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Economics and Conservation in the Tropics:
A Strategic Dialogue

January 31 – February 1, 2008

Conference Synthesis Note

John Reid and James Boyd

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Summary

This note summarizes the results of the meeting, "Economics and Conservation in the Tropics: A Strategic Dialogue," held in San Francisco, January 31–February 1, 2008, and organized by the Conservation Strategy Fund, Resources for the Future, and the Gordon and Betty Moore Foundation. At the meeting, experts (see Annex 1) were asked to discuss the role of economic analysis as a tool to achieve conservation in developing countries. Ideas advanced can be grouped under three broad themes.

1) **Conservation economists should do more than valuation.**

Economic analysis should be used for more than calculating the "total economic value" of conserving ecosystems. Valuation is a means to an end (better decision making), rather than an end in itself, and should be tied clearly to real-world conservation policy and management issues. Further, placing a total monetary value on nature conservation is often methodologically impractical. Meeting participants emphasized the value of other sorts of strategic economic studies to identify:

- distributional impacts of conservation actions,
- low-cost conservation interventions,
- opportunities for ecosystem service payments, and
- costs and benefits of high-impact development projects.

2) **Deploying conservation economics in the field involves more than payment for ecosystem services (PES) schemes.**

PES is one kind of policy intervention that has captured the attention of many conservation organizations. Economic analysis may recommend a PES scheme, some other incentive-based instrument (pollution/development tax), or a command-and-control or education-based intervention. Conference presentations suggested that green subsidies, with a single government or private "buyer," have far better chances for success than true markets (e.g., tradable deforestation permits) for most ecosystem services, with the possible exception of carbon. Participants' level of optimism for PES varied widely.

Whatever policy or conservation project is attempted, it needs to be supported by locally generated research, received by local policy makers with a strong grasp of its economic rationale,

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and administered by professionals also familiar with economic principles. Because economic analysis often seeks to capture very local benefits and costs, it cannot be effectively handled by generic models or far-off experts. The development of local expertise and capabilities is fundamental. Conference participants supported several academic and professional development approaches.

Finally, participants noted the need to communicate economic information more clearly, both within conservation organizations and to outside audiences.

3) **Conservation economics methods need improvement in a few key areas.**

- More "scientific evaluation" is needed to determine which interventions actually further environmental and/or sustainable development goals. Like controlled clinical trials in medicine, scientific evaluation would allow us to identify the key ecological, economic, and institutional factors that lead to conservation success. Rarely does this kind of systematic analysis occur because of the high cost, technical difficulty controlling for all variables and lack of incentives for it within NGOs, foundations, or academia. The group offered partial solutions to these problems, such as suggesting collection of a limited set of simple indicators of human well-being in a large network of sites, rather than detailed data on any one site.
- Both economics and ecology will become more useful for conservation the more they can be done together. Good conservation economics requires a thorough understanding of ecological factors, forces, and changes.
- A possible consensus emerged on proposing lower discount rates for long-term environmental benefits, which means that long-term conservation would be given more value in economic analyses.
- Economists need to refrain from calculating incremental (marginal) losses in economic value from degrading ecosystems that may be near the point of collapse.
- Economists need to account for possibly large shifts in future demand for environmental goods and services.
- More needs to be done to bring the difficult-to-measure values of pure public goods (biodiversity) into decision making.

Background

The meeting, "Economics and Conservation in the Tropics: A Strategic Dialogue," featured a range of speakers with expertise in the application of economics to conservation. This synthesis does not aspire to include all of the statements and perspectives advanced at the meeting. Rather, our goal is a depiction of broad themes and concrete opportunities identified by the group.

Geographically, the meeting focused on tropical conservation, but the lessons learned are applicable to ecosystem conservation generally. Participants explored the deployment of economic analysis, not as a stand-alone approach to conservation assessment, but as a complement to ecological, political, legal, and institutional analysis and interventions.

We have organized the synthesis into three themes. The first describes the variety of economic research and analysis tools that can be used to support conservation. The second theme focuses on the practical deployment of economic tools in developing countries, where financial, human, and institutional resources are often limited. The third theme centers on how conservation economics[1] methods can be improved.

Theme #1 Economic Analysis for Conservation: Valuation and (way!) Beyond

Environmental economics provides a set of tools to estimate the monetary value of nature. In principle, by using a variety of methods, one can estimate the total economic value (TEV) of an ecosystem and use that figure to argue for its protection. In practice, it is extremely difficult and costly to do the analysis necessary for a "total" economic valuation. TEV should be viewed as an aspiration, not as a realistic goal for analysis. More common are "partial" economic valuations that identify *some* of an ecosystem's economic values.

Economic analysis of commercial, agricultural, and infrastructure development is easier than economic analysis of conservation. First, conservation provides public goods, which are not traded in markets and thus are not associated with observable prices and profits. Pro-development analyses rely heavily on prices and profits to make their case. It will always be much easier to attach a monetary value to private property, businesses income, wages, or public infrastructure arising from activities that threaten nature. Conservationists do not have recourse to such data, leaving the playing field decidedly uneven. Second, ecological systems are more complex—and thus more poorly understood—than conventional production technologies. Ecosystem degradation can also have effects over broad geographic regions and long time horizons. Many of nature's benefits, some that are likely of immense value, are the most difficult to value in monetary terms because they are public, not market, goods. Accordingly, conservationists' analytical challenge will always be greater than that faced by a developer.

Some meeting participants cautioned that it is nearly impossible to reliably calculate total economic value and that policymakers do not value such calculations anyway. Others rejoined that valuation is useful, even if it is partial. For example, often the value of a single ecosystem service will yield enough value to make a convincing argument in favor of protection. Coral reefs provide a dizzying array of benefits to people, but often the lion's share of reef benefits arise from two activities—tourism and fishing. Focusing on the value of ecological inputs to these activities fails to depict the whole value of the ecosystem, but it may provide all the information needed to encourage greater protection. Research should be prioritized based on (a) what matters to relevant stakeholders and (b) the practicality and cost of measurement. As pointed out in John Dixon's talk, use values are usually easier to measure and more comprehensible to people than are non-use values, also known as "existence" values.

Beyond valuation, economic analysis provides an entire framework for depicting nature's role in our lives. So even if the all-embracing monetary value of an ecosystem is elusive,

[1] Conservation economics is not a technical term. To us, it simply means the use of economic research and interventions to improve conservation outcomes. So, it encompasses some kinds of analysis (of development activities, for example) left out by environmental and ecological economics.

economic analysis may yield a variety of other insights and calculations that can be used strategically by conservationists. The following examples illustrate the point.

Distributional/political analysis: Economic analysis can identify the costs and benefits of particular decisions, as well as who gains and who loses. For ethical and strategic reasons, these "distributional" effects are often just as important as the raw value of protection. For example, as John Reid noted, a CSF-led analysis of dam projects in Panama valued only some environmental costs, quantified the losses likely to be suffered by indigenous people, and the substantial benefits likely to accrue to a private firm and to the central government. The findings had internal strategic value to conservation partners because they better understood the magnitude of economic interests involved. They were also important to underscoring the ethical issues involved in implementing a development project with national economic benefits and highly localized social and environmental costs borne by already-disadvantaged indigenous people.

Cost analysis: Economic analysis can identify conservation actions that have low opportunity and other costs. Where costs are low, there is less of a burden to show large benefits. More use of *cost* analysis would improve conservationists' ability to target and motivate interventions. Cost analysis is actually the analysis of commercial and other non-ecological production benefits, since these benefits are foregone when conservation prohibits land conversion and other ecologically destructive actions. For example, extensive spatial modeling in the Amazon by IMAZON, IPAM, and others shows the profitability of timber extraction and soybean planting in different areas. The benefits of timber extraction are equivalent to the opportunity costs of conservation. Accordingly, this kind of analysis shows where the threats to conservation are most intense and provides an estimate of the costs associated with prohibitions on development. The reason we emphasize cost analysis is that the costs of conservation may often be *low*. Analysis showing that conservation costs are low may be as effective—if not more so—as showing that the benefits are high. Moreover, the analysis of costs is much more straightforward than the analysis of benefits. Alex Pfaff's presentation on Costa Rica showed how cost analysis could help better target a program like Costa Rica's environmental service payments.

Economic analysis of development projects: Economic analysis is often used to justify transportation, water, and energy-infrastructure and land-use conversions that are environmentally harmful. These analyses may themselves be flawed and incomplete. Conservation economics can be used to critique and modify pro-development economic analyses used to justify decisions that threaten conservation. For example, CSF infrastructure studies have often focused on the *internal* economics of development projects, highlighting those that are wasteful both in conventional economic and environmental terms. CSF analysts have sometimes found glaring technical flaws and biased assumptions—and almost always a complete exclusion of environmental costs. Projects in a number of Latin American countries have been altered, delayed, or stopped with the help of this kind of economic analysis, with large conservation payoffs.

Lucy Emerton took a somewhat pessimistic view of conservationists' ability to influence development projects with their own economic analysis, citing the political nature of most decisions. John Reid took a more optimistic perspective, but acknowledged that success depends on a number of variables, most notably, local demand for the analysis and willingness to use it.

Local market research: Jeff Vincent noted that in conventional markets (automobiles, laundry detergent, banking services) economists often conduct "market research" to identify and measure the demand for—and technological opportunities to produce—new products and services. Market research helps producers see market opportunities. It can also help consumers communicate needs currently unmet by the market. By analogy, market research can be extended to natural goods and services as well. Nature's economic value to individuals and communities is not always immediately obvious. A greater emphasis on working with indigenous communities and listening to their depictions of nature and the role it plays in their lives would help in the design of policies to motivate protection. As made clear in Dick Rice's presentation, conservation incentive schemes will work best when the conservation benefits and the specific incentives offered are matched to local culture and preferences. A good economist (paired with a sociologist) focused on people's desires, relative preferences, and well-being and can help structure conservation deals in cultures remote from the market economy.

Strategic analysis: In the private sector, economics is often used to develop organizational strategy. Economics can help identify high-benefit, low-cost management objectives and evaluate success and failure. This should be true in the conservation non-governmental organization (NGO) sector as well. For example, CSF and the state parks agency in Amazonas are building a tool to identify the most effective allocation of financial resources in parks, taking budget restrictions and prioritized management goals into account. Economic analysis can likewise be central to the development and direction of NGO strategies.

It is natural for conservationists to look to economics to deliver a single, monetary value to support the argument for conservation. After all, the opponents of conservation often deploy their own monetary value to make the case *against* conservation. Strict adherence to this aspiration is unproductive, however. First, for both ecological and economic reasons, it is currently (and may always be) impossible to estimate a total economic value. Second, publicizing a monetary TEV is just one of many economic strategies conservationists can deploy to promote protection.

Theme #2 The Deployment of Conservation Economics

Economic analysis and research have proven useful in conservation. But, analysis does not take place in a vacuum and, to be legitimate, it must both meet the needs of and deploy the skills of local experts, stakeholders, and institutions.

Theme #2 concentrates on the deployment of knowledge and analysis so that conservation happens. Meeting participants discussed one sort of intervention, payments for ecosystem services (PES), at length, noting that this mechanism is one of a range of interventions that can be used to change incentives for conservation. Discussion also focused on the role and most promising modes of training and on the challenge of communicating our work to other members of society.

PES: Incentives to the rescue or the new "Rainforest Crunch"? The term "payments for ecosystem services" encompasses a range of interventions designed to encourage conservation. Examples include government subsidies for particular land uses or management practices (like

the U.S. Conservation Reserve Program), markets for ecosystem services (emissions cap-and-trade systems), and compensatory mitigation schemes (Brazil's Environmental Compensation obligations for industrial projects). Payments are a direct and powerful way to change behavior. However, payments for ecological services present practical challenges.

First, PES requires the creation of an institution to guide, evaluate, and administer the payments. Sven Wunder asserted that the most likely PES systems to succeed on a large scale are government-sponsored, essentially subsidies for certain behaviors. In these cases, the state is both buyer and oversight institution. This is particularly the case for public, non-excludable goods (such as biodiversity benefits), where powerful incentives for free-riding prevail, and de facto willingness to pay is likely to remain limited. Arrangements among multiple private buyers and sellers have high transaction and monitoring costs relative to the scale of the services being traded. Wunder argued, however, that there is a niche for smaller, direct payments between service users and providers in the case of watershed management and that many such schemes are beginning to develop in Latin America. Francisco Alpízar presented a specific case of a government-sponsored proposal in Honduras. His "best practices" case study showed that PES markets will not spontaneously emerge, but need substantial investments in design and monitoring.

Second, the discussion highlighted difficulties associated with measuring the performance of ecosystem service delivery. Ecosystem services are difficult to measure because they often arise from idiosyncratic natural, geographic, biological, and chemical processes subject to extreme variability. In such situations, paying for performance creates significant measurement costs.

Dick Rice promoted private NGOs' acquisition of conservation commitments from communities and governments. But, rather than buying specific services, like water, carbon, or biodiversity, his approach involves buying the easily-monitored conservation of the whole ecosystem, which saves on the cost of quantifying specific services, and tying them to the seller's conservation efforts. The deals Rice described have a clear goal of conserving biodiversity and so focus only on very biologically diverse places, but d not require detailed monitoring of the sellers' "production" of biodiversity. Similarly, Jim Boyd argued that our current biophysical knowledge (and the site-specific nature of ecological processes) prevents us from drawing clear enough relationships between conservation actions and measurable ecosystem service outcomes—undermining the feasibility of service-specific payments or markets.

Subhrendu Pattanayak, Paul Ferraro, and Alex Pfaff emphasized what can be called the "baseline and additionality" issue in all conservation interventions. Pfaff showed how it applies to PES, using the Costa Rican system as an example. He showed that the buyers (government) paid for conservation that would have happened anyway. A similar criticism has been leveled at conservation easements in the United States; people take advantage of tax breaks for conserving land they have no intention of developing. Absent clear knowledge of baselines (environmental outcomes in the *absence* of conservation payments), it is hard to prove that conservation investments, including PES, are securing *additional* services. A related concern is known as "leakage," where conservation in one area induces greater-than-baseline ecological destruction in

another, not subject to conservation payments or development restrictions. This issue has mostly arisen in payments for projects that reduce carbon emissions.

Jared Hardner presented findings on governments' minimal prospects for *selling* ecosystem services from Amazon parks, drawing from examples in Peru. Jim Boyd complemented with the American experience, noting that the still-limited scope of PES in the United States augurs poorly for the deployment of this tool in countries where institutions are more precarious and underfunded. Stefano Pagiola's view was more optimistic, based on a conviction that the only conservation that will happen is that which is paid for.

Distilling something out of all these views on PES is not easy. There was broad acceptance of the economic insight that non-market ecosystem services have value and should be paid for to encourage people to produce and preserve them. Where buyers are less concerned about detailed accounting for the services purchased and more driven by precautionary environmental principles, conservation payments seem a practical approach. Where more precise quantification of services is demanded, the high cost of measuring and showing who produced them presents a serious obstacle. This can be the case with hydrological services, but applies less to others. Observers differ on whether those costs are so high that markets for certain ecosystem services will never fully develop or whether we are at the research and development phase of what will be a major conservation solution. Is this the latest big fad or the next big thing?

The moderators are inclined toward the former view for most services, with the exception of carbon (which was not explored in depth at the meeting). Forest carbon stocks are easy to measure, its gaseous form mixes uniformly in the atmosphere, and the scale of demand for its abatement is monumental. The persistent additionality, leakage, and permanence problems do not bode well for large-scale protection of carbon in forests *on a project basis* (through the Clean Development Mechanism or voluntary markets). However, once forested countries adopt absolute, tradable forest stock commitments in an international treaty, this market could explode. The most important investments now, therefore, could be in the policy arena, encouraging such commitments and helping countries devise policies to fulfill them, and in the technological arena, refining remote monitoring methods. Carbon-offset projects have demonstration value, but are otherwise a distraction from the need for national treaty commitments.

Other generalizations we would draw related to PES echo Wunder and Rice's presentations. The government subsidy approach is more feasible, where (as in Costa Rica) there is a single, public buyer not greatly concerned with measuring to make sure it is getting exactly what it is paying for. As Alex Pfaff argued, there are real concerns that the government may not be getting as much additional conservation as it thinks, and that the solution to that problem is improvements in the targeting of investment. Such improvements are practical, according to Wunder, who cautions that public support for Costa Rica's program could erode if its environmental benefits become seriously suspect. Rice's examples suggest that transaction costs can by cut by bundling services, i.e., again, not worrying about quantities of specific services received.

In conclusion, PES is one kind of intervention that can change people's incentives and may only be applicable in a small fraction of ecosystems of global concern. Other interventions are command-and-control regulation and zoning (parks and land-use rules), environmental taxes, and education. All of these, and the choice among them, can be informed by economic analysis.

Teach some people to practice conservation economics and teach lots of people to understand it: Good economic ideas will do the most good when they come from and are understood by local people. For example, Allen Blackman discussed the challenge of having his work on shade-grown coffee plantations matter politically—and the key role of local NGOs in making that possible. Unfortunately, as of 2002, only 5 percent of conservationists had any degree in economics (according to a 2002 global survey done by CSF for the Moore Foundation). Given this situation, training of both producers and consumers of economic analysis is needed. Konrad Ritter's presentation advocated the use of online tools to disseminate knowledge to a much wider audience. Keith Alger focused on the need to do training in developing country universities.

Among the training endorsed by many participants was that offered by the regional environmental economics networks for Latin America (LACEEP), Southeast Asia (EEPSEA), and South Asia (SANDEE). These focus on nurturing young researchers with grants, short courses, and networking. Also mentioned was CSF's "Economic Tools for Conservation" training, primarily as a means to prepare conservationist consumers of economic analysis.

Economic analysis is an organic analytical process that relies heavily on place-based analysis. In order to both improve conservation economics as an intellectual discipline and to translate its tools into real-world accomplishments, there is a need for practical applications in real places with real communities and institutions. In other words, research and interventions focused on geographically specific conservation outcomes are the best training ground for emerging researchers. Gretchen Daily and Josh Farley did point with optimism to the modeling efforts at large geographic scales ongoing at their respective institutions, but these were not debated in detail outside the discussion on benefits-transfer analysis.

Communicate: A common lament among participants was that economists do a bad job of communicating with other people, which deprives their work of impact. Part of the problem is that economists are the bearers of bad news, in those circumstances, for example, where conservation is clearly not the most economically beneficial land use. Still, how can we best impress the general public with the value of environmental capital and ecosystem services when they are significant? How can we effectively convey policy recommendations directly to decision makers? Staff economists at NGOs even have a hard time communicating strategic economic information to their own co-workers! Conservation economics involves a host of esoteric technical issues, from institutional design to econometric practices, data protocols, financial discounting, and accounting practices. Field practitioners need a way to cut through these highly technical issues and deploy the fundamental insights of conservation economics in a way that is useful to their non-academic objectives. The group acknowledged a gap between academic best practice and the needs of field staff more focused on quick practical tools.

This topic relates to the discussion of valuation and its uses. The group identified a tension between the generation of careful estimates for academic or technocratic purposes and the less fastidious calculation of round numbers, forcefully and simply conveyed (without caveats!) for maximum impact. John Dixon asserted that less rigorous calculations undermine the credibility of economic analysis. This sort of criticism has fallen on papers like Peters, Gentry and Mendelsohn's June, 1989, *Nature* piece, which showed a startlingly high value for a patch of rainforest, and on Costanza et al.'s article in the May, 1997, issue of the same journal, which placed a "$33-trillion" value on the world's ecosystems, While figures like these make

good copy, policy makers, courts, and governments seem to give them little notice. No participants argued directly to the contrary, but many noted that the numbers do no good unless they can be made into compelling stories.

The back-and-forth on this subject points up a false dichotomy. We have to do good work to remain credible—and when we make speculative assumptions, we should point them out. But, economists have to make the clearest and simplest case we can with the numbers and have to talk about the values of nature more than methods used to calculate them. Academic gatherings often shun discussions of "policy relevance" and reward esoteric achievements in statistical analysis or mathematical elegance. Dixon championed simple valuation analyses with well-established methods as the best inputs to conservation policy. We can do good analysis and still tell understandable stories. Some participants did feel that the communications work should be left to public relations experts, rather done by economists with "media training."

Theme #3 Better Methods for Conservation Economics

The meeting generated a clear set of ideas for how the practice and application of conservation economics can be improved. Some of the ideas relate to the biophysical science underpinning the economics (prediction of non-marginal ecological change) and some to the economic issues arising from the conservation problem (e.g., the proper way to discount future benefits and costs).

Scientific evaluation of conservation interventions: Scientific evaluation is an experimental process designed to test the relationship of successful conservation outcomes (ecological or economic outcomes better than the counterfactual) to variables under the control of conservationists and policymakers. Many participants felt that not nearly enough of this evaluation work is done.

There are numerous difficulties in a controlled scientific approach to conservation. Success depends on a wide variety of factors that are hard to isolate even in a very detailed analysis, so it is difficult to apply lessons from one study to other communities, societies, or interventions. Ecology has a corresponding problem related to the ability to transfer ecological functions and processes across different landscapes.

A key—perhaps *the* key—feature of scientific evaluation is its careful construction and measurement of statistical "controls" to eliminate or control for variability and thereby detect true cause and effect between actions and outcomes. In medicine, for example, controlled clinical trials are the foundation on which evaluation of new medicines and medical interventions are proven. In the medical context, controls include the measurement of age, smoking, other lifestyle choices, and environmental factors. To show that a new drug improves health, these factors must be statistically eliminated as the cause of differences in people's health. If they are not, the ability to say a new drug works is significantly weakened.

With this as an analogy, the group noted recent activity, investment, and advances in the scientific evaluation of public health interventions. Jim Boyd called for a corresponding activity dubbed "ecodemiology" that would allow conservation scientists to more effectively identify conservation actions that improve the delivery of ecosystem services. But, the group also emphasized that the need for scientific evaluation goes beyond the need for purely biophysical

experimentation. Linwood Pendleton advocated the same kind of approach applied to the social benefits (the value) of conservation interventions. He discussed and presented an application of the kinds of site-specific data needed to control for variation in both biophysical and social factors that determine the relationship of conservation actions to positive changes in community well-being.

Subhrendu Pattanayak drew similar conclusions in his discussion of what economists call the "benefits-transfer" method. This method takes a monetary estimate of the value of an ecosystem good or service calculated in one location and applies that same value to another location. Unfortunately, the value of an ecosystem service is highly dependent on the social landscape in which is arises. This is true because the extent and nature of economic activities change as you move across the landscape. The value of irrigation water, for example, depends on the number of farms, the kinds of crops grown, and access to markets. These all vary spatially. The demography of the social landscape also affects value. Consider the value of recreation. New York's Central Park is much more valuable—recreationally—than parts of remote Alaska. The only way to overcome the benefit transfer problem is, again, to statistically control for the enormous social variability across sites, which economists do with mixed success.

Moreover, several participants (Juan Camilo Cárdenas, Paul Ferraro, and Jeff Vincent, for example) emphasized the need to control for institutional variables, such as the property rights underlying environmental laws and regulations and PES institutions involved in conservation interventions. Since all of these factors vary across conservation interventions, if we are to draw broad, transferable conclusions about "what works," we need to control for these factors.

Thus, the meeting identified three broad sets of controls that must be developed in order to scientifically evaluate conservation actions:

1) *Biophysical variables*—What climate, hydrological, topological, and biological features are associated with the site where the intervention occurs?
2) *Economic and social variables*—What is the income, employment, demographic, commercial, and cultural status of the study population?
3) *Institutional variables*—What policies, property rights, financial incentives, and extension resources are in place?

Several other things about these control factors are worth noting. First is the need to measure them over time. Statisticians refer to data sets that include variables over both space and time as "panel data." To make the case for cause and effect, panel data is necessary. To again draw an analogy to medical science, clinical trials rely on panel data that captures both variability across patients, their households, and their environment and changes in those variables and outcomes over time.

A second point is that this kind of data is rarely collected in a systematic fashion—even in counties where research funding is relatively abundant. Basic knowledge of even baseline conditions are poorly documented and almost never documented in a consistent fashion. Measuring these factors is important. So, too, is measuring them is a consistent way, a point

emphasized by Carlos Eduardo Young. Even when studies report biophysical and social panel data (which is rare), there is no consistently defined protocol for the units used.

Finally, we note an incentive problem within our own community. No one has a strong incentive to do scientific evaluations. There are few academic incentives in ecology or economics to measure conservation outcomes over time or construct coordinated performance systems to allow comparison of interventions. Donors and their grantees place higher priority on "getting something done now" than on measuring their actual impact, so expensive evaluations are not often conducted. To address this problem, there must first be recognition of what is being lost: the ability to really know what works! Second, we must deal with the collective nature of this problem. Consistent measurement over time will require a scale of investment and coordination that requires focused leadership from the governmental, foundation, or NGO community.

Integration of economics and ecology: Historically, ecology and economics have done a better job talking about collaboration than actually making it happen. Many of the meeting participants are trying! Economists are increasingly sophisticated in their appreciation of ecological change and their ability to measure the dependence of economic wellbeing on natural systems. For their part, ecologists are increasingly open to economists as partners in their efforts to motivate conservation and policy innovations. Among the participants assembled, there was almost no detectible difference in philosophy or aims, although active debate over means continues.

Valuation of non-marginal changes: Economists tend to study small, "marginal" changes, like the change in ecosystem values and agricultural profits from deforestation of a few thousand or even a few tens of thousands of hectares (out of hundreds of millions) in the Amazon. This happens because most decisions made in commercial activity, or even in the policy world, are marginal. Also, most economic data relating to value (i.e., prices) relates to marginal values. The price of milk is the marginal value of another gallon to some consumer. It is not the total value of all milk (even if you multiply it by all the gallons sold).

Should we value ecosystems in the same way, namely, one acre, bird, or gallon of water at a time? Often, that is what we are forced to do. Ecological systems raise some unique problems, however. First is the idea, that—due to complex, poorly understood processes—marginal losses may create non-marginal (large) effects. The concept of "tipping points" describes this phenomenon. In other words, a marginal loss of wetlands or rainforest may seem to imply a conventional marginal loss in value. But, if it leads to a non-marginal ecosystem collapse, we need to calculate a non-marginal loss in economic value. This is economically difficult to do because value is usually inferred by looking at people's marginal choices (for example, the prices they are willing to pay for one more home, car, or loaf of bread). Economists lack data on non-marginal values because we (individuals and society) almost never make non-marginal decisions or choices that yield revealed evidence of value.

A second, related problem is that ecosystem service losses may be irreversible. If losses cannot be corrected in the future (extinctions are an example), there is an option value associated with preservation of these goods services. Once lost, they are lost forever. Given our incomplete knowledge of the role played by species, habitats, processes, and other ecological features, irreversible ecosystem losses impose a real—if hard to measure—cost.

Josh Farley's presentation proposed that where alterations to an ecosystem are still mild, valuation of the marginal ecosystem goods and services is an acceptable approach to informing policy. But, in cases where damage is already severe and thresholds of ecosystem function collapse may be near, this sort of economic analysis is inappropriate and a precautionary principle should prevail. Invoking that principle exasperates developers because the line at which precaution overrides the weighing of marginal costs and benefits is not clear. On the other hand, the world is littered with examples of how nature died a "death by a thousand cuts." The implied scientific agenda is twofold: first, we clearly need a better understanding of non-marginal biophysical effects and what can prevent them; and second, development of sound non-marginal valuation techniques by economists could generate more accurate and plausible estimates of the profound economic losses that would occur from the collapse of entire systems.

Discounting: In economics, current and future costs and benefits are adjusted, so that they can be compared to one another in decision-making. Consider the question, "is it worth investing $1 million in a park—or a dam—now, in order to reap a future stream of benefits that totals $1.2 million?" The answer depends on how far in the future the benefits come. It is routine and appropriate in personal, business, and government decision making to discount both future benefits and costs in order to adjust for the time value of money (the fact that a dollar today is worth more than a dollar promised to you tomorrow).

The problem with discounting is that it renders benefits arising in the distant future literally worthless. Any value discounted with even a moderate rate, say, 5 percent per year, is less than a tenth of its original value in 50 years and close to zero in a hundred. This makes sense if we are talking about trading off money left in the bank with money we can use now. But to many, it seems wrong that ecological benefit seen in 100 years should be worthless in a world that has provided that benefit for millions of years.

Jeff Vincent offered a three-part rationale for using a very low, or even negative, discount rate for long-term environmental projects. He pointed out that savings interest rates, which reflect the time preferences of ordinary people, are lower than those of businesses and may be a better benchmark of attitudes about the future (i.e., people care more about the future than firms, which do not have grandchildren). He also proposed that a negative discount rate might make sense in a scenario in which severe economic contraction is expected as a result of climate change, such that future income will be more highly prized than current income. Finally, in the face of uncertainly about what discount rate should be applied in long-term projects, economists should arguably err on the low side, giving more weight to the future. In summary, conservation economics can and should pioneer a solid approach to environmental discounting that admits the possibility of sustainability.

The evolution of preferences: Economic analyses derive estimates of value by looking at people's actual choices and behavior. The problem, which most economists will quickly acknowledge, is that preferences need not stay the same over time. As incomes, knowledge, political freedoms, and communities change over time, so may basic values. This may be particularly true of preferences for certain environmental goods and services, many of which have assumed much greater importance within the space of just the last decade. Economic

forecasts involving the environment need to account for the potentially large shifts in the value attributed to things such as biodiversity and climate stability.

Pure public goods: There is an inherent bias toward the analysis of conservation benefits that are not purely public. Nature's benefits to private parties are easier to observe, measure, and explain, precisely because there is a private party that perceives and receives the value of the natural system. The value of water or the value of pollination to farmers are examples. Pure public goods—like the preservation of cultural heritage, species existence, and the resilience of global systems—are harder to measure. It is also harder to motivate people to conserve public goods due to free rider problems. Arguably, however, these public goods are the most important and economically valuable natural outputs. This argues for the continued development of tools specifically designed to capture nature's public value. In practice, this means tools not dependent on data and inferences from private goods and markets.

Conclusion

Motivating and achieving lasting conservation outcomes is not easy. Historically, the ecological sciences have been called on to help make the case for preservation. Increasingly, economics is being seen as an important partner in this effort. Economic analysis can shed light on the interactions between nature and the conventional economy, quantify the pressures that lead to habitat loss, and depict nature's economic contributions to communities, industry, agriculture, and our overall well-being.

It remains the case, however, that while economists have expanded and refined our economic understanding of the environment, they do not routinely participate in the practical business of crafting conservation strategies in tropical regions. This meeting discussed ways in which economics can be a more active and effective partner to conservation in these areas. Despite clear challenges, the overall mood of the assembled group is decidedly positive. Economics already supports conservation all over the planet by training a spotlight on nature's central economic role in our lives, opportunities to conserve resources at low cost, and the sometimes faulty arguments used to justify actions hostile to ecosystem preservation. It is clearly within the capacities of the group assembled in San Francisco, and our many partners, to dramatically increase the contribution of economics to ecosystem conservation.

Annex 1 Invited Speakers

Alex Pfaff	Duke University
Allen Blackman	Resources for the Future
Carlos Eduardo Young	Federal University of Rio de Janeiro
Dick Rice	Conservation International
Francisco Alpizar	CATIE/LACEEP
Gretchen Daily	Stanford University
James Boyd	Stanford University and Resources for the Future
Jared Hardner	Hardner & Gullison
Jeff Vincent	Duke University
John Dixon	Independent/World Bank (ret.)
John Reid	Conservation Strategy Fund
Joshua Farley	University of Vermont
Juan Camilo Cardenas	Universidad de los Andes
Keith Alger	Conservation International
Konrad Ritter	World Bank
Linwood Pendleton	Coastal Ocean Values Center and the Ocean Foundation
Lucy Emerton	World Conservation Union
Paul Ferraro	Georgia State University
Robin Naidoo	World Wildlife Fund
Stefano Pagiola	World Bank
Steve Polasky	University of Minnesota
Subhrendu Pattanayak	Research Triangle Institute
Sven Wunder	Center for International Forestry Research