feedback necessary to understand the behavioral underpinnings of a tradable carbon emission program. By supplying information on the behavioral links between incentives, preferences, beliefs and choice, experiments explore the nature of behavior in alternative institutions, complementing both field and simulation data. The lab can be used to test the specific predictions of alternative stylized models, and it can be used as a test bed to measure the performance of a new institution with many uncertainties.

For example, the efficiency of emission trading can be enhanced by providing so-called "when" flexibility: firms can bank and borrow emission permits by either carrying permits forward to or drawing permits from a future compliance period. Using a series of test bed double auction experiments, Rob Godby and his colleagues have shown that banking has strong positive impacts on the efficiency of an emissions market. Two reasons drive that finding: firms can mitigate the distortion caused by an initial allocation of permits that is suboptimal over time; and firms planning to bank

some permit have less incentive to hoard additional permits as a hedge against bad states of nature. The research also showed that the introduction of a future market increases efficiency. The question remains as to how imperfect enforcement affects those results.

Other aspects of global climate change policy can also be better understood by turning to the lab. Since climate change is a public good—nonrival and nonexclusive in consumption—accepted theory says people will free-ride off the emission reductions of others. Evidence from the lab, however, reveals that neither complete self-interest nor cooperation govern behavior. Manipulation of marginal payoffs, group size, and communication results in more cooperative behavior. Extensions of the basic lab design could improve the design of institutions to maintain cooperation in the face of environmental uncertainty.

Regulators might still complain that climate change policy is too complex to be captured adequately in the lab. But complexity is not an argument against the lab, rather it argues for a research program that gradually increases complexity to isolate and control the factors that reduce the effectiveness of emissions trading. The lab can provide the best basis for guiding environmental policy. By identifying how such complexities as trust, cooperation, transaction costs, strategic behavior, risk reduction mechanisms, and information affect behavior, the lab allows new institutions to be tested before they are promoted at a grand scale. Big questions do not always need big science. And while one must always be wary of extrapolating the specific to the general, it might be advisable for regulators to test out their latest rules in the lab prior to experimenting with society. It could save us all a lot of money.

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IF YOU BELIEVE IN GHOSTS

It was with both pleasure and some amusement that I read John Calfee's "The Ghost of Cigarette Advertising Past" in the summer 1997 issue of *Regulation.* I confess to thinking that "specter" might be a better term than "ghost," and that Calfee was probably thinking of both the past and the future when he originally wrote his piece in 1986. Calfee has been an eloquent spokesperson for the view that sellers must have sufficient incentives if they are to provide information—hardly a free good—to the buying public. Modern advertising is a remarkably efficient vehicle for the provision of such information. Moreover, firms have strong economic incentives to deliver the information forcefully and to the most relevant consumers. But that will not happen, Calfee argues persuasively, unless the implied "take-away" of information favors the advertised brand.

Much commends that line of thinking, and those in public policy positions should consider Calfee's argument when they debate when and how to regulate the flow of advertising information on health and safety issues. If, for example, a firm is prevented from associating its brand with a verifiable health benefit because other brands provide the same benefit, there is no incentive for a firm to communicate that information to consumers via advertising. So, no firm may do so. Calfee championed that view and deserves credit for it.

When Calfee tries to apply his formula to cigarette advertising, however, he inevitably must make some assumptions about the value of the information and the effects of the advertising. As in retailing, where the three most important factors are said to be location, location, and location; when assessing reactions to advertising, there is considerable evidence that it comes down to context, context, and context. Calfee's failure to appreciate some fundamental differences in context dooms his analysis, or as Ella might sing it, "It's the wrong game with the wrong chips."

In the context of advertising designed to associate a health benefit with a brand of high fiber or oat bran cereal, the value of the information is clear, and following the advertiser's recommendation is the most desirable policy for consumers. The benefit to consumers is real and verifiable and only competitors who are not quick enough to associate the benefit with their products are "injured" (resulting from an unimpeded flow of information). The competitors have the means to respond, both by improving product performance and utilizing even more effective advertising.

In the cigarette advertising context, the benefit of smoking high filtration and lower tar cigarettes has always been a matter of debate. (Indeed, recent evidence suggests that the greater depth of inhaling low tar cigarettes in order to obtain the desired level of nicotine may be more harmful than shallower inhaling of higher tar cigarettes.) So, the desirable policy for consumers (at least from a health standpoint) is not switching down to lower tar cigarettes but quitting smoking entirely.

The effects of "fear advertising" on consumer behavior are also heavily a function of context. Cigarette advertising designed to reassure smokers that their choice of a lower tar cigarette is wise has been an artfully conceived way of appealing to "health concerned" smokers. A serious public policy analysis of cigarette advertising must recognize the strong likelihood of injury to consumers who find it difficult to quit and for whom such advertising claims and slogans provide a rationale for continuing to smoke. Calfee prefers to regard such advertising as fear-arousing, choosing to emphasize how well such advertising served to remind people of potential health problems. But, in keeping with the thrust of his argument, no cigarette manufacturer has an incentive to raise fears about the use of his product. Instead, manufacturers have an incentive to reassure smokers about their brands—hence to lower fears. Cigarette industry documents identified the types of appeals Calfee applauds (i.e., for raising health concerns) as ways of reassuring smokers, and the appeals became part of a strategy to retain the large and growing segment of "health concerned" smokers in the market.

I believe it is appropriate and prudent

for the FTC, under its mandate, to prohibit a claim when it has not been established by competent scientific proof that the claim is true, and if true, that any differences across alternatives are significant. Standards of proof may need to be more flexible to accommodate the limitations of scientific inquiry. Once again, context clearly matters, including explicit consideration of choice alternatives and their cost-benefit tradeoffs. The fact that the FTC resisted what are tantamount to implied cigarette health claims strikes me as good public policy towards cigarette advertising, because of the inappropriateness of reassuring smokers when there was so little justification for doing so.

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