BSR

Measuring and Managing Corporate Performance in an Era of Expanded Disclosure

A Review of the Emerging Domain of Ecosystem Services Tools

January 2013

www.bsr.org

About This Report

This report was written by Sissel Waage and Corinna Kester, with input from Kit Armstrong. The detailed tool-tracking tables were developed by Corinna Kester, with input from Sissel Waage.

We are grateful for support, guidance, and input from the corporate members of BSR's Ecosystem Services Working Group, including (in no particular order): Sarah Connick, Rich Woods, Laura Napoli, Nina Springer, Greg Biddinger, Joanna Cochrane, Mikkel Kallesoe, Sachin Kapila, Roberto Bossi, David Norris, Ann George, Cristian Strickler, Teague Raica, Shirley Oliveira, Rachel Kennedy, Mark Johnston, Maarten Kuijper, Judy Gunderson, Mark Weick, Jonathan DiMuro, Rich Helling, Melissa Barbanell, Gail Ross, Nathan Monash, Tabby Resane, Nick Cotts, and Craig Duxbury.

Please direct comments or questions to Sissel Waage at swaage@bsr.org and Corinna Kester at ckester@bsr.org.

DISCLAIMER
BSR publishes occasional papers as a contribution to the understanding of the role of business in society and the trends related to corporate social responsibility and responsible business practices. BSR maintains a policy of not acting as a representative of its membership, nor does it endorse specific policies or standards. The views expressed in this publication are those of its authors and do not reflect those of BSR members.

ABOUT BSR
BSR works with its global network of nearly 300 member companies to build a just and sustainable world. From its offices in Asia, Europe, and North and South America, BSR develops sustainable business strategies and solutions through consulting, research, and cross-sector collaboration. Visit www.bsr.org for more information about BSR's more than 20 years of leadership in sustainability.

Contents

4 Introduction

7 The Emerging Tool Landscape

10 Verification and Validation

13 Early Private-Sector Points of View

15 Barriers to Private-Sector Applications

17 Looking Forward

19 Appendix: Categories of Tools

Table 1: Framework Tools for High-Level Screening
Table 2: Landscape- and Watershed-Level Tools
Table 3: Site-Specific and Parcel-Level Tools
Table 4: Product-Level Tools
Table 5: Valuation Tools
Table 6: Data Sources
Table 7: Data Sources for Specific Regions
Table 8: Tools for Specific Types of Ecosystems
Table 9: Sector-Specific Tools
Table 10: Assessment Resources

Introduction

Is your company measuring its impacts and dependencies on ecosystem services? Will there be requests for disclosure of this information in the coming years? If so, what measures should be used? What analytical approaches are credible? Which tools have been independently verified and validated for assessing corporate ecosystem services impacts and dependencies?

These questions are becoming relevant to corporate managers as interest in natural capital and ecosystem services is on the rise. The evidence of this building wave includes:

- **The Dow Jones Sustainability Index (DJSI)** takes into consideration whether or not companies in some industries have processes in place to understand their impacts and dependencies on ecosystem services.[1]
- **The International Finance Corporation (IFC)** conducts due diligence based on a range of factors, including impacts and dependencies on ecosystem services.
- **Seventy-eight global financial institutions** referred to as Equator Banks are factoring ecosystem services impacts and dependencies into due diligence practices.
- **Forty-one financial institutions, as well as the global Association of Chartered Certified Accountants (ACCA)**, have signed the Natural Capital Declaration to "demonstrate our commitment to the eventual integration of Natural Capital considerations into private sector reporting, accounting and decision-making, with standardization of measurement and disclosure of Natural Capital use by the private sector."
- More than **16 national and regional governments** are addressing ecosystem services in public policy.
- At least **24 nations** are deploying some form of natural capital accounting.

[1] Personal communication via email from Mattias Mueller of DJSI's research entity, Sustainable Asset Management (SAM), who refers to page 82 of the 2012 SAM "Sustainability Yearbook, and the forestry and paper sector as providing an example of a where ecosystem services criterion is applied.

Ecosystem Services

Ecosystem services are the benefits provided by functioning ecosystems to people. Though seldom acknowledged, people realize these benefits in terms of factors that contribute to personal health, jobs, and safety.

The 2005 Millennium Ecosystem Assessment (MEA) organized ecosystem services into four overarching categories:

- **Provisioning services**, which are goods or products produced by ecosystems (e.g., food, fresh water, wood and fiber, etc.)
- **Regulating services,** which are natural processes regulated by ecosystems (e.g., climate regulation, food regulation, disease regulation, water purification, etc.)
- **Cultural services,** which are non-material benefits obtained from ecosystems (e.g., aesthetic, spiritual, educational, recreational, etc.)
- **Supporting services**, which are functions that maintain all other services (e.g., nutrient cycling, soil formation, primary production, etc.)

Source: www.maweb.org

As interest grows, corporate decision makers are well-advised to understand how they can begin to measure and manage their businesses' impacts and dependencies on ecosystem services.

A number of companies have indeed begun to explore applications of ecosystem services concepts. The current state of corporate practice covers a wide range—though many efforts are in the early stages of exploration. Some initiatives seek to integrate ecosystem services into accounting. Other corporate work focuses on assessing current or potential future ecosystem service impacts and dependencies, in order to factor these findings into new project planning, impact assessment, and/or risk management.

The findings of the first known set of independent interviews with corporate leaders on ecosystem services applications—which BSR reported on and continued through 2012—indicate that an ecosystem services approach may offer decision makers a more complete picture. In particular, business leaders report that these studies have offered information on ecosystem services dependencies which have not been traditionally considered. For example, will the water that a company needs in a particular area to operate be available, given projected rainfall patterns, underground aquifer recharge rates, demands of other users in the watershed and other dynamics that may affect water flows and access?

Interviews with early pilot testers of ecosystem services concepts and tools have surfaced numerous challenges and questions, such as:

- **What indicators should be measured and analyzed in an ecosystem services approach?** How? With what data (or data-gathering methods) and what assessment tools?
- **Why should these measures and tools be selected instead of others?**
- **Have the ecosystem services tools been verified and validated?** Have they undergone third-party examination? If so, was the process itself scrutinized and supported? By whom?
- **Do these tools mesh neatly with existing corporate performance measurement and management systems?**
- **What are the costs and benefits of applying these tools in private-sector settings?**
- **Are there documented private-sector case studies of tool applications?** If so, do these cases specify the appropriate application context? Do they demonstrate that the tool results in new insights that improve business decisions (such as by decreasing risk, increasing competitiveness, improving operational efficiencies, addressing customer needs, etc.)? Do they document costs of applications?
- **Can corporate managers feel confident that they are selecting a credible measurement and assessment approach and that the benefits will outweigh its costs?**

Few of these questions have clear answers. While this situation is not surprising given the emerging nature of ecosystem services tools and applications field, it

presents challenges to corporate managers who are tasked with deciding how their companies will assess impacts and dependencies on ecosystem services.

In response, BSR has developed this report to assist the businesspeople who are asking questions about ecosystem services. It is intended to help corporate decision-makers understand and assess the current state of play within the ecosystem services tool landscape. Our analysis is based on six years of tracking the field and collaborating in what is (to the best of our knowledge) the world's only comparative tool testing, conducted by BSR's Ecosystem Services Working Group along with the U.S. Geological Survey (USGS) and the U.S. Bureau of Land Management (BLM).

This report offers a unique view of the full suite of current tools. It also suggests areas of corporate application and summarizes the challenges that private-sector representatives reported during interviews in 2011 and 2012. Finally, the report lays out a few pathways forward that could accelerate pilot testing as well as the process of verifying and validating ecosystem services tools.

Overall, this report depicts an emerging tool domain. The tools available today may (or may not) be those that companies will be applying several years from now. History is still being written. Therefore, this report offers a point-in-time assessment.

For corporate decision makers, the takeaway message is that key stakeholders are increasingly looking at ecosystem services. The challenge is to identify, test, and generate credible support for a robust, yet feasible, way to integrate ecosystem services into corporate decision-making processes. The private sector has an opportunity to engage with the concepts, new tools, and pilot testing. This work is an essential part of forging a path forward.

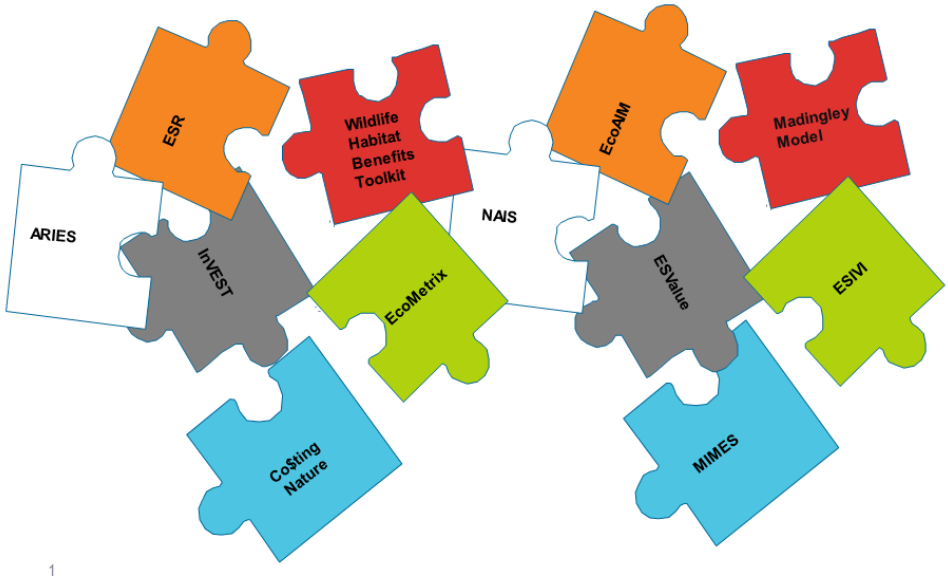
We welcome comments on this report, as well as about other BSR analyses of applications of ecosystem services in corporate contexts. Please email input to Sissel Waage (swaage@bsr.org).

The Emerging Tool Landscape

The ecosystem services tool domain is rapidly expanding. Tools have emerged from academic institutions, nonprofit organizations, and public-sector agencies around the world. Some are global in scope, whereas others were developed to be applied in specific regions. Some are based on a set of questions (which are organized in an Excel spreadsheet); others require users to enter quantitative ecological data into a format that can generate geographic information system (GIS) maps. The range of approaches is wide and growing. (For detailed examinations of these tools, please see past BSR reports on the topic, such as "New Business Decision-Making Aids in an Era of Complexity, Scrutiny, and Uncertainty" as well as that report's supplementary materials.)

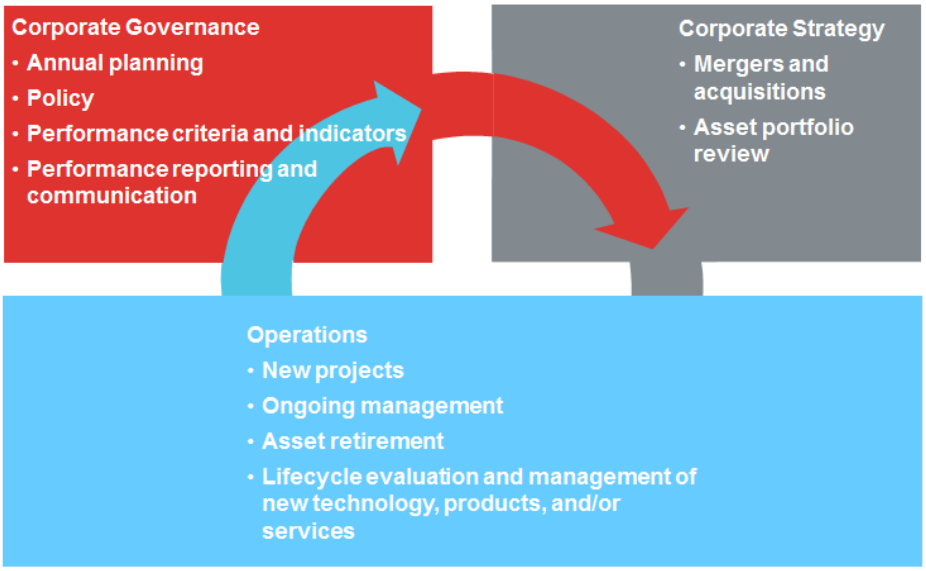
Tool proliferation has resulted in a complex tool landscape. Some describe it as difficult to navigate and even overwhelming. Many tool developers use similar language to describe very different approaches and distinct analytical architectures that underlay the tools. As the figures below depict, it is unclear to many newcomers how, if at all, many tools relate to one another, as well as to existing corporate decision-making processes and protocols.

Figure 1: *Growing set of ecosystem services analytical tools with unclear complementarities and distinctions (illustrative tools listed)*



1

Figure 2: *Lack of clarity on if, when, and where ecosystem services tools mesh with existing corporate decision-making processes*



Many corporate managers face challenges in understanding the ecosystem services tool domain. Yet, it is increasingly clear that these same managers will need to craft a feasible approach for responding to requests from investors, corporate ranking organizations, and other stakeholders around disclosing information about their companies' impacts and dependencies on ecosystem services.

A myriad of questions face corporate managers, with few answers, most notably:

» What tool should a company select? Why?

» How confident can a corporate manager feel about these tools—in terms of both the accuracy of the resulting analysis as well as the value they add to the company's decision-making processes, particularly in relation to tool application costs?

» Have these tools been verified and validated in robust and transparent processes? Which tools are credible? According to what metrics?

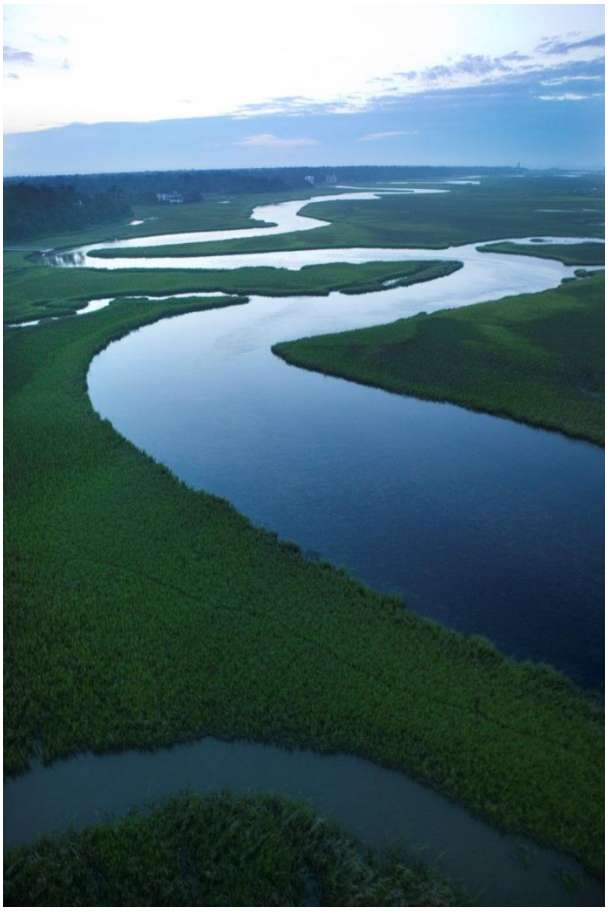
This report suggests some answers to these questions, insofar as anyone can provide answers about a still emerging domain. The real value of the report, however, lays in the most up-to-date list of tools that we know of today that is relevant to the private sector for identifying, measuring, assessing, considering trade-offs, and, in some cases, valuing ecosystem services.

In terms of scope, we have included only those tools that have been developed to examine multiple ecosystem services concurrently. These tools have been designed to understand impacts and dependencies on ecosystem services within complex, interrelated systems. Therefore, this report does *not* include carbon calculators, water calculators, or biodiversity-only tools that have been developed. While these single-parameter tools are important, they do not easily enable the user to take an integrated, systems approach.

Combining these screening criteria with the potential for application in private-sector settings, we have developed a series of tables that lay out the current ecosystem services tools and decision-making aids. Given the number of tools, we have grouped them into the following categories (in the form of separate tables):

- **Table 1:** Framework Tools for High-Level Screening
- **Table 2:** Landscape- and Watershed-Level Tools
- **Table 3:** Site-Specific and Parcel-Level Tools
- **Table 4:** Product-Level Tools
- **Table 5:** Valuation Tools
- **Table 6:** Data Sources
- **Table 7:** Data Sources for Specific Regions
- **Table 8:** Tools for Specific Types of Ecosystems
- **Table 9:** Sector-Specific Tools
- **Table 10:** Assessment Resources

We hope that these tables, presented in the appendix, will assist corporate decision makers in asking more informed questions about ecosystem services concepts, approaches, indicators, and assessment tools. We are reluctant to provide any more detailed mapping of when and how specific tools can be used at this time because the field is still evolving—though we have provided high-level suggestions about potential corporate applications in the past.



Key Definitions

The Institute of Electrical and Electronics Engineers (IEEE) defines the terms as follows:

Validation *[is] the assurance that a product, service, or system meets the needs of the customer and other identified stakeholders. It often involves acceptance and suitability with external customers.*

Verification *[is] the evaluation of whether or not a product, service, or system complies with a regulation, requirement, specification, or imposed condition. It is often an internal process.*

Excerpted from the IEEE Guide to Project Management

The Verified Carbon Standard (VCS), for example, applies these concepts by asserting that:

All projects and credits under the VCS Program must be independently audited to ensure compliance with rigorous VCS requirements for environmental integrity. This is a central aspect of VCS quality assurance. Under VCS, auditors known as validation/verification bodies (VVBs) are tasked with validating project descriptions and verifying actual emission reductions. Currently, more than three dozen VVBs are located across five continents. VVBs are accredited to work in specific sectors, known in the industry as sectoral scopes, ranging from energy to agriculture and forestry.

Excerpted from: http://v-c-s.org/verification-validation/what-vvb.

Verification and Validation

The tool domain, while maturing, remains a young field. The reason is simple. Few, if any, of today's ecosystem services tools have been subjected to a robust, transparent, independent verification and validation process.

Verification and validation processes are key to assuring the intended users that tools are accurate and consistent. Overall, these processes are essential for establishing credibility and supporting widespread adoption.

Specifically, the verification process is focused on ensuring that a tool performs as intended and that its equations and analytical components are free of errors. Such a verification process would ideally be part of the development of all new tools. However, in practice, available funding may limit tool verification.

In addition, tool developers would ideally validate or test their tools to compare their conceptual models against real-world data. This process is intended to ensure that tools are not only error-free, but are also effective in achieving the desired results. Some elements that can be useful in validating tools include:

» **Clear validation plan:** One of the requirements, for example, of the U.S. Food and Drug Administration's Principles of Software Validation is that developers create and follow a plan to guide the overall validation process.

» **Process transparency:** When tool developers transparently communicate their tool verification and validation processes, stakeholders can evaluate and develop trust in these processes.

» **Reliability:** To test new measurement tools, social scientists typically assess the reliability of the tool's results across multiple users and in multiple settings. Scientists use statistical approaches to determine the necessary sample sizes and to determine if the pilot results show that the tool is adequately rigorous.

» **Standards:** In more heavily regulated areas, standards are a common way to validate tools and approaches. The Financial Accounting Standards Board (FASB), for example, outlines standards for how to conduct processes, what internal documentation must take place, and what information must be shared.

» **Peer review:** Used for both professional practice and academic literature, the peer-review process is a common validation method. Though practices vary, the usual approach is to submit a journal article to at least two reviewers, who follow a clearly defined, transparently communicated review process. If the study or article passes the review process, the journal then publishes it.

» **Consensus:** Though not strictly necessary for a market-facing tool, best practice in standards development, as outlined by the International Organization for Standards (ISO), is based on expert, multi-stakeholder consensus. Some tool developers may seek consensus in order to further strengthen their tool.

These principles could be used when establishing verification and validation processes for ecosystem services tools. Without such processes, a number of corporate decision makers have concerns that tool conclusions may later prove erroneous and may lead to poor decisions.

Numerous areas of practice underscore the importance of verification and validation of their approaches, standards, and/or tools. For example, these approaches are applied to software and computer systems as well as to reviewing the safety of food, pharmaceuticals, medical devices, motor vehicles, and traffic and transport processes, among other areas.

For example, in the climate domain around carbon transactions, the Verified Carbon Standard (VCS) asserts that: "[I]ndependent auditing ensures all reductions are verified by professional, third-party validation/verification bodies."[2] In addition, the Climate, Community, and Biodiversity Alliance (CCBA) has developed standards that "must be used through a two-step process [of]: [1] *validation* [that] demonstrates good project design to generate significant climate, community, and biodiversity benefits [and] [2] *verification,* [which] is a rigorous independent endorsement of the quality of project implementation and the delivery of multiple benefits."

Overall, validation and verification are commonly understood terms and processes that are applied to a wide range of sectors and issues. These processes are widely perceived as an essential component to establishing credibility.

While numerous peer-reviewed articles exist on ecosystem services tools, such as the InVEST tool[3] (Integrated Valuation of Environmental Services and Tradeoff, see Table 2), few tools (if any) have been subjected to an independent, robust, transparent, process of verification and validation that follows multiple guiding principles such as those outlined above.

Looking forward, it will be important that a respected entity establish a clear process that can be applied to reviewing tools that would ultimately lead to validation and verification. There are numerous entities that could take on this task, such as the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES), the U.S. National Academy of Sciences, or a coalition of respected United Nations entities and NGOs, such as those that led the Millennium Ecosystem Assessment (MEA) or TEEB (The Economics of Ecosystems and Biodiversity).

In the interim, the pathway forward for corporate decision makers is to conduct more pilot tests of ecosystem services concepts and tools within private sector contexts—either through homegrown approaches that emerge within companies or the off-the-shelf tools described in this report (see the appendix), or a combination of the two. A few potential contexts for corporate applications of ecosystem services are laid out in the box below. Ideally, applications would be followed by public documentation of the methods used, costs incurred, capabilities required, and insights gained.

---

[2] VCS, "What Is a GHG Program?" http://v-c-s.org/GHG_program.

[3] For example, see: www.tandfonline.com/doi/abs/10.1080/21513732.2011.647835, as well as http://onlinelibrary.wiley.com/doi/10.1111/j.1749-6632.2009.04152.x/abstract;jsessionid=9B355939B5C764602AD47C7816DD07A1.d02t01 and www.naturalcapitalproject.org/pubs/tradeoffs-2012.pdf. In addition, numerous other publications by the Natural Capital Project, developers of the InVEST tool, which pertain to the tool, are listed at: www.naturalcapitalproject.org/publications.html.

Box 1: Potential Corporate Application Sites for Ecosystem Services Tools

Discussions among BSR's Ecosystem Services Working Group members indicate some promising applications of ecosystem services tools within companies, such as:

- **New project planning and development,** particularly in terms of impact assessment and permitting processes, to show companies, governments, and other stakeholders where and how impacts or co-benefits may result
- **Real estate strategy** and management
- **Property portfolio priority-setting exercises** to assess relative risk and opportunity for property retention, disposition, remediation, restoration, and other options
- **Ongoing management and decommissioning** of operations
- **Valuation** of the impacts on or benefits to ecosystem services
- **Corporate performance and communication dashboard or scorecard,** in terms of measuring performance and progress toward a corporate-level ecosystem services goal
- **Scenario planning and modeling,** such as developing a strategy for adapting to climate change
- **Project planning** within a landscape-level context, in terms of natural resources use, beneficiaries, and minimum ecological parameters for continued flow of ecosystem services
- Outlining additional relevant areas for inclusion in **environmental and social impact assessments** (ESIAs)
- Assessment of **lifecycle ecological impacts of products**
- Selection of **potential building sites**
- Understanding the functions of ecosystem services at the **facility level**
- Identifying corporate dependencies on ecosystem services at various geographical and supply chain sites as a part of **supply chain management**
- Exploring new potential corporate **strategies**
- Optimizing the **sourcing of natural resources**
- **Engaging stakeholders** in at least some of the aforementioned contexts

Early Private-Sector Points of View

Based on our interviews and discussions in 2011 and 2012, business managers perceive that ecosystem services tools cover the spectrum in terms of return on investment (ROI)—from highly worthwhile to worthless.

Some corporate managers reported that the tools did not add any new information. This lack of insight was particularly reported in cases where companies have already undertaken in-depth environmental and social impact assessments (ESIAs), in response to regulatory requirements, stakeholder (or shareholder) demands, community relations, or other drivers.

These individuals explained that they would adopt ecosystem services metrics and tools only if this lens would clearly add value relative to current performance assessment approaches (e.g., ESIAs, lifecycle assessments (LCAs), etc.).

All interviewees indicated that they had yet to see an assessment of business as usual (in terms of ESIAs and other corporate environmental management approaches) versus an ecosystem services tool-based approach. It would be essential to understand the difference between current and alternative approaches prior to advocacy for new ecosystem services work within companies. Such a side-by-side comparison would help clarify whether additional data or new processes must be created to assess ecosystem services as well as whether new data, processes, or tools will reveal new insights. In other words, numerous corporate managers are asking: *What is the difference between current corporate environmental practice and a future ecosystem services-informed approach?*

Some corporate managers who have pilot tested ecosystem services tools asserted that the tools revealed new impacts and dependencies that they had not previously identified and considered in corporate decision-making processes. In particular, the managers garnered new insights around water filtration and circulation processes that may in turn affect future water availability and thus the company's access to needed water for operations (or within supply chains).

Most notably, several individuals stated that quite a few companies do not consider whether or how they depend on ecosystem services. Rather, corporate managers commonly just expect natural resources to be available. For example, when they consider water access, businesspeople rarely consider underground aquifer recharge rates and other user demands within a given basin. Applying ecosystem services tools within some companies highlighted this omission and has already led some firms to internalize new approaches that complement and improve upon their processes and practices, by highlighting risks.

Even when ecosystem services tools deliver value, there are challenges—ranging from the high cost of application relative to few insights gained, through results reported in such large ranges that they undercut confidence.

One company that tested multiple tools concurrently in the same context asserted that the findings varied widely—sometimes by as much as an order of magnitude. These ranges made the findings inappropriate for use in corporate decision making, as it significantly undercut confidence in results. While some tools may be sufficient for short-term valuation, according to the representative from this business, the monetary figures' significant ranges limited the findings' relevance and undercut the company's confidence in them.

The core issue is that there is still active debate as to which methods for valuing ecosystem services are best, or most appropriate, for widespread application.

BSR's interviews with corporate managers highlighted a broad range of challenges within the current domain of ecosystem services tools:

» **It is difficult to select tools for a specific site or set of conditions** since at present there is no guidance—based on widespread private-sector pilot testing—about how to choose a tool that matches the types of questions that a company is asking, within specific application contexts, and given available data sets. Companies state that they have relied on trial and error or the recommendations of experts and their peers in other companies.

» **Ecosystem services tools are usually difficult to apply** because they seldom run on available data (many require custom inputs) and few corporate employees have the skills needed to apply them, which would necessitate a larger budget and new personnel.

» **The findings of ecosystem services tools have been reported in interviews as difficult for others to consistently replicate,** even when the same tool is applied to the same question using the same data within companies' internal pilot tests. This inconsistency implies that these tools are beta versions that developers must refine.

» **Companies could not easily apply and align the tool outputs with their existing corporate decision-making processes**, ideally through well-linked, end-to-end processes that a company could "roll out" throughout its business units.

Finally, and most importantly, none of the current set of ecosystem services tools has undergone a clear, independent, rigorous, transparent verification and validation process that companies would expect of any other tool that they adopt. Therefore, corporate managers who seek ecosystem services tools will likely need to remain in exploratory mode and consider adapting tools so that they are appropriate for their specific contexts and available data sets.

Yet, at this early juncture, two tools mentioned in several interviews as yielding potentially useful insights in pilot test applications include: (1) the Corporate Ecosystem Services Review (ESR) as a high-level framework for preliminary issue identification and (2) EcoMetrix as a tool for conducting detailed, quantitative, site-level analysis and prioritization.

In summary, findings from 2011 and 2012 interviews with corporate representatives who have tested ecosystem services tools led to the overall conclusion that most existing tools are still proving their value in terms of adding new insights. Further, some early pilot testers reported that the cost of applying the tools currently outweighs their benefits. These ratios are likely to shift in the coming years, as knowledge improves and costs decrease. In these early days, however, the learning curve remains steep, and overall costs are reported to be relatively high.

These findings imply that the field of ecosystem services decision-making aids will continue to evolve in the coming years, as existing tools are refined and new ones are created.

Barriers to Private-Sector Application

Our research has identified three main barriers to integrating ecosystem services into corporate decision-making processes.

Barrier 1: Some companies believe that current practices are sufficient to identify all relevant environmental impacts and opportunities.

Business managers in numerous firms with which we spoke—particularly within agriculture as well as forestry—asserted that their current sustainability initiatives already address many ecosystem services parameters. Some agricultural corporate representatives argued that their tracking of ecosystem services issues confirmed that the best approach to managing environmental impacts, including those related to ecosystem services, is to address each one individually. In interviews, one corporate manager asserted that "an integrated ecosystem services lens does not provide the level of detail needed to make corporate decisions." In a few cases, decision makers have stopped tracking ecosystem services issues and ended their external engagement on the topic after their exploratory work led to these conclusions.

The key questions to answer in order to remove this barrier include:

» What is the difference between today's environmental and social assessment processes relative to one that includes ecosystem services assessment? What new indicators does the latter consider?

» Why are these indicators selected? How are they measured? What new analytical processes are required?

» What new insights does this process offer to business decision makers and at what cost?

Barrier 2: Some companies have determined that ecosystem services concepts and tools are of limited relevance today, though they may become important if a growing number of investors, corporate ranking organizations, and/or regulators take action on the topic.

For example, a pharmaceutical company representative asserted that it was impossible to make ecosystem services concepts relevant to any part of the business, primarily because it was infeasible to show that *not* taking action would represent reputational and/or regulatory risks. However, this representative added that if the company's funding sources began to require information about ecosystem services, then the company would take action immediately to gather the requested data.

Corporate decision-makers who have assessed the issue and chosen not to act at this time still report that they are closely monitoring it. These individuals assert that a wait-and-see approach is most judicious as the field matures.

A key question to answer in order to remove this barrier includes:

» Will a greater number of investors within the financial services domain inquire about ecosystem services impacts and dependencies of the companies with which it does business? When? With what implications on flow of capital?

Barrier 3: The salience of ecosystem services varies widely in different parts of the world.

Many corporate managers reported that they face internal debates about the relevance of ecosystem services to the firm as a whole, but they acknowledge a growing interest in engaging on the issue within distinct geographic regions. Specifically, European business units tend to perceive that both biodiversity and ecosystem services (as a linked concept of BES) are critical to successfully managing environmental and social impacts. Further, in interviews these individuals pointed out that examining BES as an integrated concept has enabled more successful uptake given regional differences.

Within this context of differing regional interest in the concept, the absence of publicly available information about some companies' ecosystem services-related activity sometimes masks their very active internal discussions and exploration.

Looking Forward

The ecosystem services tools domain is very much still emerging. Most, if not all, of the current tools are not yet independently verified and validated, though some are farther along than others in terms of publishing their methods and pilot test applications in peer-reviewed articles. Yet, none have gone through a clear, transparent, independent verification and validation process that includes extensive pilot testing in private-sector settings.

In the coming years, it will be essential for a respected international entity to define and launch a process for verifying and validating ecosystem services tools based on a clear, transparent, and independent process.

It is unclear whether the tools of today will be the tools of tomorrow. Which tools prove useful depends upon what the coming review processes unearth, both in terms of analytical approaches and applications.

Looking forward, ecosystem services concepts and tools will continue to be developed and tested, as well as ultimately verified and validated. In the process, the tool domain as a whole will mature. However, the arena will likely remain crowded and confusing as more tools are developed in the coming years.

At the same time, pressure from investors and other stakeholders to consider ecosystem services impacts and dependencies appears to be growing, which will likely drive more private sector pilot testing. Corporate representatives have expressed concerns that, in this coming period, policy makers and others may drive companies to use tools before they have been robustly tested and proven to be appropriate for widespread use. It is unclear how this situation will play out. The pathway forward is still very much emerging.

There are a few scenarios that could accelerate both corporate engagement and pilot testing, such as:

» ***If national or subnational regulations addressing ecosystem services impacts and dependencies were passed, then there would likely be a need for clear tools and measurement approaches.*** Government exploration of ecosystem services issues has been on the rise—as documented in BSR's public policy tracking report—but developing policy and enforcing new regulations takes time. Calamitous events can, however, spark new policy or even regulation. A few more big storms submerging or significantly disrupting coastal metropolitan areas around the world could spark government action around restoration of natural storm buffers as well as other elements associated with well-functioning ecosystems. This action would ideally be accompanied by funds to assess and measure progress and thus yield work on ecosystem services tools in the process.

» ***If lenders and/or insurance companies adopted more detailed assessment protocols for understanding ecosystem services impacts and dependencies as part of their internal due diligence processes for assessing their exposure to risk, then work on ecosystem services measurement tools would quickly mature.*** The analytical approaches and tools needed by analysts would likely include both a set of questions or checklists on whether a company has a process in place, as well as more granular quantitative data on regional ecosystem service trends. One approach to getting these analytical tools in place could be that financial services firms and insurance companies could jointly fund the granular analytical tools and databases to enable all players to better understand risk.

Tool Attributes

Based on discussions within BSR's Ecosystem Services Working Group, corporate decision makers assert that ideally they want tools to have the following attributes:

» **Scalability, adaptability, and repeatability** for different locations, conditions, types of company activity, etc.

» Ability to generate and compare **scenarios**

» **Ease of use** (related to time and resources)

» Generation of **spatially explicit display of information** (e.g., maps)

» **Transparency,** in terms of tool inputs, operation, and outputs that are easy to understand and communicate

» **Avoid the need for new metrics reported in aggregate across the entire company,** unless there is a corporate-wide policy that names ecosystem services

» **Ability to integrate the tool into existing corporate decision-making processes** (e.g., ESIAs or site restoration)

This process would require infusion of funds—potentially a combination of public and private—but would winnow the tool domain and gather the data needed to apply tools in decision-making contexts.

» ***If more private sector pilot testing of tools occurred and was publicly shared, then it would drive improvements in tools and provide greater clarity about which tools add value to what application contexts.*** Both ecosystem services tools and business decision makers could benefit from pilot test applications and refinement in business settings. Such private-sector testing is essential to understanding the value that ecosystem services tools add, as well as for building the support for application within companies. Specifically, developers need to refine tools so that businesses are better able to mesh these new analytical processes with their existing corporate decision-making processes.

Ultimately, tool developers will need to demonstrate the benefits that are realized from applying these new tools within companies. In addition, business managers will need clarity about how, when, and why to apply tools to particular business activities and issues, most notably including ESIAs and LCAs.

Having clear evidence of tool credibility and widespread support—based on the verification and validation of tools—will be essential to justify applying ecosystem services concepts and tools in corporate settings. Key areas are to explore the harmonization of ecosystem services definition and metrics used by tools, to conduct rigorous comparative assessments of multiple tools, to assess data needs, and to provide quality control.

The path may well be long and complex. Corporate representatives and tool developers have an opportunity to engage around and explore what is feasible within, and what will add value to, corporate decision-making processes.

Appendix: Categories of Tools

Please note that, where possible, the tool description is a direct quote from the tool developer.

Table 1: Framework Tools for High-Level Screening

Tool Name	Target Audience and Ideal Application	Description	Tool Developer
Approach for reporting on ecosystem services *(under development)*	**Target audience:** Corporate decision makers and reporting staff **Ideal application:** Draft that may inform and ultimately be shaped to guide implementation of and reporting on ecosystem services activities **Tool type:** List of questions and parameters to report on	"The Global Reporting Initiative (GRI) has been assessing opportunities to translate emerging thinking around ES [ecosystem services] into *sustainability reporting indicators and approaches* that can be used as a starting point by organizations in all sectors."	Global Reporting Initiative
Biodiversity and Ecosystem Services Assessment Tool *(under development)*	**Target audience:** Corporate decision makers **Ideal application:** Company-wide assessment of risks and opportunities **Tool type:** To be determined	The tool "provides business managers quick access to information on *potential corporate risks and opportunities related to BES* [biodiversity and ecosystem services]. Using global maps and indicators, it aims to help managers improve corporate visioning and goal setting, prioritization of global BES risks and opportunities, and alert individual business units of potential BES risks and opportunities in their areas."	The Nature Conservancy and The Dow Chemical Company
Ecosystem Services Benchmark	**Target audience:** Financial asset managers and insurers **Ideal application:** Assessing companies within an investment portfolio **Tool type:** Framework (Excel-based)	"The Natural Value Initiative (NVI) has developed a toolkit to (1) *enable the finance sector to evaluate how well … [target] sectors are managing biodiversity and ecosystem services risks and opportunities* and (2) engage with … companies to reduce their risk exposure through the responsible management and harvesting of natural resources." The published version of the benchmark focuses on the food and beverage sector, but the framework has also been applied to the extractives and pharmaceutical sectors. It assesses company policies, programs, and risks.	The Natural Value Initiative
Ecosystem Services Review	**Target audience:** Corporate managers **Ideal application:** Identifying risks and opportunities and outlining strategies **Tool type:** Guidance document and Excel-based questionnaire	"The Ecosystem Services Review is a structured methodology for corporate managers to proactively develop strategies for *managing business risks and opportunities* arising from their company's dependence and impact on ecosystems."	World Resources Institute (WRI)

Ecosystem Services Review for Impact Assessment	**Target audience:** Corporate impact assessment experts and decision makers **Ideal application:** Integrating ecosystem services into impact assessments **Tool type:** Framework (Excel-based)	"The Ecosystem Services Review for Impact Assessment provides practical instructions to environmental and social practitioners on *how to incorporate ecosystem services throughout environmental and social impact assessment,* including (1) a conceptual framework of how the project, ecosystem services, and human well-being are linked and (2) step-by-step instructions to systematically incorporate ecosystem services."	World Resources Institute
Ecosystem Services Screening Criteria Framework	**Target audience:** Conservation practitioners **Ideal application:** To determine if conditions are favorable for an ecosystem services approach to conservation **Tool type:** Framework	This framework can be used "*to determine if conditions are favorable for an environmental services approach to conservation.* Screening will help evaluate key strengths, weaknesses, and information gaps that need to be addressed if an environmental services approach is taken forward." It lists 10 screening criteria for an organization to consider when using an ecosystem services approach, with key questions related to each.	Natural Capital Project and The Nature Conservancy
Final Ecosystem Goods and Services Indicators	**Target audience:** Resource managers and land planners **Ideal application:** Identifying relevant ecosystem services of wetlands, estuaries, and streams **Tool type:** List of indicators	The effort *aims to establish metrics* of final ecosystem goods and services (those ecosystem services that directly contribute goods and values to human well-being). Companies could use these metrics to align their reporting on ecosystem services with that of other organizations.	U.S. Environmental Protection Agency (EPA)

Table 2: Landscape- and Watershed-Level Tools

Tool Name	Target Audience and Ideal Application	Description	Tool Developer
ARIES (Artificial Intelligence for Ecosystem Services)	**Target audience:** Land managers, policy analysts, and scientists **Ideal application:** Ecosystem services assessment and management **Tool type:** Computer model	"ARIES is a web-based technology offered to users worldwide to assist rapid *ecosystem service assessment and valuation.* Its purpose is to make environmental decision making easier and more effective. ARIES helps users discover, understand, and quantify environmental assets and the factors influencing their values, for specific geographic areas and based on user needs and priorities."	University of Vermont

Co$ting Nature	**Target audience:** Land managers, policy analysts, and scientists **Ideal application:** Regional ecosystem assessment and planning **Tool type:** Computer model	"Co$ting Nature is a web-based tool for *analyzing the ecosystem services* provided by the natural environment, *identifying the beneficiaries* of these services, and *assessing the impacts of human interventions.* This PSS [policy support system] is a test bed for the development and implementation of conservation strategies focused on sustaining and improving ecosystem services. The PSS incorporates detailed spatial data sets at 1 square kilometer and 1 hectare resolution for the entire world, spatial models for biophysical and socioeconomic processes along with scenarios for climate and land use. The PSS calculates a baseline for current ecosystem services provision and allows a series of interventions (policy options) or scenarios of change to be used to understand their impact on ecosystem service delivery." "The version 1 model covers water, carbon, hazard mitigation, nature-based tourism, biodiversity, and conservation priority, as well as current pressures and future threats. It currently does not include land use and climate scenarios."	King's College London and AmbioTEK
EcoAIM (Eco Asset, Inventory and Management)	**Target audience:** Land managers, policy analysts, and scientists **Ideal application:** Ecosystem services assessment and management **Tool type:** Computer model	"EcoAIM is a tool developed to 1) *inventory ecological services and help in making decisions* regarding development, transactions, and ecological restoration; 2) develop specific estimates of ecosystem services in a geographically relevant context; and 3) evaluate trade-offs among ecosystem services that result from resource management decisions."	Exponent
Ecosystem Management Decision Support (EMDS)	**Target audience:** Land managers, policy analysts, and scientists **Ideal application:** Ecosystem services assessment and management **Tool type:** Computer model	"The Ecosystem Management Decision Support [EMDS] system is an application framework for knowledge-based *decision support of ecological assessments at any geographic scale*. The system provides a very general solution method (e.g., a framework) for conducting environmental assessments. In order to conduct an assessment with EMDS, the user constructs a *data catalog* that identifies the sources of all GIS themes that can enter into an assessment, and constructs a *knowledge base* that describes the relations among all the ecosystem states and processes of interest to the assessment."	The EMDS Consortium is comprised of the U.S. Forest Service, InfoHarvest, and The University of Redlands.
Ecosystem Services Evaluation Tool (EcoSET) *(under development)*	**Target audience:** Land managers, policy analysts, and scientists **Ideal application:** Ecosystem services assessment **Tool type:** Computer model	"The aim of this project is to generate a user-friendly automatic ecosystem service evaluation tool to calculate on-demand *maps of ecosystem service provision anywhere globally*."	Biodiversity Institute Oxford

Ecosystem Services Identification, Valuation and Integration (ESIVI)	**Target audience:** Land managers, policy analysts, and scientists **Ideal application:** Ecosystem services assessment and management **Tool type:** Excel model	"The ESIVI tool provides an integrated and flexible approach to identifying, valuing, and integrating ecosystem services into project and policy decisions. The ESIVI framework uses a mix of qualitative and quantitative inputs and scoring metrics to guide users through a three-stage ecosystem services assessment involving scoping, impact assessment, and mitigation. The tool can be used by a wide range of users for projects and policies anywhere in the world and at any stage in their development. The output is a comprehensive and transparent assessment which can be integrated into existing frameworks (such as environmental and social impact assessments) or used as the basis for a standalone report to inform the development of policies and strategies."	URS
ESValue	**Target audience:** Land managers, policy analysts, and scientists **Ideal application:** Ecosystem services assessment and management **Tool type:** Computer model	"ESValue measures the relative value of each key ecosystem service rather than the absolute monetary value, which can be controversial and subject to uncertainty. The tool has two primary components: 1) the ecological effects model, which uses commonly available data to *model the effect of development on ecosystem services,* and 2) the ecosystem services valuation model, which *uses input by stakeholders to model the relative value of ecosystem services* to stakeholders."	Cardno ENTRIX
InVEST (Integrated Valuation of Environmental Services and Tradeoffs)	**Target audience:** Land managers, policy analysts, and scientists **Ideal application:** Ecosystem services assessment and management **Tool type:** Computer model	"InVEST is a family of tools to *map and value the goods and services from nature* that are essential for sustaining and fulfilling human life. InVEST enables decision makers to assess the trade-offs associated with alternative choices and to identify areas where investment in natural capital can enhance human development and conservation in terrestrial, freshwater, and marine ecosystems."	Natural Capital Project
Madingley Model *(under development)*	**Target audience:** Policy analysts and scientists **Ideal application:** Modeling terrestrial and marine ecosystems **Tool type:** Computer model	"Microsoft Research and the UNEP-WCMC have spent the past two years developing a *prototype GEM (general ecosystem model) for terrestrial and marine ecosystems*. The prototype is dubbed the Madingley Model and is built on top of another hugely ambitious project that the group just finished, modeling the global carbon cycle. With this as their starting point, they set out to model all animal life too: herbivores, omnivores, and carnivores, of all sizes, on land and in the sea."	Microsoft Research and the United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC)
Madrona	**Target audience:** Land managers, policy analysts, and scientists **Ideal application:** Land and ocean assessment **Tool type:** Computer model	"Madrona provides software developers with a set of building blocks that can be mixed and matched to create cutting-edge, web-based tools for *decision support and spatial planning at any scale*. It can be used in sectors ranging from natural resource management to ocean and land-use planning, urban and community planning, energy, transportation, health care, and more."	EcoTrust

Marine Integrated Decision Analysis System (MIDAS)	**Target audience:** Marine managers, policy analysts, and scientists **Ideal application:** Land and ocean assessment **Tool type:** Computer model	MIDAS "was developed to assist the MMA [Marine Managed Areas] users and managers in understanding the critical factors that influence MMA effects so that they can plan accordingly, to estimate likely MMA effects based on the ecological, socioeconomic, and governance conditions, and finally, to advise management plan revisions that will result in optimization of outcomes and outputs." "MIDAS-SeaPlan is a marine spatial decision support system for Massachusetts. Its underlying modeling framework is MIMES [Multi-scale Integrated Models of Ecosystem Services], which enables dynamic spatial modeling. When completed, MIDAS-SeaPlan will demonstrate a suite of *scenarios involving human use trade-offs to help inform marine spatial planning."*	Boston University
Multi-scale Integrated Models of Ecosystem Services (MIMES)	**Target audience:** Land managers, policy analysts, and scientists **Ideal application:** Ecosystem services assessment and management **Tool type:** Computer model	"The Multi-scale Integrated Models of Ecosystem Services (MIMES) is a suite of *models for land use change and marine spatial planning decision making.* The models quantify the effects of land and sea use change on ecosystem services and can be run at global, regional, and local levels. The MIMES use input data from GIS sources, time series, etc., to simulate ecosystem components under different scenarios defined by stakeholder input."	Affordable Futures
NatureServe Vista	**Target audience:** Land managers, policy analysts, and scientists **Ideal application:** Land use planning **Tool type:** Computer model	"NatureServe Vista is a powerful, flexible, and free decision-support system that *helps users integrate conservation with land use and resource planning of all types.* Planners, resource managers, scientists, and conservationists can use NatureServe Vista to integrate conservation values with other planning and assessment activities, such as land use, transportation, energy, natural resource, and ecosystem-based management."	NatureServe
Regional Vulnerability Assessment Environmental Decision Toolkit	**Target audience:** Land managers, policy analysts, and scientists **Ideal application:** Estimating the large-scale changes that might result from policy actions **Tool type:** Computer model	"EPA's Regional Vulnerability Assessment program is designed to produce the methods needed to understand a region's environmental quality and its spatial pattern. The objective is to *assist decision makers* in making more informed decisions and in *estimating the large-scale changes that might result from their actions."*	U.S. Environmental Protection Agency (EPA)
Social Values for Ecosystem Services (SolVES)	**Target audience:** Land managers, policy analysts, and scientists **Ideal application:** Integrating social concerns into ecosystem services valuation **Tool type:** Computer model	"SolVES is a geographic information system [GIS] application designed to *use data from public attitude and preference surveys to assess, map, and quantify social values for ecosystem services.* SolVES calculates and maps a 10-point Value Index representing the relative perceived social values of ecosystem services such as recreation and biodiversity for various groups of ecosystem stakeholders. SolVES output can also be used to identify and model relationships between social values and physical characteristics of the underlying landscape."	Rocky Mountain Geographic Science Center and Colorado State University

Table 3: Site-Specific and Parcel-Level Tools

Tool Name	Target Audience and Ideal Application	Description	Tool Developer
EcoMetrix	**Target audience:** Managers in research and development, operations, remediation, and sustainability **Ideal application:** Provide quantified values related to the potential impacts and/or benefits of decisions on landscapes and affected communities **Tool type:** Customizable software tool	"EcoMetrix is an *environmental measurement and modeling tool* that supports sustainable infrastructure, restoration projects, and enterprise-level decision making. It models and quantifies changes within an ecosystem, enabling users to evaluate the positive or negative effects of different scenarios on ecosystem services."	EcoMetrix Solutions Group and Parametrix

Table 4: Product-Level Tools

Tool Name	Target Audience and Ideal Application	Description	Tool Developer
Eco-LCA	**Target audience:** Lifecycle assessment (LCA) professionals **Ideal application:** Incorporating ecosystem concerns into lifecycle assessments **Tool type:** Computer model	"Eco-LCA is a framework to *account for the role of ecosystem goods and services in the life cycle of economic activities.* Conventional LCA focuses mainly on quantifying lifecycle emissions and their impact, and some resources. This approach has at least two shortcomings that Eco-LCA addresses: (a) It does not account for the role of ecosystem goods and services such as the biogeochemical cycles, pollination, carbon sequestration, climate regulation, etc. (b) For interpreting emissions data, conventional LCA uses sophisticated impact assessment methods to reduce dimensionality and assist in decision making. Similar aggregation and interpretation methods are not commonly used to account for resources. Consequently, despite their crucial role, resource use and the role of nature in making resources available does not receive as much attention as the impact of emissions."	Ohio State University

Table 5: Valuation Tools

Tool Name	Target Audience and Ideal Application	Description	Tool Developer
Coral Reef Valuation Tool	**Target audience:** Marine policy makers and scientists **Ideal application:** Valuing coastal ecosystems **Tool type:** Excel-based valuation tool	The tool provides "a way for policymakers, civil society, or other interested parties to *assess the value to their economies of goods and services provided by coral reefs* and to aid in setting coastal management policies." It assesses the value of fisheries and tourism/recreation. Although it was developed for the Caribbean region, it can likely be used in other marine areas.	World Resources Institute (WRI)
Guidance Manual for the Valuation of Regulating Services	**Target audience:** Valuation experts **Ideal application:** Valuation of ecosystem services **Tool type:** Guidance document	"The objectives of this manual are: » to identify and evaluate different methodologies for valuing regulating services in economic terms; » to provide guidance on the main issues that need to be considered and addressed when using these different » valuation methodologies; and » to demonstrate, through case studies, the application of these *methodologies to the valuation of regulating services* and the scope for incorporating these values into decision-making processes."	UN Environment Programme (UNEP)
Guide to Corporate Ecosystem Valuation	**Target audience:** Corporate decision makers **Ideal application:** Understanding whether and how to undertake corporate ecosystem valuation **Tool type:** Framework	"This guide explains how corporate ecosystem valuation can be used to improve corporate performance and decision making. The aim is to provide a consistent and robust *ecosystem valuation framework for business managers* to link corporate ecosystem service risks and opportunities more directly to the company bottom line."	World Business Council for Sustainable Development (WBCSD)
Marine and Coastal Ecosystem Services: Valuation Methods and Their Practical Application	**Target audience:** Valuation experts **Ideal application:** Valuing marine and coastal ecosystem services **Tool type:** Guidance document	"Economic valuation *of marine and coastal ecosystem services* is increasingly being considered to be of critical importance for informed decision making and effective management of marine and coastal resources. This report provides an *overview of the main methods of economic valuation,* their strengths and weaknesses, and practical applications. Theoretical concepts are illustrated with a number of practical examples throughout this report, to demonstrate how these approaches can be of practical use across all scales, in policy development, decision making, and communication. Practical guidance on how to implement a valuation exercise and how to overcome common challenges is also provided."	UNEP World Conservation Monitoring Centre (WCMC)

Natural Assets Information System (NAIS)	**Target audience:** Land managers **Ideal application:** Assessing and valuing ecosystem services **Tool type:** Proprietary computer model	"The Natural Assets Information System was developed by Spatial Informatics Group, LLC (SIG) to estimate Ecosystem Service Values (ESVs) *using state-of-the-art value-transfer methods and geospatial science.* Value transfer involves the adaptation of existing valuation information to new policy contexts where valuation data is absent or limited. For ESVs, this involves searching the literature for valuation studies on ecosystem services associated with ecological resource types (e.g., forests, wetlands, etc.) present at the policy site. Value estimates are then transferred from the original study site to the policy site based on the similarity of ecological resources at the policy site. Value transfer is a 'second-best' approach for gathering information about the value to humanity of ecosystem goods and services. However, the alternative, primary valuation research, is extremely costly and is rarely feasible in the context of the policy and planning process. Therefore, value transfer integrated with geospatial science has proven to be a critical tool in decision making and planning."	Spatial Informatics Group
Wildlife Habitat Benefits Estimation Toolkit	**Target audience:** Land managers, policy analysts, and scientists **Ideal application:** Valuation of wildlife habitat **Tool type:** Excel-based valuation tool	"The Wildlife Habitat Benefits Estimation Toolkit is a set of user-friendly Excel models that allows users to generate *quantitative estimates of the economic values generated by specific natural areas* of interest to them." Over the next one to two years, the toolkit, which is also known as the Benefit Transfer and Use Estimating Model Toolkit, will be updated and migrated to the USGS website.	Defenders of Wildlife and Colorado State University

Table 6: Data Sources

Tool Name	Target Audience and Ideal Application	Description	Tool Developer
Data Basin	**Target audience:** Land managers, policy analysts, and scientists **Ideal application:** Spatial analysis of ecosystems **Tool type:** Spatial data sets	"Data Basin is a free system that connects you with *spatial data sets, nontechnical tools, and a network* of *scientists and practitioners.* You can explore and download a vast library of data sets, connect to external data sources, upload and publish your own data sets, connect to experts, create working groups, and produce customized maps that can be easily shared."	Conservation Biology Institute (CBI)
Ecosystem Goods and Services Production Function Library *(under development)*	**Target audience:** Land managers, policy analysts, and scientists **Ideal application:** Assessing ecosystem services **Tool type:** Ecosystem services data source	"EPA scientists are developing production functions for ecosystem services and benefits for numerous areas in the United States. These production functions are being catalogued so that this information will be easily accessible for [the] EPA, other agencies, NGOs, and others interested in considering the ecosystem services trade-offs associated with changes in environmental conditions or decision alternatives. This work will result in a searchable database, the Ecosystem Goods and Services Production Function Library, that provides the best available information about *how to estimate the distribution and value of ecosystem services,* including how they might change under alternative future scenarios."	U.S. Environmental Protection Agency (EPA)

Ecosystem Service Indicators Database (ESID)	**Target audience:** Land managers, policy analysts, and scientists **Ideal application:** To identify relevant ecosystem services indicators **Tool type:** Indicators database	"The Ecosystem Service Indicators Database [ESID] was created to *make ecosystem services metrics and indicators readily available* for use in policy dialogues and decisions, in ecosystem assessments, and in natural resource management decisions. ESID is an online searchable database where users can find—and contribute—indicators that have been used to apply ecosystem services approaches or hold promise for doing so. Indicator descriptions and other supporting information about how the indicator has been or could be applied are also provided."	World Resources Institute (WRI)
Ecosystem Valuation Toolkit	**Target audience:** Land managers, policy analysts, and scientists **Ideal application:** Ecosystem services valuation **Tool type:** Valuation database and collaboration platform	"The Ecosystem Valuation Toolkit offers the world's first global ecosystem services values-exchange platform with a comprehensive library of bibliographic information on published and gray literature, primarily ecosystem service valuation studies. A component of the Ecosystem Valuation Toolkit, SERVES (Simple and Effective Resource for Valuing Ecosystem Services) is "a subscription-based self-service natural capital appraisal tool for natural resource managers to *estimate the value of a specific area's ecosystem services."*	Earth Economics
Environmental Valuation Reference Inventory (EVRI)	**Target audience:** Land managers, policy analysts, and scientists **Ideal application:** As a data source for valuations based on the benefits-transfer method **Tool type:** Valuation database	"The EVRI [Environmental Valuation Reference Inventory] is a *searchable storehouse of empirical studies* on the economic value of environmental benefits and human health effects. It has been developed as a tool to help policy analysts use the benefits-transfer approach. Using the EVRI to do a benefits-transfer is an alternative to doing new valuation research."	Environment Canada
European Space Agency (ESA) Earth Observation Data	**Target audience:** Land managers, policy analysts, and scientists **Ideal application:** As a data source for valuations based on the benefits-transfer method **Tool type:** Ecosystem assessment data source	The European Space Agency (ESA) offers a variety of *earth observation data* that has been used for ecosystem assessment, for example, in Borneo.	European Space Agency
Global Map of Human Impacts to Marine Ecosystems	**Target audience:** Marine managers, policy analysts, and scientists **Ideal application:** Identifying human impacts on marine ecosystems **Tool type:** Ecosystem assessment data source	"The goal of the research presented here is to estimate and visualize, for the first time, the *global impact humans are having on the ocean's ecosystems."*	National Center for Ecological Analysis and Synthesis (NCEAS)

Multipurpose Marine Cadastre	**Target audience:** Marine managers, policy analysts, and scientists **Ideal application:** Assessing marine ecosystems **Tool type:** Ecosystem assessment data source	"The Multipurpose Marine Cadastre is an integrated *marine information system* that provides legal, physical, ecological, and cultural information in a common geographic information system (GIS) framework. All organizations considering an offshore activity can benefit from this comprehensive, visual approach to data analysis."	National Oceanic and Atmospheric Administration (NOAA)

Table 7: Data Sources for Specific Regions

Tool Name	Description	Tool Developer
EcoSpatial Information Database (under development)	"This project will collate existing sources of information to produce a database containing *ecological and spatial information* for portions of the Bureau of Ocean Energy Management's *Atlantic Region*. This database will be the EcoSpatial Information Database (ESID, pronounced *EE-sid*) and will be designed to accept additional ecological information for all marine and coastal areas of the United States."	Bureau of Ocean Energy Management
GecoServ (Gulf of Mexico)	"The two main goals of the GecoServ database are to allow for the distribution and sharing of information about *ecosystem services valuation studies relevant to Gulf of Mexico region* and to identify current gaps in the ES literature. The studies summarized here are for habitats that are relevant to the Gulf region even though they may have been conducted elsewhere."	Harte Research Institute
Lakes Ecosystem Services Database and Online GIS (Northeast USA) *(under development)*	"The Lakes Ecosystem Services Database provides unique identification numbers for more than 28,000 geographically referenced lakes in the *Northeast United States*. These data include standard physical-chemical measures of water quality and subjective assessments (e.g., appeal, integrity, etc.) of lakes. These data form the basis of EPA research efforts on lakes ecosystem services." "The Lakes Ecosystem Services Online GIS [geographic information system] provides geospatial visualization, query, and analysis tools. With the various tools provided in the Online GIS, users can make and print maps from the data sets provided, query and display data with different cut points, conduct buffer analyses around lakes, summarize key data sets, and generate multivariate radar graphs of water-quality data."	U.S. Environmental Protection Agency (EPA)
The National Atlas for Sustainability and The Urban Atlas *(under development)*	"The National Atlas for Sustainability is a web-based, easy-to-use, mapping application that allows users to view and analyze multiple ecosystem services in a specific region. The atlas will provide users with a visual method for interpreting ecosystem services and understanding how they can be conserved and enhanced for a sustainable future." "The Urban Atlas component of the National Atlas will provide fine-scale information linking human health and well-being to environmental conditions such as urban heat islands, near-road pollution, resource use, access to recreation, drinking water quality, and other quality-of-life indicators. Researchers are working to develop the Urban Atlas initially for *50 cities and towns* of varying size, location, demographic makeup, and environmental and health risks. The first version of the Urban Atlas will be released in 2013, with subsequent releases following as more data become available. In future years, an additional 100 to 200 cities will be included, dependent upon available funding and program success."	EPA

Ocean Data Viewer	"The purpose of this Ocean Data Viewer is to provide an overview and *access to a range of data and relevant conventions, which are available to help inform decisions* that are important for the conservation of marine and coastal biodiversity."	UN Environment Programme World Conservation Monitoring Centre (UNEP-WCMC)
SERVIR	"SERVIR will improve environmental management and resilience to climate change by strengthening the capacity of governments and other key stakeholders to integrate earth observations and geospatial technologies into decision making for sustainable development. SERVIR is a platform for collaboration and cross-agency coordination, international partnerships, and delivery of web-based information services and applications." It is a regional visualization and monitoring system for *Mesoamerica, East Africa, and the Himalayas.*	National Aeronautics and Space Administration (NASA), U.S. Agency for International Development

Table 8: Tools for Specific Types of Ecosystems

Tool Name	Target Audience and Ideal Application	Description	Tool Developer
Wetlands, Estuaries, and Streams			
Integrated Wetland Assessment Toolkit	**Target audience:** Resource managers and land planners **Ideal application:** Wetlands planning **Tool type:** Framework and process overview	"This toolkit sets out a process for integrated assessment and provides a set of methods that can be used to investigate the links among biodiversity, economics, and livelihoods in wetlands and to identify and address potential conflicts of interest between conservation and development objectives. The integrated approach presented in the toolkit also enables practitioners to *assess a wetland in terms of its combined biodiversity, economic, and livelihood values*. It has a particular focus on strengthening pro-poor approaches to wetland management." "It is intended to help overcome the current methodological and information gaps in wetland assessment, thereby facilitating the factoring of wetland values into conservation and development decision making and management planning. It can be applied to all sorts of wetlands and at all scales."	International Union for Conservation of Nature (IUCN)
Wetlands-At-Risk Protection Tool (WARPT)	**Target audience:** Local government and NGOs **Ideal application:** Wetlands planning **Tool type:** Framework and process overview	The Wetlands-At-Risk Protection Tool [WARPT] *helps users assess local wetlands* and develop a plan for protecting at-risk wetlands and their functions. The basic steps of the process include quantifying the extent of at-risk wetlands, documenting the benefits they provide at various scales, and using the results to select the most effective protection mechanisms.	U.S. Environmental Protection Agency (EPA) and Center for Watershed Protection (CWP)
Forests			
High Conservation Value Forest Toolkit	**Target audience:** Government, NGOs, and land managers **Ideal application:** Forest management planning **Tool type:** Framework and process overview	This toolkit provides a framework for *assessing whether forests are of high conservation value,* including their ecological and economic benefits.	High Conservation Value (HCV) Resource Network

Table 9: Sector-Specific Tools

Tool Name	Target Audience and Ideal Application	Description	Tool Developer
Construction and Land Development			
Leadership in Energy and Environmental Design for Building Design and Construction (LEED BD&C)	**Target audience:** Building designers **Ideal application:** Building construction **Tool type:** Rating system	LEED BD&C version 4 includes draft credits *encouraging sourcing from "manufacturers that have publicly released a report from their raw material suppliers,* including the following: » raw material supplier extraction locations, » a commitment to long-term ecologically responsible land use, » a commitment to reducing environmental harms from extraction and/or manufacturing processes, [and] » a commitment to meeting applicable standards or programs voluntarily that address responsible sourcing criteria."	U.S. Green Building Council (USGBC)
QuickScan	**Target audience:** Policy makers **Ideal application:** Assessing policies regarding green infrastructure **Tool type:** GIS tool	"It is a flexible and modular modeling environment currently being developed in the European Environment Agency. It allows the users to explore the *different implications and trade-offs which occur when developing and implementing policy options for Europe*. Green infrastructure can be explored either as a purely structural theme, by looking at different land cover types and administrative declarations, or it can be explored with a more functional approach, which seeks to identify areas and networks that might not be measured using purely mechanical means."	European Environment Agency
Sustainable Sites Initiative	**Target audience:** Land developers **Ideal application:** Implementing sustainable land development and site management practices **Tool type:** Rating system	"The Sustainable Sites Initiative is dedicated to fostering a *transformation in land development and management practices* that will bring the essential importance of ecosystem services to the forefront. For the purposes of the initiative, land practices are defined as sustainable if they enable natural and built systems to work together to 'meet the needs of the present without compromising the ability of future generations to meet their own needs.'"	Sustainable Sites Initiative
Food, Beverage, and Agriculture			
Biodiversity Risk and Opportunity Assessment (BROA) Tool	**Target audience:** Corporate risk managers and sustainability managers **Ideal application:** Identification of site-specific risks and opportunities and the creation of action plans **Tool type:** Excel-based assessment and tracking tool	"It allows a business to *identify and assess its impacts and dependencies on biodiversity and ecosystem services* (BES), to prioritize and to create action and monitoring plans that address risks and opportunities both for BES conservation and to build greater resilience in [the] agricultural landscape. Because tobacco is grown in mixed agricultural landscapes and is commonly rotated with a variety of crops, including rice, barley, beans, and oats, BROA is not a tool specific to the tobacco crop—it deals with issues generic to many agricultural landscapes."	British American Tobacco Biodiversity Partnership

Fieldprint Calculator (United States only)	**Target audience:** Farm managers **Ideal application:** Assessment of environmental impacts of farming and comparison with baselines and alternative scenarios **Tool type:** Web-based assessment tool	"The Fieldprint Calculator is meant to be an educational resource to *get growers thinking about their operations and how their practices relate to natural-resource management* and sustainability. It will not provide you with a precise evaluation, but [instead will] allow you to generally benchmark your performance against county, state, and national averages. It also helps you to look at different scenarios of practices and see how those changes may affect your overall outcomes." The calculator does not discuss ecosystem services directly, but it allows users to see the impact of different management practices on land use, soil conservation, soil carbon, GHG [greenhouse gas] emissions, energy use, and water use. Additional indicators are under development. The calculator addresses a variety of common crops, including corn, cotton, potatoes, rice, soybeans, and wheat.	Field to Market
Energy and Extractives			
EcoNomics	**Target industries:** Utilities, minerals and metals, hydrocarbons, infrastructure, and environment **Ideal application:** Project selection and design **Tool type:** Proprietary computer model	"The EcoNomics assessment process allows users to *quantify and monetize relevant environmental, social, and financial project factors across the asset life cycle,* allowing project options to be compared on a like-for-like dollar-value basis over a range of possible future conditions. This allows decision makers to identify optimal solutions for profit and sustainability."	WorleyParsons
IPIECA Biodiversity and Ecosystem Services Guide	**Target audience:** Decision makers in oil and gas companies **Ideal application:** Identify risks and opportunities related to ecosystem services for oil and gas developments **Tool type:** Guidance document	"The aim of this guide is threefold. Firstly, it explains the relationship among biodiversity, ecosystem services, and the oil and gas industry. Secondly, it provides *a set of checklists* to help identify the main *ecosystem service dependencies and impacts of oil and gas developments.* Thirdly, it highlights key associated risks and opportunities for oil and gas companies and provides guidance on potential measures for managing them."	IPIECA (International Petroleum Industry Environmental Conservation Association)

Table 10: Assessment Resources

Tool Name	Target Audience and Ideal Application	Description	Tool Developer
Ecosystems and Human Well-Being: A Manual for Assessment Practitioners	**Target audience:** Land managers, policy analysts, and scientists **Ideal application:** Ecosystem assessment **Tool type:** Guidance document	"This manual, *Ecosystems and Human Well-Being: A Manual for Assessment Practitioners,* allows for the wider adoption of the Millennium Ecosystem Assessment [MEA] conceptual framework and methods. The manual, which contains numerous case studies of best practice, offers a *practical guide for undertaking ecosystem assessments* and includes tools and approaches that can assess options for better managing ecosystems."	UN Environment Programme World Conservation Monitoring Centre (UNEP-WCMC)

Integrating Ecosystem Services into Development Planning	**Target audience:** Development professionals **Ideal application:** Development planning **Tool type:** Guidance document	"This guide on Integrating Ecosystem Services into Development Planning aims to assist advisors, project staff, and development planners in partner countries in recognizing the links between nature and development. It considers the environmental and economic trade-offs associated with development measures and helps to systematically incorporate ecosystem services–related opportunities and risks into the planning and development of strategies."	Deutsche Gesellschaft für Internationale Zusammen-arbeit
Measuring and Monitoring Ecosystem Services at the Site Scale *(under development)*	**Target audience:** Land managers, policy analysts, and scientists **Ideal application:** Ecosystem assessment **Tool type:** Guidance document	"… [This] new 'toolkit' for *measuring ecosystem services at the site scale* is accessible to nonexperts and delivers scientifically robust results. This booklet explains some key concepts, including the need to consider a 'plausible alternative state' to measure differences resulting from changes in land management and use, and the importance of identifying beneficiaries." The introduction has been released, but the full document has not yet been published.	Cambridge Conservation Initiative
National Ecosystem Goods and Services Classification System (NEGSCS) *(under development)*	**Target audience:** Land managers, policy analysts, and scientists **Ideal application:** Ecosystem assessment **Tool type:** Standardized measurement system	"[The] EPA is developing the National Ecosystem Goods and Services Classification System (NEGSCS), an online database. In the past, there has been a lack of a system of measurement to compare functions across different geographical locations—an acre of wetland here will not contain the same kinds of natural functions as an acre of wetland there, for example. This research will develop a *standardized measurement system for ecosystem goods and services* that will allow researchers to compare functions in different environments and better understand the link between ecosystem changes and human health and welfare. In addition, the NEGSCS will quantify lost or impaired natural environments and allow for a form of ecosystem goods and services 'trading,' where one could 'make up for' ecosystem damages."	U.S. Environmental Protection Agency (EPA)