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Simple Ecosystem Service Valuation Can Impact National Forest Management

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Introduction

Environmental and resource economists emphasize advances in theory and methods because they are foundational to our research and teaching. However, in our natural zest for conceptual advances, we may lose sight of the power of simple applications that can affect programs and resources on the ground. After all, the end goal of scholarship is to improve human welfare by helping to solve pressing environmental challenges. This essay is about how a relatively simple application of the 'new scarcity' paradigm for non-market ecosystem services (Simpson, Toman and Ayres 2005) changed the management plan for a national forest. We identify lessons from our experience for AERE members.

Concern about improving the management of U.S. national forests is justified on economic and ecological grounds. One hundred and fifty five national forests cover nearly 190 million acres and comprise 8.5 percent of the total U.S. land area. However, due to being largely undeveloped, the lands have disproportionate stocks and flows of natural resources including timber, water, wildlife, and carbon storage that provide a panoply of ecosystem services. With the exception of timber and other extractive products, the services lack market prices and rents to inform the development of forest management plans. Sound theory and a wealth of evidence show how the lack of such values leads to degradation and unsustainable use of ecological assets (Pearce and Barbier 2000). The remedy is to develop credible values for the nonmarket ecosystem services that can inform the management of these natural assets.

Our project began in 2000 with an interdisciplinary team of government and academic scientists tasked to build sustainability indicators for the Mt. Hood National Forest in Oregon. The exercise was part of a larger national effort, called Local Unit Criteria and Indicators Development (LUCID) project, to test the feasibility of implementing such measures for eight national forests. The Mt. Hood LUCID project included criteria and indicators development for all three dimensions of sustainability, environmental, social and economic. Although we only discuss the impact of economic indicators here, the social criteria and indicators have had a strong influence in the literature and forest management worldwide (Magis and Shinn 2009; Shinn and Magis, 2002; Machlis and Force, 1997; Flora et al, 1997).

Background

The larger context for the LUCID project stems from the 1992 United Nations sponsored Conference on Environment and Development (UNCED) in Rio de Janeiro, Brazil. At the Rio conference, principles for a global consensus on the management, conservation and sustainable development of all types of forests were offered and then adopted by the United Nations General Assembly (United Nations Conference on Environment and Development, 1992). In 1995, the Montreal Process Working Group created a common framework for describing, assessing and evaluating national progress toward sustainability in approving national-scale criteria and indicators (C&I) for sustainable forests.

In 1998 the USDA Forest Service selected the Boise National Forest as a test site to localize the Montreal Criteria and Indicators at the local forest management unit (FMU) level. Based on the test, Forest Service Chief Mike Dombeck chartered the USDA Forest Service LUCID program with the specific purpose of developing C&I that forest managers could use to improve forest management plans, enhance collaboration between national forests and other government agencies, and relate forest plan outcomes to national criteria and indicator trends. One of the objectives in LUCID project was to generate, define and evaluate criteria and indicator suites for each domain, i.e., ecological, social and economic. In a real sense, the LUCID exercise explored what it would take to add a sustainability lens to ongoing federal forest management practices at the local forest unit scale. LUCID employed a systems-based framework to assess criteria and indicators. A systems approach focuses on both contexts and outcomes or states of ecological, social and economic systems, not merely on inputs or outputs. In the case of LUCID, the authors focused on criteria and indicators relevant to production of goods, services, and amenities on National Forest lands. This focus on such outputs is familiar ground for resource and environmental

economists. However, the criteria and indicators were based on the broader foundational notions of sustainability in international agreements, national government policies, and other organizations, and therefore required that the economic analysis be integrated with the ecological and social dimensions.

LUCID Scope

The LUCID study focused on the federal forest estate of the US National Forest System. LUCID responded to the growing realization among those interested in sustainability that sustainability issues are multi-scaled and that attainment of national sustainability goals rested, in the case of forestry, on the actions carried out at the forest management unit level. The importance of this local scale is that it is where FMU decisions are made. The aim of the LUCID study was to develop and test the feasibility of a set of criteria and indicators (C&I) that would "help provide insight into the sustainability of the underlying ecological, social, and economic systems that function coincident with the FMU [forest management unit] scale" (p. ii). Eight interdisciplinary teams carried out this policy experiment on the Allegheny, Malheur, Modoc, Mt. Hood, Ottawa, Wallowa-Whitman, Tongass, and Umatilla National Forests.

Mt. Hood Forest LUCID Study

Mt. Hood is situated in close proximity to and is ever-present on the skyline of the greater Portland/Vancouver metropolitan area. It is one of Oregon's signature mountains, home to the iconic Timberline Lodge and provides a wide array of ecosystem services to the region's residents and visitors. The Forest Supervisor of the Mt. Hood National Forest (Larsen) had particular interest in having the Forest participate in the LUCID study because of his experience as lead negotiator at the 1992 Earth Summit in Rio for the Agenda 21 Chapters on Combating Deforestation, Combating Desertification, Fragile Mountain Ecosystems, and Sustainable Agriculture. Moreover, he was aware that while the forestry community in the U.S. involved with criteria and indicators for sustainability was very conversant and expert in the environmental dimensions of sustainability, they were not conversant and expert in the social dimensions. In addition, while good at valuing the commodity aspects of forestry, the U.S. forestry community struggled with valuations for environmental services. The Forest Supervisor recognized that the Forest with its 5 million visitors per year and its close association with Portland State University provided an excellent opportunity to expand the forestry community's understanding of the social dimension of sustainability and the relevance and importance of valuing the environmental services. A partnership was struck between faculty and graduate students of Portland State University and the Forest to participate as part of the Mt. Hood National Forest LUCID interdisciplinary team.

The economic valuation of ecosystem services discussed in this essay was part of a larger partnership effort between Portland State University and the Mt. Hood National Forest (USDS-FS). The collaboration was created to explore what it would take to move sustainability from theoretical constructs to on-the-ground practice. As part of this collaboration, the Mount Hood Forest leadership team accepted a more comprehensive suite of criteria and indicators in social dimensions of sustainability reflecting the importance of communities in relationship to forests. Also, the leadership team was quick to understand the limited data available to populate social and economic indicators that were offered. Central to the story line of this article, data for important forest values like recreation, water and carbon sequestration were not available or not available at forest management unit scales. This recognition allowed the LUCID research team to offer coarse estimates and place holders as interim steps in improving the information basis of management decisions, as well as monitoring and evaluation. Finally, the leadership team resonated with the research team's early determination that sustainable forest management requires an understanding of the interactions and emergent properties characteristic to a particular system. Such sustainability challenges, where social, ecological and economic systems interact, often give rise to 'wicked' problems not amenable to reductionist science (Batie 2008). Therefore progress would be an ongoing journey characterized by adaptive management of which criteria and indicators of forest sustainability could contribute.

Developing Economic Indicators and Estimating Ecosystem Service Values

To guide the development of economic criteria and indicators, we relied on the theory of 'weak' sustainable development that argues the total of all capital stocks should be non-declining over time to assure intergenerational equity (Solow 1992). It's worth emphasizing that the objective of maintaining a non-declining capital stock generally differs from achieving dynamic efficiency (Pezzey and Toman 2005). This weak theory has limitations, e.g., assuming unlimited substitution between all forms of capital. However, 'strong' versions of sustainable development that specify

complementarity of certain forms of natural capital and irreversible threshold levels, were not feasible given limited ecological information for the Mt. Hood Forest to estimate these more complex relationships. Hence, the weak version was our starting point.

The first step was to identify the major criteria and indicators for the Mt. Hood National Forest that stem from the weak sustainability model. The list included:

Criterion 3.1 Sustain minimum stocks of natural, human and built capital

Indicators

I 3.1.1 Natural Capital, e.g., land, timber, water, wildlife

I 3.1.2 Human Capital, e.g., private forest workforce and public workers

I 3.1.3 Built Capital, e.g., Forest Service facilities and other facilities

Criterion 3.2 Produce and consume sustainable (annual) flows of market goods and services

Indicators

I 3.2.1 Commercial products from the forests and lands, e.g., timber

I 3.2.3 Energy flows, e.g., kilowatts generated

I 3.2.3 Developed recreation, e.g., ski passes

Criterion 3.3 Produce and consume sustainable flows of non-market goods and services

Indicators

I 3.3.1 Undeveloped active recreation, e.g., hiking

I 3.3.2 Passive tourism and scenic amenities, e.g., sightseeing

I 3.3.3 Water flows and quality, e.g., municipal water supplies

I 3.3.4 Air quality effects, e.g., carbon sequestration

Note that this framework has criteria for both capital stocks and the flows of market and nonmarket flows of services from those stocks (Ervin et al 2002; Ives, 2003). Those two variables are inextricably linked, yet the mere presence of a stock of natural capital does not automatically translate into a fixed pattern of service flows. For example, multiple services can flow in different proportions from natural capital assets depending upon built and human stock levels and management strategies, such as timber harvest and recreation levels. Hence, we retained the dual set of economic indicators for stocks and flows.

Our original intent was to establish a baseline set of values for major natural, manmade and human capital stocks for the Forest to assess progress or losses over time in meeting the weak sustainability requirement. However, it became quickly apparent that insufficient data on both physical quantities and values existed to do such a capital valuation exercise. Lesson 1: Teaching weak sustainable development theory is very different from successfully applying it!

So we quickly moved to the valuation of market and nonmarket ecosystem service indicators under criteria 3.2 and 3.3. We decreased the indicators to four major categories because of their observed prominence in the Forest, as well as budget and time limitations. They included timber, water supply, energy (hydropower) and recreation. Biophysical information on carbon storage in the Forest was not available. Industrious graduate students pieced together the biophysical data from the Mt. Hood Forest Office and a wide variety of other sources (Ervin et al 2002). Valuation of the biophysical flows proved even more challenging, as this type of ecosystem service valuation had never been conducted for the Forest as a whole despite its regional importance to all sustainability dimensions.

The estimated average values for annual major ecosystem service flows included:

1. Harvestable Timber (1991-99 average annual harvest level X stumpage price) = ~$15.2 million

The average harvest level over the 1991-1999 period for the Mt. Hood Forest was 44,905 Mbdft. The estimated average stumpage value in 2000 dollars was $339/Mbdft based on US Forest Service research (Haynes, 1998). This harvest volume should not be considered the sustainable flow level from a commercial timber products standpoint as it was affected by actions taken to protect endangered species habitat, e.g., spotted owl. The stumpage value approximates the scarcity rent of the harvested timber. If harvesting practices do not cause significant negative environmental effects, then this figure is the net social economic value of the timber production service coming from the Mt. Hood National Forest lands.

2. Recreation (1997 recreation visitor days for five types of recreation times average use value per RVD) = ~ $55.8 million

Recreation visitor day (RVD) estimates for the Barlow, Bear Springs, Clackamas, Estacada, Hood River and Zigzag recreational sites were collected from the internal USDA Forest Service Infrastructure System "RVDS and Occasions by fiscal year, Administrative unit and Activity" report. These sites did not cover all Mt. Hood National Forest recreational areas but were judged the major areas of visitation. RVD's were multiplied by conservative estimates of recreation day "market clearing" use value by activity (camping/day use,

fishing/hunting, car/boat travel, trail use/ viewing, winter sports) used in the USDA Forest Service (1990). It's important to emphasize that these use values do not measure the consumer surplus (CS) from recreation that would be comparable in concept to stumpage value. Such net economic value estimates for these specific sites were not readily available at the time of the analysis and could not be constructed due to time and budget constraints. The use values were commonly accepted in US Forest Service and in other Federal policy processes and therefore adopted for this analysis despite their conceptual shortcomings. Given the high visitation levels and close proximity to the recreation sites by Portland area residents, these figures likely underestimate consumer surplus for the sites.

3. Water supply (1997 withdrawal levels X USFS water values) = ~$45.0 million

We used data from the USGS Water Survey to estimate water withdrawals by type of use (e.g. irrigation, municipal, industrial). The Forest Service, Resource Pricing and Valuation Procedures for the Recommended 1990 RPA Program provided estimates of market clearing use values of water per acre-foot. Again, we realized that these values were not commensurate with net economic value. However neither the RPA nor local studies provided such estimates by type of water use. The RPA market clearing prices were commonly accepted within the USFS and adopted for this analysis. However, they likely underestimate net economic value as including just extractive water uses for irrigation, municipalities and industry omits instream values of water for biodiversity and other uses.

4. Energy production (average production levels X .02 per KWH) = ~ $ 32. 9 million

The Oregon Water Resources department reported the kilowatt hours generated on three hydroelectric dams situated on rivers in the Mt. Hood Forest. The average number of kilowatt hours (1,545,150,072) generated at the Sandy, Clackamas and Hood River facilities was multiplied times a unit value (energy price) of $0.02/KWH reported by the Bonneville Power Administration (2000) for that period. Since the Bonneville Power Administration is operated as a non-profit, the energy price was considered a conservative lower bound and may underestimate the benefits provided by the electricity. Credible estimates of CS for energy use in the region served could not be produced given the project time and budget constraints. Given the relatively low energy price for the region, it's highly likely that CS would have exceeded the estimated transactional value. Moreover, the inclusion of hydro power produced from just the dams situated on the Forest lands omits the power from Mt. Hood Forest waters that travel downstream beyond the boundaries and produce valuable power. However, we had no way of calculating the portion of power produced from Mt. Hood waters flowing through off-Forest hydro dams. Therefore the energy value estimates were considered conservative for multiple reasons.

Given the limited time and resources to conduct the analysis, the lack of certain biophysical data and values, e.g., biodiversity and carbon sequestration, the need to use mostly secondary data and values, including the imperfect "market clearing" use value measures, we cautioned that the economic values should be interpreted only as relative values so as to not imply high precision. In general, we used conservative estimates of the values for ecosystem services other than timber. Nonetheless, as the first attempt to quantify and monetize the major ecosystem services from the Forest, the estimates had unanticipated impacts.

The Impact of Mt. Hood LUCID Project Findings on Policy and Forest Management

Reflecting on the use of information from the Mt. Hood LUCID project in community dialogue, strategic planning and forest plan monitoring and evaluation reinforced the value of applying a sustainability lens to forest management decisions. In particular, order of magnitude information regarding the value of ecosystem services shifted peoples understanding of the relative importance of some aspects of forest assets. The criteria and indicators, even with low quality data, provided a means for guiding decisions and tracking impacts across all dimensions of sustainability. More specifically, the Mt. Hood LUCID test had three surprising findings. The first and perhaps most obvious is that the Forest is a vital part of the community in which it is situated. It enriches the lives of all the people, families, and communities of which it is a part in myriad ways. It is part of the reason why families moved here. It is what families do when they recreate. It gives many people and organizations an opportunity through their volunteer efforts and partnerships to be part of something larger than themselves. From this finding arose an accepted recommendation to strengthen the social aspects of Montreal Process Forest Criteria and Indicator Set.

The second finding is the importance of the Forest's economic significance. Among all the goods and services provided by the Forest, the largest in economic value created is recreation at an annual value of $56 million, followed closely by water at an annual value of $45 million, followed by hydroelectricity at $33 million, with timber products being a distant fourth at $15 million. Sustaining this valuable set of services requires

management of natural, manmade, social and human capital stocks. Altogether the Forest provides 2,700 total jobs and induces recreation spending in local communities of over $33 million annually. Not only is the Forest connected to people's hearts and imaginations, it is also connected to their pocketbooks and their communities' economic vitality.

The last finding is more subtle, but nonetheless important. Despite the best science, data, and efforts of the interdisciplinary team, a judgment about the state of sustainability of the Forest could not be reached. Because of the complexity and interconnectedness of people and the ecosystem, the best that could be done was to make a determination—indicator by indicator—of whether the Forest was moving toward or away from sustainability. This realization reinforces the point that sustainability is not a state of being, but rather, an ongoing process—a notion recognized in the final LUCID report (Castle, Berrens and Polasky 1995)

It is from this surprising conclusion about sustainability that the Forest set out to create a new strategic plan—one that started with the community of which it is a vital part. The plan puts people in the central role in our collective quest for sustainability. The logic of the Forest's Strategic Stewardship Plan that emerged is simple. The challenges facing the Forest were determined to be five:

1. Protecting communities from wildfire;
2. Restoring critical public and private lands stream habitat for the recovery of aquatic species;
3. Managing for a healthy forest that sustainably provides goods and services for people;
4. Working with public, private, and civic interest for sustainable regional recreation; and
5. Assuring relevance of public lands, goods, and services in an increasing diverse society.

For every one of these challenges, the Forest made the decision to deploy its own special skills, its financial resources, and its dedicated employees to the task of creating citizen stewardship opportunities. And, their efforts stimulated caring citizens to roll up their sleeves and engage in co-production of forest management—citizen stewardship, an investment in social capital.

The results have been amazing. Previously acrimonious relationships with environmental activists turned to award-winning collaborative partnerships in forest and aquatic restoration. Communities became engaged in their own fire prevention. The aquatic restoration program collaborations became the best in the nation. Controversial issues such as off highway vehicle management were resolved without appeal. Citizens and citizen groups became Wilderness Stewards helping the National Forest manage its wilderness. Agreement was reached on wide-scale road decommissioning and upgrading to improve wildlife and aquatic habitats and recreation access. Our partnerships in outreach programs for youth and community engagement increased dramatically. Trails are being maintained with volunteers.

Lessons for Environmental and Resource Economists

We came away from this project with what we think are important insights. First, environmental and resource economists are most helpful as full-fledged members of interdisciplinary teams from the outset to effectively address wicked problems such as National Forest management. Second, economists must be engaged over extended periods of time in such projects (the collaboration lasted nearly a decade) to evolve their analyses for most relevance and build trust among the team and Forest leadership. Third, simple estimates of major ecosystem service values for a Forest can illuminate the wide range of impacts of the Forest on the diverse community of users and impact strategic planning. We acknowledge that some of the estimates are imperfect but interpreted them conservatively. In essence we followed Voltaire's admonishment "Don't let the perfect be the enemy of the good." Finally, this type of economic analysis must accurately reflect the ecological system and be integrated with the social system that governs resource management. Analysis done in a silo will stay in a silo and likely have little usefulness for the complex task of making progress on sustainability.

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