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The State of Ecosystem Services

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The idea of taking an ecosystem services approach to conservation—that is, engaging in conservation efforts that address the sustainability of natural assets *in the context of how people use those assets*—has gained significant momentum in the past decade.

Consider: Since the seminal book, *Nature's Services,* was published in 1997, the number of publications focused on ecosystem services across academic fields has grown 1,108 percent, from 255 publications in 1997 to 3,080 in 2007.[1] A major milestone occurred in 2001, with the launch of Millennium Ecosystem Assessment (MA), an international effort chartered by the UN involving more than 1,300 scientists. Another milestone occurred in 2005, when MA published its initial findings.

More recently, multinational gatherings, including the Conventions on Biological Diversity, the Ramsar Convention on Wetlands and Migratory Species, and the Convention to Combat Desertification, have incorporated the concept of ecosystem services into their discussions and convenings. And major NGOs including The Nature Conservancy, the World Wildlife Fund, and the World Resources Institute (WRI) have begun piloting ecosystem services programs, as have major intergovernmental agencies including the United Nations Development Program (UNDP) and the World Bank. (Of the World Bank's environmental projects, the proportion of biodiversity-focused projects has increased four-fold since the 1980s.) (Tallis et al, 2008)

Ecosystem services

According to the Millennium Ecosystem Assessment (MA), "ecosystem services are the benefits people obtain from ecosystems." The MA classifies ecosystem services as follows:

Provisioning services: Products that come from ecosystems, such as food, fiber, fuel, pharmaceuticals, etc.
Regulating services: Benefits that come from regulating ecosystem processes, such as climate regulation, water purification, flood control, crop pollination, etc.
Cultural services: Nonmaterial benefits people get from ecosystems, such as recreation, cultural and religious values, artistic and scientific inspiration, etc.
Supporting services: Services necessary for all other ecosystem services, such as soil formation, nutrient cycling, primary production, etc.

Some services, such as food or fuel, already have economic value, principally because they are relatively scarce, or are owned, and therefore supply is controlled. Others, though, are considered "common goods" with no clear ownership, and these are generally "consumed" with no concerted thought given to their depletion.

At its most literal, an ecosystem services approach to conservation seeks to assign monetary value to the benefits people receive from a given ecosystem's services, and then frame conservation efforts around that ecosystem.

[1] Google Scholar search using "ecosystem services"

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With so many diverse efforts underway, it has been difficult, if not impossible, for many of those involved in the field to get a sense of what the ecosystem services landscape looks like as a whole, much less learn from one another's experiences. To help provide a map of the field, and to facilitate learning, researchers at Bridgespan, funded by the Gordon and Betty Moore Foundation, undertook a project to provide a comprehensive overview of the current state of ecosystem services and its potential for impact in environmental conservation.

This report synthesizes:

Thirty-six interviews with experts from academia, nongovernmental organizations (NGOs), government agencies, and corporations;

A literature review of over 60 white papers and reports (a list detailing these resources is included at the end of this document); and

Impact results from 194 case studies from the Nature Valuation and Financing Network (NV&F) CaseBase database and 46 from the WRI's Corporate Ecosystem Services Review project database.

The report is divided into eight sections:

1. Ecosystem services: The essential concept and the goal of conservation
2. The tradeoffs of focusing an ecosystem service either narrowly (on a single service or set of services) or broadly (on the full set of services in a given ecosystem)
3. Conditions that must be present in order for ecosystem services conservation programs to succeed
4. The state of play
5. The potential environmental impact of widespread adoption of this approach
6. Potential barriers and risks
7. Conclusion
8. Acknowledgements and references

1. Ecosystem services: The essential concept and goal of conservation

Concept

The concept of conserving ecosystem services goes beyond traditional conservation approaches—of setting aside nature in preserves and protected areas—to address the sustainability of natural assets within the context of human activity. The concept presumes that conservation can best be achieved by explicitly linking nature to human well-being, and framing the idea of conservation in light of the services, or benefits, that any given ecosystem produces. Once people recognize this link, and the value provided to them by a given ecosystem, the impetus for conservation is born. This broadens the potential for conservation from the estimated maximum achievable conservation of 20 percent of land through traditional preserves and protected areas to addressing every ecosystem on the planet.

Goal

Our research suggests that proponents of an ecosystem services approach to conservation agree on a common goal: Including the value of natural capital in policy and business decisions across all sectors of the economy in order to conserve services where human activity affects ecosystem health.

However, opinions are split on whether there is a need to place a dollar value on ecosystem services. Some experts believe that identifying the intrinsic value of an ecosystem service is enough to inform decisions and change behaviors to more environmentally sustainable practices. Others believe that the value of natural capital assets should be embedded into the economy, creating a cost of business where none was previously incurred. The latter view supports the development of policies and payment schemes to change behavior and positively affect ecosystem service production and sustainability.

2. The trade-offs of focusing an ecosystem service either narrowly (on a single service or set of services) or broadly (on the full set of services in a given ecosystem)

Ecosystem services programs are typically developed to conserve one service or a discrete bundle of services, rather than the full set of services in an ecosystem. The reason is that often, with a single service or a discrete bundle, the science is clearer and the analysis more straightforward. What's more, in the case of regulating policies, government authority is generally limited to a single service (e.g. clean water) due to departmental structures, and it is easier to frame conservation efforts in a context that doesn't muddle the already complex paths of governmental decision-making. Likewise, in business, most often companies are most interested in the protection of the service or services most important to their bottom line (e.g. soil erosion increasing river sedimentation and adversely affecting hydropower).

More than 40 percent of the 194 ecosystem services programs identified by NV&F, including 28 percent of knowledge projects and 48 percent of implementation projects for conservation benefit, are single service projects.

This narrow focus, however, may hinder conservation. In fact, while there may be instances where prioritizing a single service or bundle of services maintains the natural integrity of the ecosystem, prioritizing one service over another within a single ecosystem can lead to significant trade-offs.

For example, prioritizing a single ecosystem service may not protect biodiversity—the variation of life forms in any given ecosystem. Naidoo et al. (2008) found that locations selected for conservation of ecosystem services would conserve only 22 percent to 35 percent as many species as locations selected for preservation of

Single versus multiservice projects

Experts believe that the prevalence of single service projects is the result of:

Fragmented expertise: Scientific expertise is typically service specific, and coordination among experts has been limited.
Disjointed government authority: Authority over service provision is split among natural resource stewardship agencies and governing statutes, each of which typically has authority over a subset of services.
Split motivation for projects: Advocacy and the impetus for action usually come from concern centered on one particular service.

These three reasons make it easier to focus a project on a single service versus a more effective multiservice approach. However, many projects that are articulated as a single service project affect multiple services through co-benefits—although these co-benefits are less studied and their interdependencies less well understood.

biodiversity. What's more, only 16 percent of World Bank biodiversity-focused development projects resulted in a win-win for biodiversity and human well-being (Tallis et al., 2008).

That said, the optimization of an ecosystem for one or a few services can prove beneficial provided the ecosystem can function as a whole. For example, the research indicates that there may be instances where managed ecosystems can provide some services as well as or better than natural ecosystems. For example, monoclonal forest farms can provide greater carbon sequestration than native forests (Tallis & Kareiva, 2006). Such farms might be preferred if climate regulation is the sole desired outcome.

Tradeoffs are inherent in an ecosystem services approach, which is actually one of the most attractive aspects of it relative to traditional conservation. Traditional conservation efforts don't always recognize the need for (or inevitability of) tradeoffs. Unfortunately, a single-service approach can tend to work against that very attractive aspect of ecosystem services conservation.

3. Conditions that must be present in order for ecosystem services conservation programs to succeed

Experience suggests that four factors determine whether an ecosystem services conservation program successfully changes behavior and achieves impact: clear science, defined benefit, confined system, and good governance.

Clear science

In order for an ecosystem services program to work, it must be rooted in sufficient scientific knowledge. This includes scientific understanding of:

- The functions of an ecosystem and the specific service(s) being evaluated;
- The ways in which the ecosystem services interact (e.g., how a change in one service affects another); and
- The way in which proposed actions would affect services and the overall functioning of the ecosystem.

Defined benefit

The link to human well-being must be clear and quantifiable. An ecosystem services program succeeds when the decision maker or payee receives a clearly defined benefit that is prioritized or paid for under behavior-changing payment schemes.

Certain services—such as agricultural products, fish, and timber—which directly benefit individuals, and which are perceived to be in limited quantity, have quantifiable market value. Other services, however, such as disease regulation, flood control, and nutrient cycling, do not have a recognized market value. For these services, either the individual benefit may not be obvious, or the quantity is perceived to be unlimited. As a result, they are viewed as common goods (shared by all). Water, though it is considered a "provisioning service" (See "Ecosystem Services" sidebar at the beginning of this report) is most often viewed as a common good.

Carbon sequestration[2] is one example of a common good for which market value was created by policy regulation and offset schemes. Where market values do not exist, values may be inferred by analyzing what people are willing to pay. However, the more esoteric a service is, the more decision makers discount its inferred value.

In some instances, the link to human well-being does not need to be quantified monetarily. Need or scarcity can drive successful ecosystem services programs even without a quantifiable value or direct beneficiaries.

> Need drove Vittel (Nestle Water) to address nitrate contamination of its source product. Vittel financed farmers in its catchments to change farming practices and technology—changes that improved water quality and sustained farmer income. (*The Economist*, 2005; Kumar, 2005)
>
> Scarcity drove Cape Town to establish a water supply payment scheme to ensure sufficient water availability. The scheme involved work programs that employed hundreds of people to remove invasive trees that were transpiring water.

Confined system

Ecosystem services conservation programs work best in confined systems with clearly identified stewards (e.g., a municipal water supplier), perpetrators of negative impact (e.g., farmers whose agricultural run-off and pesticides enter the water supply), and service beneficiaries (e.g., consumers of the water). Without an identified perpetrator whose behavior can be changed for the better, there is no agent of change. Without identified stewards, there is no one to safeguard the system. And without identified beneficiaries, there is little impetus for a perpetrator to change behavior and for a steward to sustain a particular service.

The scale of a given conservation program should be tied to the natural scale of the service being addressed. Aside from carbon sequestration, which is global (e.g., carbon sequestered in one area positively affects carbon levels the world over), ecosystem services tend to be local in nature and have local beneficiaries. Some

[2] Carbon sequestration is the process through which carbon dioxide (CO_2) from the atmosphere is absorbed by trees, plants and crops through photosynthesis, and stored as carbon in biomass (tree trunks, branches, foliage, and roots) and soils (Source: EPA website)

research suggests that beneficiaries further than a few thousand kilometers away from the source of a service cannot be successfully linked back to or expected to value the benefit they may receive.

Good governance

Good governance is essential, particularly when payments for good stewardship are part of the ecosystem services program. Good governance includes:

Clear identification of ownership or tenure;
A legal system to ensure proper program execution;
Enforcement against negating activities;
Monitoring of impact; and
A functioning infrastructure to enable payment.

Lacking these components, an ecosystem services conservation program may pay for changes in behavior that either do not occur or are negated by other activities. What's more, to ensure the right party receives payment for benefits received, an infrastructure must have limited corruption. Equity issues often arise because the poorest people, who often most depend on an ecosystem service, have no voice in decision making and receive no payment for good stewardship of their ecosystem.

Good governance is the principal issue raised in opposition to Reducing Emissions from Deforestation and Degradation (REDD) in developing countries. While the carbon beneficiary side of payment for credit is clear and has defined legal and payment infrastructure, the monitoring and enforcement systems are not well established, and payment for desired stewardship behavior is less clear. As a result, payments may not actually lead to conservation or may be made for forests that would have been preserved regardless of the payment.

4. The state of play

Interviews and secondary research reveal three fundamental components of ecosystem services conservation: knowledge, decision support tools, and implementation.

Knowledge

Sufficient knowledge in three areas is a prerequisite for successful ecosystem services program implementation:

> Function: How an ecosystem functions and what its services produce
> Interaction: How an ecosystem, its services, and human well-being interact; also, how activities that degrade the ecosystem interact with ecosystem services that counteract those activities
> Location: How location (culture, economics, and politics) influences the interrelationship of ecosystems, their services, and human well-being

While our interviews revealed varying opinions on whether current collective scientific knowledge is sufficient for successful ecosystem services program implementation, there was agreement that a comprehensive understanding of how ecosystems function and how they interact with human well-being in a wide range of locations does not exist across all ecosystems and services. That said, the knowledge base for some ecosystems (such as wetlands and forests) and for some services (such as carbon and water) is relatively robust. Analysis of the NV&F database supports these opinions. With 51 percent of projects (98 of the 194 in the database) focused on assessments, modeling, and experimentation, knowledge is still being developed. Wetlands and forests continue to be a central focus for 73 percent of knowledge-building projects.

TABLE 1: Knowledge building projects by ecosystem and region (n=98)

Project type	Percent of knowledge-building projects by ecosystem
Projects by ecosystem (Note: Projects may address more than one ecosystem so percentages will add up to more than 100 percent.)	
Wetlands	49%
Forest: Tropical & Subtropical	16%
Forest: Other	8%
Drylands	7%
Marine	7%
Grasslands	6%
Sub-terrain	0
Projects by region	
Africa	30%
Asia and Middle East	21%
Americas	21%
Oceania, Australia, & Fiji	11%
Europe	8%
Other	6%

TABLE 2: Knowledge projects by number of ecosystem services addressed

Project type	Number of services addressed			
	1	**2**	**3**	**4+**
Knowledge	29	11	6	52
Cultural (Tourism & Recreation)	6			
Supporting (Habitat & Biodiversity)	6			
Regulating (Other)	6			
Provisioning (Production & Extraction)	5			
Other	2			
Regulating (Carbon & Climate)	2			
Regulating (Watershed)	1			
Cultural (Other)	1			

Source: Based on analysis of the NV&F database of ecosystem research and implementation

In recent years, more projects have focused on services other than carbon and water, including other regulating, supporting, and cultural services. Projects involving multiple services and the interactions among services are also on the rise. Finally, projects increasingly have a global spread, spanning major world hotspots. An analysis comparing the current NV&F database with an earlier version from 2006 supports these opinions.

While expansion in breadth of services, interactions, and location is improving knowledge capture, some of our interviewees caution that in order to build a comprehensive knowledge base, researchers must:

Increase replication and standardization of projects: Projects that are replicated and standardized enable scale and the identification of commonalities across projects. Yet even among highly studied systems and services, academic incentives for originality have created a bias against replication and standardization of studies. This has resulted in fragmented knowledge.

Increase coordination across disciplines: Experts from the fields of physical, natural, and social sciences all must contribute in order to create effective ecosystem solutions. To date, coordination has been insufficient to fully articulate what one discipline may require of another.

Shift to more prospective, decision-guiding research: Thus far, researchers have done well at documenting past damage. But studies that aim to guide future decisions could contribute even more to the required knowledge base and help influence policies and activities that affect the environment.

Be more willing to publish and accept preliminary results: While scientific rigor must be maintained, important advances have been delayed by the desire for "bullet proof" results. Academics need to be more comfortable publishing preliminary results—and the field, including policymakers, must be more accepting of them. In the absence of comprehensive data to guide a decision, preliminary results certainly provide more guidance than no results.

Focus on local conditions: While global assessments can create an incentive for change, policy decisions require an understanding of local conditions.

A number of initiatives are underway to address these issues.

The International Council for Science has proposed a 10-year program comparing matched ecosystems in different cultural contexts. Leading researchers note that this program will help determine commonalities that can be leveraged for replication and scale.

The US Department of Agriculture (USDA) has created a new office of Ecosystem Services and Markets to provide technical guidance for implementing Section 2709 of The Food, Conservation, and Energy Act of 2008 (USDA, 2008). This policy calls for the Secretary of Agriculture to "establish technical guidelines that outline science-based methods to measure the environmental services

benefits from conservation and land management activities in order to facilitate the participation of farmers, ranchers, and forest landowners in emerging environmental services markets."

The Ecosystem Services Research Program (ESRP) at the Environmental Protection Agency (EPA) has announced a coordinated research effort to "establish ecosystem services standards, indicators, and measurement protocols, advance valuation techniques, create institutional capacity for investment in natural capital, and to improve the ability to perform assessments across institutional, spatial, and temporal scales." (Source: EPA website)

The World Conservation Monitoring Center of the United Nations Environmental Program (UNEP-WCMC) is conducting a gap analysis on the interactions and disconnects between science and policy. The analysis is a result of the November 2008 intergovernmental and multi-stakeholder meeting on biodiversity and ecosystem services. Held in Malaysia, the meeting investigated how science can be used to better influence policy. Once the gap analysis is complete, a second meeting should be convened.

The United Nations University has assumed responsibility for the Millennium Ecosystem Assessment (MA) subglobal assessments (SGA)[3], which focus on the necessary local analysis to support local decision-making for effective sustainable living and conservation policies. The university is in the process of tightening the requirements for SGA inclusion. Currently, among the approximately 40 officially registered MA SGAs, the scope, scale, and completeness of the assessments vary considerably. A survey of 21 SGAs found that 33 percent were complete, 57 percent were ongoing, and 10 percent were just beginning (UNEP-WCMC, 2007). Our research indicated that SGAs were initially intended to be "policy relevant," but so far they have not resulted in significant policy change. The SGAs have, however, affected how research institutions conduct their work and have created broader public awareness.

[3] In connection with the Millennium Ecosystem Assessment (MA), sub-global assessments (SGAs) of ecosystem services were undertaken at varying geographic levels to strengthen the global findings of the MA with on-the-ground reality; strengthen the local findings with global perspectives, data, and models; and to meet needs of decision-makers at the scale at which they are undertaken (Source: Millennium Ecosystem Assessment website).

Decision support tools

For ecosystem services programs to succeed, most experts agree that knowledge must be packaged for ease of use by key stakeholders, policymakers, and business decision makers. While some technology exists to gather, organize, and analyze ecosystem service knowledge, the tools for doing so are not yet used in a standardized way that supports decision making.

Ecosystem knowledge databases: At this writing, a comprehensive and organized data clearinghouse does not exist. While governments or intergovernmental organizations such as the World Bank and UNEP may have the standing to consolidate and curate data, none have stepped forward. There are, however, instances of collaboration and knowledge sharing such as Conservation Commons (partially supported by UNEP) and The Nature Conservancy's Conserve Online.

Measurement and monitoring: Most ecosystem services measurement and analysis— including trade-off analysis, scenario planning, and commodity-style trading of ecosystem services—is insufficient to support effective decision making. For example, there are currently over 15 different carbon calculations with no common methodology. Likewise, monitoring is not systematic or standardized. Remote sensing (particularly Landsat) satellite systems are increasingly being used for cost-effective monitoring, but this method is at risk due to government funding cuts (Goetz, 2007; Lawler, 2005).

Applications: Plenty of applications have been developed to aid decision making with respect to ecosystem services. These include traditional conservation planning tools such as Marxan, Ecopath (for marine systems), and the Conservation Action Planning protocol. They also include new service-specific tools such as InVEST, the Multiscale Integrated Model of Ecosystem Services (MIMES), and the Ecosystem Portfolio Model under development by the US Geological Survey (USGS). While each of these tools has value, they remain independent efforts.

Summary observations on knowledge and decision support tools:

- The Ecosystem Services field lacks a comprehensive knowledge base (and needs more viable databases for capturing knowledge)
- Greater depth of knowledge exists for wetlands and forests than other ecosystems
- Greater depth of knowledge exists for water and carbon services
- Projects are globally spread, but there is a lack of replication and standardization of projects
- The field lacks of standards and sufficient measurement and monitoring tools
- The field lacks standard decision support applications
- No application covers all geographies for even the most prevalent ecosystems and services

Implementation

The actual implementation of ecosystem services programs is relatively new, and as such, it is evolving. Of the 194 projects in the NV&F database, 49 percent are implementation projects (as opposed to knowledge projects). These projects are principally carbon or water projects. Many of them are in an early stage and have yet to demonstrate significant impact. Sustainability is also a concern, as many projects implemented within the last five years no longer exist. However, in this same time period, our interviewees, research, and case examples all attest to an increase in both the number of projects and the number of projects achieving conservation impact.

While the number and success rate of implementation projects are still relatively small, they can be segmented into two types: either policy-driven or business-driven. Further, implementation projects generally use one of two mechanisms: either trade-off analyses to inform decision making or a cost for services scheme, requiring beneficiaries to make payments.

Implementation types

As many as 64 percent of implementation programs in the NV&F database are *policy-driven*, while only 16 percent are principally business-driven (20 percent are nongovernmental organization (NGO) or academic experimentation projects, or are unclear). Since most ecosystem services are common goods, policy is the principal mechanism for driving change. Some experts suggested that 80 percent to 90 percent of all impact achieved through the conservation of ecosystem services will be policy-driven, whereas independent business decisions will achieve only 10 percent to 20 percent.

While some policies have incorporated ecosystem services concepts, these concepts have not been widely adopted. This is partially because of the rigorous requirements for:

> Scientific evidence that is on a comparable scale to the policy's authority; geographically applicable; sufficiently validated; and appropriately standardized to avoid legal challenges; and
> Strong leadership and advocacy to create the drive to change.

These requirements exceed the traditional requirements of clear science, defined benefits, confined system, and good governance.

Examples of ecosystem services in policy

The Conservation Reserve Program (1985) within the Farm Bill, National Wetland Mitigation Plan (2002) under the Clean Water Act, and conservation banking under the Endangered Species Act (1973) are all examples of ecosystem services policy, although some of these policies preceded the "ecosystem services" terminology.

More recently, Section 2709 of The Food, Conservation, and Energy Act of 2008 (Farm Bill) called for the Secretary of Agriculture to establish technical guidelines to measure environmental services benefits from conservation and land management activities. To accomplish this goal, a government-wide Conservation and Land Management Environmental Services Board was established in December 2008. In addition, the USDA created a new office of Ecosystem Services and Markets to provide technical guidance for implementing Section 2709.

With regard to *business-driven* implementation programs, research indicated that corporations adopt ecosystem services to comply with regulations, at times anticipating compliance or going beyond compliance when the decision is also in the organization's best interest. Best interests include: new business opportunities, cost reductions, sustainability of inputs, or brand/reputation differentiators. In general, corporate representatives expressed a current resistance to invest in anticipation of compliance requirements due to lack of certainty around future regulatory direction. And, adoption based on a corporation's best interest has been limited by the lack of clear science, established methods, and easy-to-use, applicable tools.

Why have some businesses incorporated an ESA into their operations?

Business incorporate ESA into their operations for several reasons:

Compliance	Risk Mitigation	Bottom Line Impact
Regulatory requirements • Mandated activity – E.g., Regulated carbon markets • More efficient or cost-effective way to meet compliance obligations – E.g., Using trees to remediate contaminated material instead of material disposal	Future regulation • Alleviate future regulatory or legal liability – E.g., Using conservation easements to prevent risks from development of remediated land • Influence pending or future regulations (policy and implementation programs) – E.g., Experimentation in voluntary carbon markets Reputation and values • Social license to do business – E.g., Goldman Sachs: "We…help to address the challenges facing the environment"	Additional asset value • Convert or expand asset utility – E.g., ChevronTexaco's wetland mitigation bank converted from a tapped-out drilling site Cost reductions • Reduce or stabilize input or operating costs – E.g., Energia Global hydropower investments by in watershed maintenance New business opportunities • Revenue opportunities from new environmental markets – E.g., Intaran Indonesia production of neem trees which help replenish soil quality and prevent erosion

Source: ACES conference presentations; Bridgespan Interviews

Implementation mechanisms

A minority of NV&F implementation projects use *trade-off analysis* for decision making with no payment or reward system—versus 68 percent charging a utility cost and requiring beneficiaries to make payments.

Using trade-off analysis or scenario planning appears to be most effective in the areas of infrastructure planning, land use development, and energy sourcing, where both owners/stewards and beneficiaries have equal stake in the decision, such as municipal land-use development projects. For example, in Canada the province of British Columbia implemented a water use planning program to balance environmental, social, and economic values. The planning process involved watershed stakeholders, including First Nations, environmental organizations, Fisheries and Oceans Canada, the government of British Columbia, and nearby communities. BC Hydro developed scenarios for different reservoir levels and river flow rates that illustrated how the project would affect each user of the ecosystem. And stakeholders used trade-off analysis to agree on a preferred alternative that became the operating plan for the dam. (Hanson et al., 2008)

As effective as trade-off analysis can be, many of the people we interviewed note that *payment schemes* are the principal mechanism for changing behavior, even with policy-driven programs. Payment schemes are best used when beneficiaries are removed from the stewardship of the ecosystem service in question.

Payments for ecosystem services (PES) is narrowly defined as the payments beneficiaries make to the owners or stewards of an ecosystem to protect and rehabilitate a desired service. However, payment schemes can be defined more broadly to include not only PES, but also payments arising from cap and trade regulations[4], mitigation banks[5], taxation or usage fees, and markets. Many of these payments schemes exist today and have succeeded in preserving and rehabilitating ecosystems and services.

Due to the prevalence of payment schemes, commodity markets for ecosystem services are starting to emerge—though experts are divided on their potential. Today, the World Bank estimates the value of carbon markets to be over $126 billion (in 2008), and some leading researchers predict that value will grow to $1 trillion by 2020 (New Energy Finance, 2008). Water markets may be even larger as scarcity increases. Still, some

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[4] Cap and trade is a market-based policy tool that sets an aggressive cap, or maximum limit, on emissions. Sources covered by the program then receive authorizations to emit in the form of emissions allowances, with the total amount of allowances limited by the cap. Each source can design its own compliance strategy to meet the overall reduction requirement, including sale or purchase of allowances, installation of pollution controls, implementation of efficiency measures, among other options. (Source: EPA website)

[5] Mitigation banks are part of an environmental crediting system established by governing bodies that involves allocating debits and credits. Debits occur in situations where a natural resource has been destroyed or severely impaired and credits are given in situations where a natural resource has been deemed to be improved or preserved. (Source: Wikipedia)

experts maintain that without the standardization, rules, accountability, and business ownership that exists in other commodity markets, these markets will not survive.

Summary observations on implementation

- Nascent, but growing number of ecosystem services implementation projects
- Relatively high number of carbon and watershed projects
- Conservation impact and sustainability often unclear
- Successful projects are more likely to be policy-driven than business-driven
- Payment schemes are more likely to be used than trade-off analysis

5. The potential environmental impact of widespread adoption of this approach

While the ecosystem services approach has yet to achieve its goal of inserting natural capital into the economy, it is still evolving. Interviews and research suggest that the concept's potential has yet to be fully realized. To assess the strategic significance of the conservation of ecosystem services, it's worth considering the way it has spread through and been adopted by segments of the economy. This section shares stories of:

- Long-standing, successful implementations;
- Early adoption by major governments; and
- Early adoption by primary, secondary, and tertiary-sector businesses.

The following examples indicate that ecosystem services conservation is between proof-of-concept and early adoption, with some services and segments of the economy more advanced than others, but none further along than early adoption.

Long-standing, successful implementations

Experts often cited Latin American water and watershed projects as examples of successful ecosystem services programs. Latin American governments have long engaged in watershed projects focused on water quality, quantity, and turbidity, charging usage fees on downstream users or hydroelectric companies that depend on a specific ecosystem and its water services. Beneficiaries make payments that go to state water agencies or local governments to maintain water sources upstream. The payments, in turn, may be distributed to local landowners/stewards. Or, they may be paid to users/perpetrators upstream to incent them to reduce

their negative impact on a watershed by changing farming practices, reducing land development or exploitation, and avoiding particularly high-risk areas such as steeps.

Some programs, like Mexico's National Water Commission usage fees, have been in place since the 1990s. By increasing companies' water-right fees 17-fold, Mexico's program has brought about systemic private sector change. For example, in response to increased fees, Ingenio San Francisco Ameca, a sugar factory, introduced water efficiency technologies and successfully reduced water consumption by 94 percent and wastewater pollutant concentration by 20 percent. These changes, while costly, were paid for within two years of avoiding the increased fees. (Miranda-da-Cruz, 1997)

While the Mexico example is notable, many ecosystem services watershed programs have been small in scope. Located in developing countries and plagued by governance issues, they have tended to focus on watersheds where the ecosystem service stewards and beneficiaries are easily identified and payments schemes can be implemented in the absence of robust economic infrastructures. Small scale can result in a lack of overall impact, since it is unclear whether the adverse behavior successfully stopped in one watershed is not simply moved to another watershed. Holistic regional or national programs with strong governance in monitoring, tenure rights, local steward payment schemes, and enforcement could ensure this does not occur.

For example, Costa Rica's Payments for Environmental Services is a countrywide program of payments to cover water, biodiversity, and carbon. Over the last decade, it has been credited with helping the country achieve negative net deforestation (Wunder et al., 2008). Critics suggest that, despite the breakthrough scale of the project, the program's actual impact has been limited by its inability to target land that is at high risk for conversion from its natural habitat into farmland or development. They also suggest that the program was introduced as an appeasement measure to compensate for traditional land use restrictions introduced at the same time that may have had greater potential for impact. Others point to Costa Rica's small economic size as the reason for lack of replication in other countries. Some say that it will take a large, economically important country like China or the US to implement a comprehensive, national ecosystem services program like Costa Rica's for other countries to follow.

Early adoption by major governments: China

China may be headed towards a global leadership position in the conservation of ecosystem services. Chinese environmental agencies have implemented a series of sweeping national programs. These include harvest restrictions for timber and restoration of land from cropland to forests. The restrictions collectively aim to reduce

deforestation and the conversion of land from its natural habitat into farmland or development, and increase reforestation and afforestation[6].

In addition, China has started what is arguably the most ambitious ecosystem services mapping program in the world to identify critical ecosystems and sustain, restore, or rebuild key ecosystem services. Its most recent economic development plan, the 11th Five Year Plan (2006-2010), identifies sustainable development, renewable energy, and zoning of ecological areas to protect key ecological functions as core elements of the plan. In an effort to conserve and rehabilitate China's biodiversity, China's Ministry of Environmental Conservation has formed the China Biodiversity Partnership Framework (CBPF) to partner with national and international governments, NGOs, and businesses. The program seeks to improve biodiversity and mainstream it into the socio-economy, increase the number of protected areas, improve biodiversity measurement, and export conservation learning. Still in a planning phase, the potential of CBPF could be significant in a country that includes over 600 categories of ecosystems and 10 percent of the world's species—but where 70 percent of all electricity is coal-generated and one-fifth of waterways are at the highest toxic levels.

Early adoption by major governments: United States

The US government has long been involved in the conservation of ecosystem services through programs that precede the concept. These include:

The Conservation Reserve Program (1985) within the Farm Bill;
The National Wetland Mitigation Plan (2002) under the Clean Water Act; and
Mitigation banking under the Endangered Species Act (1973).

In particular, The Conservation Reserve Program has been highly successful in reducing soil erosion, improving water quality, and enhancing forest and wetland resources. This program—which pays more than $1.8 billion a year to farmers to convert targeted cropland to vegetative cover—has helped retire more than 36.8 million acres since inception.

Several experts cited agriculture, both within the US and around the globe, as the single biggest economic sector for impact. For example, the US Farm Bill comes up for renewal in 2012. Some interviewees pointed out that if production subsidies are changed from subsidizing environmentally detrimental agricultural practices to promoting benign or sustainable practices that support ecosystem services, this could achieve tremendous conservation impact. US acceptance and use of ecosystem services conservation in decision-making is

[6] The process of establishing a forest on land that is not a forest, or has not been a forest for a long time by planting trees or their seeds. (Source: Wikipedia)

growing, but not in a way that is as significant, coordinated, or widespread as it is in China. Environmental agencies such as the Forest Service, the National Oceanic and Atmospheric Administration, USGS, USDA, and EPA have begun to incorporate ecosystem services into their planning and activities. Several agencies are using tools such as MIMES and including ecosystem services in environmental or commercial decisions. Examples include the New Jersey Department of Environmental Protection mapping and evaluation of the state's natural capital (Mates, 2007); and the USGS's work in Dade County to build decision making tools that consider the impact of development on the Everglades ecosystem and ecosystem services (USGS website). Despite these moves, natural resources stewardship agencies have limited capacity to divert resources to ecosystem services projects from projects that are core to their mandate.

However, there is movement at the highest levels of government to embrace an ecosystem services approach to conservation, which could supersede agency mandates and impose new policies that will require the taxation and regulation of ecosystem markets and services to enforce better environmental management practices.

> In the Florida Everglades, the USGS is working with Dade County to build decision-making tools that consider the impact of development on the Everglades ecosystem and ecosystem services (USGS web site). The project weighs trade-offs between using an area for conservation versus city expansion by assigning inferred values of specific ecosystems or services—such as the habitat for the Florida panther—to give a conservation value. This, in turn, can be compared to the commercial or residential development value. While this still leads to subjective decisions based on stakeholders' relative priorities of conservation versus development, it does provide knowledge of impact and environmental trade-offs.
>
> The Office of Ecosystem Markets and Services (OEMS) is ramping up and on pace to expand to 12 staff members in 2009. It is tasked with creating an overall market infrastructure for multiple ecosystem goods and services, but is proceeding cautiously to make sure that environmental protection results from the expansion of environmental markets.
>
> On July 23, 2009 the governor of Oregon signed Senate Bill 513 establishing a framework to create rules that would enable payments for a wide variety of ecosystem services within the state. A key feature of the bill was the establishment of a Working Group to provide further policy recommendations by 2011. While the bill is more about paving the way for future ecosystem service based statutes and regulations, it does establish a policy to "support the maintenance, enhancement, and restoration of ecosystem services," authorizes Oregon agencies to manage adaptively, and authorizes agencies consider broader landscape scale mitigation that might spur the further development of mitigation baking and other credit-based markets. (Source: Ecosystem Marketplace website)

In the Chesapeake Bay region, the public-private partnership-created Bay Bank is designed to help private landowners access the mitigation and credit-trading markets created by various state and federal compacts aimed at restoring the health and vitality of the Chesapeake Bay, as well as traditional conservation incentives such as the Conservation Reserve Program. In August 2009, the Bay Bank selected Markit Environmental Registry to track credits and other market-based investments developed through Bay Bank. It is anticipated that Markit will begin registering habitat conservation, water quality protection, and forest conservation credits by 2010. (Source: Bay Bank website)

The Commodities Futures and Exchange Commission, which oversees futures trading, recently filed a notice of intent to potentially provide more oversight of the Chicago Climate Exchange and also has created an expanded Energy and Environmental Markets Committee to advise the Commission on environmental markets, with an eye towards regulatory oversight of various cap and trade systems being debated in current legislation.

And with the specific issue of climate change, both the Environmental Protection Agency (EPA) and the White House are taking steps towards controlling carbon emissions. The EPA declared carbon dioxide and five other heat-trapping gases to be pollutants that endanger public health and welfare, setting in motion a process that could lead to the regulation of the gases for the first time in the US. In turn, regulation may drive voluntary markets to become mandatory, and add legitimacy and a sense of urgency to programs like REDD.

Early adoption by primary sector businesses

Primary sector businesses[7] focus on the extraction of raw materials and have the most direct impact on the environment. They also have the most economic dependence on specific ecosystems and services. As such, primary sector business-driven decisions often include the conservation of services, even in the absence of policy. Mondi, BC Hydro, Rio Tinto, and Syngenta all helped develop and pilot the WRI's "Corporate Ecosystem Services Review" methodology. They have each subsequently changed their business practices based on pilot findings. For example:

Upon gaining insight into the direct business implications of water degradation, Mondi, an international paper and packaging company, has implemented production changes that will make the company more efficient in using fresh water (Hanson et al., 2008).

[7] The primary sector of the economy extracts or harvests products from the earth. Activities associated with the primary sector include agriculture (both subsistence and commercial), mining, forestry, farming, grazing, hunting and gathering, fishing, and quarrying. (Source: Wikipedia)

> Syngenta, an agribusiness corporation, used the tool to understand the risks its farming customers in southern India faced from degrading land management practices. In response, the company began offering improved pest management services, a change in seed mix to more water-efficient crops, and increased training in best practices. These steps improved their customers' farming practices, as well as farm production and profitability. (Hanson et al., 2008)

Keep in mind, where degrading behavior, such as logging or natural resource extraction, is deemed as profitable as or more profitable than the long-term value of the ecosystem service(s), primary sector businesses are unlikely to change behavior in the absence of policy.

In some primary sector businesses, policy-driven business changes have resulted in conservation and new lines of business and profits.

> Inland Empire Paper Company and Potlatch of Idaho have, in effect, turned their forestlands into over 300,000 hectares of profitable parks, charging user fees to hikers, campers, and hunters (Hanson et al., 2008).

> Likewise, Chevron Texaco converted a tapped-out drilling site in Louisiana into a 2,800 hectare wetland to generate credits for the US wetland mitigation banking market. At an expected market price of $50,000 to $62,000 per hectare, the company could earn as much as $150 million selling credits to developers. (Kenny, 2006)

Early adoption by secondary sector businesses

Secondary sector businesses, which focus on manufacturing and construction, have an impact on the environment through their supply chains. As such, ecosystem service sustainability is possible through supply chain management. Mars and Coke are exploring the possibility of reducing their carbon footprints by requiring suppliers to use farming methods that optimize carbon sequestration. According to one interviewee, "If 50 percent of Mars cocoa producers farm using methods that favor carbon sequestration, Mars can offset the entirety of its carbon footprint that it can't through its own factory emission reductions."

If successful, this method of farming in a way that increases carbon sequestration could lead to the inclusion of ecosystem services in commodity prices. For example, the characteristics that determine the price of agricultural commodities could in the future include the amount of carbon sequestered in growing the produce, in addition to the current commodity characteristics of color, health and safety specifications, and bulk density. While the Mars and Coke business decisions may be driven by a fear of pending regulation on carbon caps, other businesses have leveraged their buying power to force changes in their supply chain for other business

reasons. For example, DaimlerChrysler chose to switch to coconut fiber from plastic filler for their Mercedes-Benz headrest, thus promoting sustainable mixed-used agriculture in South America while reducing their costs by 5 percent and minimizing their supply chain risks.

Early adoption by tertiary sector businesses

Tertiary sector businesses include services (from transportation to financial services), as well as the sale of goods from producers to consumers (retailing, wholesaling). These businesses may implement ecosystem services conservation in several ways and for a variety of reasons—all of which affect their bottom lines. For example:

> To protect its brand, Wal-Mart US conserves ecosystem services through supply chain management. Wal-Mart only purchases farmed shrimp that are certified sustainable and pledges to source all wild-caught fish from fisheries certified by the Marine Stewardship Council (CELB, 2007; Wal-Mart 2008).
>
> To mitigate risks, lending institutions such as ABN AMRO avoid financing projects that extract resources from virgin or high-conservation value forests (ABN AMRO, 2001).
>
> To increase its revenue base, Australian tourism operators successfully lobbied for the government (Hanson et al., 2008) to implement a new zoning plan that expanded "green zones," where fishing is banned, from 5 percent to nearly 33 percent (BBC, 2003).

Tertiary businesses have leveraged ecosystem services programs to create viable, profitable enterprises from environmental policy regulations and incentives. For example:

> Allegheny Power in West Virginia used an ecosystem services approach to land valuation to double the appraisal of its real estate over traditional methods.
>
> Beartooth Capital in the US and Canopy Capital in the UK are private equity firms achieving return on investment (ROI) for their shareholders by investing in policy-driven ecosystem services programs. Beartooth Capital generates ROI by selling or donating (for tax breaks) conservation easements on land it has restored to NGOs and the government, or by purchasing protected, ecologically important land and selling mitigation credits (Beartooth website). With Canopy Capital, investors make PES payments to protect the rainforest in Guyana in return for ecosystem service rights (Butler, 2008; *The Economist*, 2008).

Summary observations on adoption in the marketplace

Ecosystem services conservation is between proof-of-concept and early adoption

Long-term conservation successes achieved, but not yet replicated globally

China and US governments may play leadership roles for ecosystem services adoption

Primary sector businesses more likely to implement ecosystem services projects than other corporations due to alignment with business goals

Some companies can leverage ecosystem services programs for new businesses

6. Potential barriers and risks

Before the conservation of ecosystem services can be widely adopted, several barriers and risks must be considered. Barriers are defined as issues that would prevent use of an ecosystem services approach. Meanwhile, risks are the potential unintended results of ecosystem services conservation. Experts repeatedly cited the following barriers:

Barrier	What it will take to overcome
Science has not met threshold for policy change • Lack of information, standards and verification • Lack of scalability	• Investment in measurement and monitoring infrastructure • Development of standards • Successful replication projects • Strengthened governance, where possible
Businesses/individuals are not willing to pay for things that used to be free	• Perceived scarcity of services • Regulation
Local stakeholders often lack rights, sufficient involvement	• Strengthened governance, where possible • Collaborative processes
ES approaches often require a long time horizon to impact	• Committed leadership, not subject to short term business or political cycles • Demonstrated results from successful projects
Insufficient leadership exists • Current ES champions primarily within academia • Resistance exists within conservation community	• Leaders from multiple sectors (government, corporate, philanthropy)
Cooperative action is needed	• Forums to enable collaboration and communication across stakeholder groups

In addition to these barriers, there are a number of potential risks:

Shifting of negative impact: The small scale of most ecosystem services efforts can lead to shifting of negative impact behavior to other regions.

Social inequity: Placing a dollar value on something that has been free creates equity concerns and can negatively affect people living in poverty.

Decreased cost-effectiveness: Ecosystem services programs may not be the most cost-effective approaches to conservation.

Diversion of scarce resources: Focusing on the conservation of an ecosystem service could divert resources from known, tested solutions to unknown, experimental approaches (e.g., restoring mangrove forests instead of building storm walls).

Abandonment of established practices: Ecosystem services programs could lead environmental groups to abandon other forms of environmental conservation that have worked in the past.

Lack of biodiversity conservation: Ecosystem services programs do not necessarily lead to biodiversity conservation and may negatively affect full, native biodiversity.

Unknown, unintended consequences: On a large scale, the risk of unintended consequences becomes a significant concern. Ecosystem services projects could lead to unpredicted, unknown, and irreversible outcomes.

Despite these barriers and risks, the majority of people we interviewed believe that an ecosystem services approach has the potential to achieve conservation beyond traditional methods.

7. Conclusion

At this point in time, the conservation of ecosystem services is in the proof-of-concept and early adoption phases. To achieve its goal—of having the value of ecosystem services or natural capital included in decision making across all sectors of the economy—the ecosystem services approach requires clear science, well-defined beneficiaries, and solid governance.

While there are still gaps in the required science, efforts to develop the science are increasing as the ecosystem services concept spreads through academic and government arenas. Filling the gaps efficiently will require a coordinated, interdisciplinary approach. And widespread adoption will require considerable public education, as well as leadership and policy reform.

Despite these challenges, the majority of experts interviewed for this report believe an ecosystem services approach has the potential to achieve conservation beyond traditional methods. Some believe the conservation of ecosystem services could be a "game changer," going so far as to imagine broad economic measures, such as GDP, including the state of nature in their measurements. Others anticipate the rise of not only carbon commodity markets, but also water and biodiversity markets in the trillions of dollars.

Still others believe the ecosystem services approach has the ability to affect policy and business practices for the populated areas of the world where traditional conservation cannot work. Even if full conservation in these areas may be impossible, key ecosystem services and function can be maintained.

Our analysis suggests that the momentum surrounding an ecosystem services approach continues to build and, more importantly, that this concept has the potential to achieve tangible gains in conserving our environment.

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8. Acknowledgements and references

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Conferences

A Conference on Ecosystem Services (ACES), Naples, FL, Dec 8-11, 2008

Conservation Learning Exchange (ConEx), Vancouver, BC, Oct 13-16, 2008