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An Overview of Ecosystem Services: Considerations for Electric Power Companies

Natural ecosystems provide important benefits that are essential to society and industry, including clean water, biomass, and flood regulation. These benefits are called **ecosystem services**.

The application of the ecosystem services concept in decision making has seen growing popularity during the past 5 years. While the concept stems from academia, agencies, environmental groups, and businesses are now testing approaches to identifying, valuing, and measuring ecosystem services for decision making. The United States Environmental Protection Agency (EPA), for example, is researching options for considering ecosystem services as a factor in the secondary National Ambient Air Quality Standards for NOx and SOx [1]. The agency is also hosting discussions on how to optimize Total Maximum Daily Load allocations for water based on ecosystem services [2].

Part of the motivation for organizations to consider ecosystem services in their decisions and policies was ignited by international research results in 2005 suggesting that 60% of the life-sustaining ecosystem services are being degraded or used unsustainably, including fresh water, capture fisheries, air and water purification, and the regulation of regional and local climate, natural hazards, and pests [3]. With the science and environmental community pushing for better conservation of ecosystem services, and regulatory agencies investigating policy approaches, it is important for electric power companies to understand their relationship with ecosystem services.

The electric power industry is directly tied to ecosystem services. Access to clean, flowing, cool water is an example of the power industry's dependence on services provided by nature. Water is used for cooling, exhaust gas cleaning, waste product transport, and driving turbines; water provides an inexpensive form of transport for coal-fired plants; water *is* the power source for hydroelectric facilities. Other services important to the industry include carbon sequestration to mitigate CO_2 releases, air purification to mitigate air emissions, and water purification to mitigate pollutant discharges like nutrients. Since the 1970s, there has been a growing understanding of the link between human wellbeing and the health of ecosystems. Today, corporations are beginning to acknowledge their dependencies, impacts and opportunities related to ecosystem services.

This topical brief provides an overview of ecosystem services and discusses how electric power companies may leverage these services to increase corporate value and reduce risk. Table 1 provides examples of how electric power companies have already taken advantage of ecosystem services.

Overview of Ecosystem Services

Societies derive many essential goods from natural ecosystems, including agricultural crops, timber, and pharmaceutical products. These goods represent important and familiar parts of the economy. What has been less appreciated until recently is that natural ecosystems also perform fundamental life-support services, without which civilizations would cease to thrive. Collectively, these benefits are known as **ecosystem services** and include products like clean drinking water and processes such as flood

control and climate regulation. Ecosystem services can be subdivided into four categories, which are listed below [7].

- Provisioning services - goods or products produced by ecosystems (clean water, timber, food, fuel).
- Regulating services - natural processes regulated by ecosystems (water purification, flood regulation, erosion control, climate regulation, natural hazard regulation, pollination).
- Cultural services - non-material benefits obtained by ecosystems (recreational, spiritual, aesthetic).
- Supporting services - Functions that maintain all other services (photosynthesis, nutrient cycling, soil formation).

For the electric power industry, ecosystem services are important in several ways. Some services are directly related to power generation, such as water supply and biomass. Other services can impact cost of operations, like erosion control, flood reduction, and the use of wetlands for wastewater treatment. The electric power industry can also realize new revenue streams through emerging markets for carbon sequestration or wetland mitigation, or recreational user fees. Finally, impacts on ecosystem services can expose the industry to corporate risks.

Valuing Ecosystem Services

Over the past two decades, a fair amount of attention has been focused on the financial value of ecosystem services. Valuation of ecosystem services, however, varies based on perspective and discipline. This section will review nonmarket valuation, direct value, markets for ecosystem services, and corporate ecosystem valuation.

Although the Costanza et al. $33 trillion value of the world's ecosystem services is a highly sited instance of valuation, this is just one example within a larger body of academic studies [8, 9]. There is a whole genre of research called nonmarket valuation [10]. Nonmarket valuation attempts to tease out the monetary value of ecosystem services through various means. The method of contingent valuation, for example, uses surveys to determine willingness-to-pay for conservation, improved water quality, or the value of preserving an endangered species half a world away. Nonmarket valuation was used by the courts to consider the natural resource damage fines levied on Exxon for its infamous 1989 Valdez oil spill in Prince William Sound [11]. More recently, ecosystem service values are being considered in fines for BP's Deep Horizon Gulf oil spill [12].

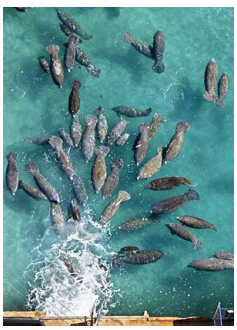
Ecosystem services can also have direct value on the free market. Prices for provisioning services like timber and agricultural crops are easily found. A lesser known direct value is that of pollination services. In the agricultural world, many producers rent bee hives. The total U.S. value of pollination services is estimated at four to six billion dollars per year [8].

Table 1. Examples of Electric Power Companies and Ecosystem Services

Dependence
"In the 1990s, Costa Rican hydropower company Energia Global (now Enel Latin America) was literally losing its source of power. Landowners were clearing the forested slopes upstream of the company's dams for livestock and agriculture. With the trees gone, heavy rains were causing increased soil erosion and river sedimentation, lowering dam reservoir capacity and power output. Energia Global now pays farmers to keep trees on their farms [4]."

Opportunities
Through an EPRI project, Allegheny Power realized over $5 million in tax savings when it considered the value of ecosystem services. The traditional real estate appraisal valued the land at $16 million. After EPRI conducted an eco-assessment of the marketable environmental benefits (carbon sequestration credits, wetland mitigation credits), the value rose to $33 million. Allegheny Power sold the land for $16 million under "bargain sale" tax provisions to the United States Fish and Wildlife Service [5] and claimed a donation of $17 million, ultimately resulting in over $5 million in savings after all other expenses were accounted for.

Provisioning
Florida power companies provide a wildlife haven when manatees flock to warm water discharge outflows. Tampa Electric opened a viewing platform in 1986 as a goodwill gesture. The state- and federal-designated sanctuary has hosted several million visitors [6].



Manatees at F &L Riviera Beach Power Plant. Photo credit: Lannis Waters / Associated Press (in LA Times, 2010)

Other services are valued by engaging in market-based instruments that create economic incentives for conservation, namely markets for ecosystem services (MES) and payments for ecosystem services (PES). There are four primary Markets for Ecosystem Services (MES), as summarized in Table 2 [13, 14, 15, 16, 17]. MES are exchange markets where ecosystem services are traded within guidelines and protocols driven by regulation or threat of regulation. The first MES experience at the international scale is the European Union emission trading system launched in 2005, which established a trading mechanism for the six major greenhouse gases [13]. In the U.S., the Chicago Climate Exchange, launched in 2003 and since closed, created a trading scheme based on voluntary targets. Companies emitting more than their target could buy credits from those that emitted less. Another example of MES is wetland mitigation banking.

Wetland mitigation banking is an option for fulfilling regulatory compensation requirements under the Clean Water Act. Wetland mitigation banking, along with a parallel system of Conservation Banking for endangered species, acts as a landscape-scale market, whereby permittees impacting natural resources drive demand, and private-party "bankers" supply credits for on-the-ground restoration and conservation. The use of wetland mitigation and conservation banking has increased from pilots to formalized regulation and a niche private industry [14, 15, 18, 19, 20].

Table 2
Primary Markets for Ecosystem Services

Natural Resource	Federal Guidance/ Policy (Year)	Credit Currency	Total Annual Market Value	Credit Price Range
Carbon (global)	Pending	Pounds/tons CO_2e	$142 billion	$1-$20
Wetlands and streams (U.S.)	Mitigation Banking (1995)	Acres	$1.8-$3.2 billion	$3,000-$653,000
Threatened and Endangered Species (U.S.)	Conservation Banking (1995-California), (2003-Federal)	Acres and individuals	$200 million	$2,500-$300,000
Water Quality (U.S.)	Water Quality Trading (2003)	Pounds of nutrients, or similarly specific credit	$10.8 million	$1.21-$10 (Pound Nitrogen) $3.76-$25.16 (Pound Phosphorous)

Water quality trading is another MES that applies at a landscape level and within the regulatory context [16]. In water quality trading, water quality goals are met by trading pollution reduction credits. Demand is driven by point sources needing to reduce nutrients, salinity, or temperature within a watershed. Supply is created by other point sources or by non-point actors such as agriculture implementing best management practices to improve water quality, as illustrated in the graphic below.

Figure 1
Example of Water Quality Trading

In contrast to MES, payments for Ecosystem Services (PES) represent purely voluntary actions that are not driven by regulatory compliance obligations. Broadly defined, PES programs are mutually beneficial contracts between consumers of ecosystem services and the suppliers of these services [21]. The world's largest and longest-running PES program is the U.S. Conservation Reserve Program, which currently pays about $1.8 billion a year to farmers and landowners covering a total of more than 34 million of what it considers environmentally-sensitive land. In exchange for payments, farmers agree to plant long-term, resource-conserving land cover to improve water quality, control soil erosion and enhance habitats for waterfowl and wildlife [22]. PES programs are used to incentivize proper land management and reduce deforestation in the rain forests of South and Central America to protect the ecosystem service of carbon sequestration [23, 24].

Other services earn their value by providing business with free services like water purification that would require additional spending if the ecosystems were degraded. Business operations can also impact the ecosystem services provided to local communities. In April 2011, The World Business Council for Sustainable Development (WBCSD) published their *Guide to Corporate Ecosystem Valuation* to help companies inform business decisions by providing direction on how to value impacts to services and benefits provided by business operations [25].

In all of these markets, there are opportunities for power companies to monetize restoration and conservation approaches for ecosystem services, either through establishing company owned banks, or by buying credits from other banks to meet compliance obligations that also protection ecosystem services [26].

Evolution of Ecosystem Services: Academia

The concept of ecosystem services originated in the late 1970s, following on the heels of the world's first Earth Day. Talking about the beneficial functions of ecosystems was a new way to increase public interest in biodiversity conservation [27]. The concept continued to grow in academic circles, becoming a mainstream topic in literature by the 1990s [4, 28, 29, 30]. Methods for estimating economic value came to the forefront of academic research, and Costanza et al's (1997) $33 trillion price tag on the global value of ecosystem services continues to be a frequently-cited figure [5]. In 2005, the Millennium Ecosystem Services Assessment was released, and marked a turning point at which the concept of ecosystem services became institutionalized, as illustrated in Figure 2 [30].

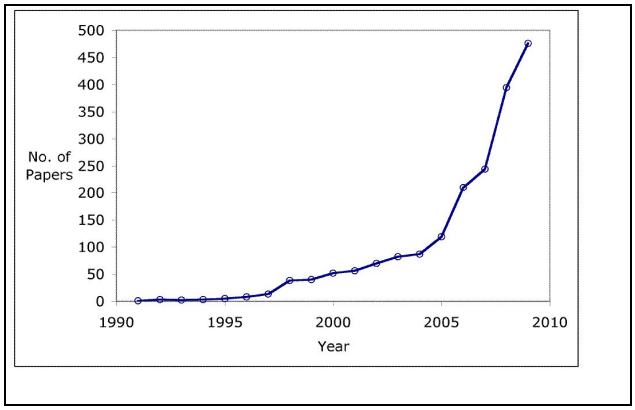


Figure 2
Growth in Number of Papers on Ecosystem Services Since 1990

The Millennium Ecosystem Services Assessment (MA) was essentially a global academic synthesis of the status and trends of ecosystem services around the world. Over 1,000 scientists from 95 countries provided input on this study commissioned by the United Nations. The MA found that over 60% of the

world's ecosystem services are being degraded or used unsustainably, exemplified by these findings:

- Water withdrawals from rivers and lakes doubled since 1960; most water use (70% worldwide) is for agriculture.
- Since 1960, flows of reactive nitrogen in terrestrial ecosystems have doubled, and flows of phosphorus have tripled. More than half of all the synthetic nitrogen fertilizer used on the planet has been used since 1985.
- Since 1750, the atmospheric concentration of carbon dioxide has increased by about 32%, primarily due to the combustion of fossil fuels and land use changes. Approximately 60% of that increase has taken place since 1959 [2].

These and many other impacts to ecosystem services stem from increasing demands on resources from population growth, which doubled between 1960 and 2000.

Evolution of Ecosystem Services: Government

Following academic interest in ecosystem services, global institutions and government agencies began to investigate the use of an ecosystem service framework in their policy and resource management decisions. On a global level, major intergovernmental agencies including the United Nations Development Program (UNDP), the World Bank, and the International Finance Corporation have begun integrating ecosystem services in their research, granting and lending decisions. For example, the International Finance Corporation recently released screening protocols for lending decisions that require clients to identify, avoid and minimize impacts on ecosystem services [31]. International environmental groups have also developed pilot projects and tools like InVEST, a tool developed in partnership between the Nature Conservancy, Stanford University, and the World Wildlife Fund that models ecosystem service provisioning on the landscape [32].

In the U.S., protection agencies and other influential organizations may implement policies based on ecosystem services management. It is important for the electric power industry to understand the initiatives of U.S. agencies to anticipate what future policies could mean in terms of industry requirements.

Several U.S. laws already incorporate ecosystem services. For example, Clean Water Act permitting of impacts to wetlands and streams incorporates the functions of aquatic ecosystems when determining mitigation requirements. Similarly, the Endangered Species Act is a reflection of the ecosystem service of habitat provisioning.

Ecosystem services are also considered under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the Oil Pollution Act during natural resource damage assessments. These assessments use nonmarket market and nonmarket valuation to levy fines for catastrophic damages to ecosystem services, like damages from the Deepwater Horizon spill in the Gulf.

Over the past decade, there has been a flurry of government activity intended to improve institutions and legal safeguards to protect ecosystem services [33]. As of 2010, federal agencies have been engaged in at least 334 research projects related to ecosystem services. Several of those projects explicitly consider federal policies and regulations, while many others provide tools and topical research to support policy decisions [34]. A sampling of these initiatives is provided below.

Within the U.S. Environmental Protection Agency (EPA), several initiatives are underway. The EPA has adopted an internal sustainability initiative that includes "Water and Ecosystem Services" as one of their four broad categories [35]. The EPA is involved in categorizing Final Ecosystem Goods and Services, high-level work to create standard terminology that will link with a new Environmental Monitoring and Assessment Program (EMAP). EMAP includes development of ecological indicators that will assist in identifying causes of impairment to ecosystem services [36, 37].

The EPA conducted the first application of an ecosystem service framework for "identifying and quantifying the policy relevant ecological impacts of NOx and SOx." The policy analysis assessed the utility

of using this framework for setting a secondary National Ambient Air Quality Standard (NAAQS)[1].

The National Ecosystem Services Partnership (NESP), initiated by USDA and EPA, was organized to enhance collaboration and coordination of research, policy, and market implementation at the national level. EPRI Senior Project Manager Jessica Fox serves on the NESP steering committee to guide NESP activities relevant to the electric power industry [38].

Within the USDA, the U.S. Forest Service is also considering an ecosystem services framework for forest management, and valuation to describe provisioning of ecosystem goods and services on public lands. In practice this has translated to a specific goal of providing ecosystem services in the 2009 Planning Rule, an application of an ecosystem services framework on a pilot National Forest, and various other research efforts [39, 40]. As well, the Forest Service's Forests to Faucets study of forest lands important to water quality led to subsequent voluntary water protection partnership projects [41].

In 2008, the USDA created the Office of Environmental Markets (OEM), which supports the development of emerging markets for carbon sequestration, water quality, wetlands, biodiversity, and other ecosystem services. USDA's involvement is based on an interest in providing financial incentives for ecosystem services as an alternative to selling and developing rural lands [41].

What do these initiatives mean for the electric power industry? At the very least, they mean that government agencies will increasingly scrutinize the effects of industry activities on the provisioning of ecosystem services to the public. For example, BSR found in interviews with corporate leaders that government regulators were increasingly requesting integrated ecosystem-based approaches in permitting processes [42]. These initiatives suggest potential for new monitoring requirements, given the attention devoted to understanding and monitoring indicators of ecosystem services. New opportunities may present themselves as well. For example, the power industry may consider engaging in environmental markets or partnering with agencies in the mutually-beneficial provisioning of ecosystem services. There may be the potential for ecosystem services to be integrated in future regulations.

Table 3. Categories of Business Risks and Opportunities [25, 44, 42]

Reputational risks and opportunities: Damage to ecosystem services can affect a company's brand and goodwill with consumers. On the positive side, telling a story about beneficial ecosystem benefits provided by the electric power sector can provide marketing messages.
Operational risks and opportunities: This refers to risks related to disruption of inputs in a company's day-to-day activities and processes. Investments in ecosystem service inputs that the company is dependent upon (e.g., water supply and quality, biomass) may ensure continued access to these inputs without having to invest in costly technological substitutions.
Regulatory and legal risks: Negative impacts on ecosystem services can limit a company's "license to operate" (e.g., the ability and length of the time to obtain permits). A 2009 EPRI TMDL Program Advisory Committee workgroup noted the following benefits of 'pre-compliance' activity: reduced costly procedural or legal challenges to regulation, valuable stakeholder relationships, and a chance to ensure fair distribution of restoration and clean-up requirements [45].
Market and product risks and opportunities. Investors are demanding broader disclosure and tracking of metrics relating to ecosystem services (carbon emissions, water footprinting, land conversion, pesticide and fertilizer use, etc.) The Global Reporting Initiative—a voluntary sustainability reporting system—is considering including ecosystem service metrics as one measure of corporate sustainability.
Financing risks and opportunities. Some financial institutions have begun to restrict access to capital for projects damaging ecosystem services. For example, banks have stopped lending to companies engaged in mountaintop mining [46].

Evolution of Ecosystem Services: Business

Following agency, scientific, and environmental group attention, consideration of ecosystem services is increasing in the business world as well. A 2010 McKinsey survey found that over half of the 1,500 CEOs surveyed considered ecosystem services and biodiversity as a potential risk or opportunity [43]. Some broad categories of business risks and opportunities related to ecosystem services are described in Table 3.

Dow Chemical is seriously considering their business risks and opportunities related to ecosystem services. In 2011, Dow Chemical Company committed to a $10 million partnership with The Nature Conservancy to incorporate the value of nature into their company goals [47]. Some other examples of developments in the corporate consideration of ecosystem services include:

- Goldman Sachs established a Center for Environmental Markets, and noted in their corporate environmental policy that the firm will "aggressively seek market making and investment opportunities in the environmental markets," including markets for water, biodiversity, forest management, forest-based ecosystems, and other ecosystem features and services. The firm recently committed to investing $40 billion in green energy projects [48, 49].
- In 2010, multiple countries supported a global study on The Economics of Ecosystems and Biodiversity (or TEEB) with a 200-page report dedicated to business and biodiversity. Although the report escaped attention in the U.S., the initiative resonated in the international arena, spawning multiple initiatives in the business sector: the European Business and Biodiversity Campaign, Germany's Biodiversity in Good Company, Japan's Business and Biodiversity Partnership, and the Brazilian Business and Ecosystem Services Partnership [44, 50, 51, 52].
- The GRI released *The Approach for Reporting on Ecosystem Services* in October of 2011. GRI noted that stakeholders were eager for ecosystem service indicators and GRI intends to develop these in their next generation of guidelines (G4). GRI also provided some "possible future reporting indicators [53]."

Case Studies

To understand the relationships between humans and natural ecosystems through the services derived from them, two case studies are discussed. Successful case studies are important to further our understanding through lessons learned, actions taken and benefits realized. The first case study is a comprehensive program of watershed protection, established by the then Commissioner of the New York City Department of Environmental Protection, as an alternative to costly water filtration works to maintain acceptable water quality for New York City drinking water.

The second case study is a complex property transaction between Allegheny Energy and the Fish & Wildlife Service, which involved a land appraisal including the valuation of eco-assets to improve the value of the property.

Catskills Water Quality

The most frequently-cited example of ecosystem services project is the case of New York City's dependence on clean water from the Catskills watershed. The New York City Water system serves millions of people, providing them with over one billion gallons of water per day. Drinking water for the City comes from three watersheds far upstate in the Catskills region, a rural area of farms, forests, small towns, and growing suburban developments. The quality of this source water is so pristine that drinking water goes essentially untreated; a rare exemption from expensive treatment technology that the EPA grants to very few water utilities. By the late 1980s, however, this natural purification system was diminishing. Due to sewage from septic systems and agricultural runoff, the water quality dropped below EPA standards.

When New York City researched the cost of replacing the natural water treatment system with a drinking water filtration plant, the estimated price tag was $4 to 6 billion in capital costs plus $250 million annually in operating costs. New York City was able to avoid those costs by investing in the natural system. The City purchased conservation easements to protect the forests in the water supply watersheds and update septic systems. The cost of this investment in ecosystem services was about $1 billion, providing a savings of around $6 billion [16, 53, 54].

Figure 3
New York City's Water Supply System [55]

Allegheny Energy

A unique property appraisal allowed Allegheny Energy to turn ecosystem services like wildlife habitat, water purification and climate regulation into environmental assets. The project yielded millions in tax savings from a bargain sale to the U.S. Fish and Wildlife Service. The project evolved from an early EPRI investigation into the eco-asset valuation of Allegheny's landholdings. Alan Noia, CEO of Allegheny Energy noted "We've known that some of our properties are truly unique, but it's always been very difficult to factor the intangible value of these physical assets into the land management equation [53]." In evaluating Allegheny properties, the natural value of the company's Canaan Valley properties became apparent. The valley's diverse and unique ecosystems support around 600 plant and 300 animal species, including the endangered Virginia northern flying squirrel and the threatened Cheat Mountain salamander. The valley also hosts one of the largest wetlands east of the Mississippi.

The challenge, then, was in realizing the value of ecosystem services of this 12,000-acre tract, beyond traditional real estate valuation. The solution was a complex property transaction involving a sale of the property to the Fish and Wildlife Service. The transaction hinged upon a comprehensive appraisal of the property's fair market value. The appraisal included the value of eco-assets, specifically mitigation credits associated with protecting and enhancing wetland and endangered species habitat, preserving open space, and sequestering carbon. For example, the Canaan Valley property included 253 acres of degraded wetlands. If those wetlands were restored and turned into a wetland bank, credits could be sold for $8,000 per acre.

While the traditional real estate appraisal valued the land at $16 million, after including the eco-assets, the value rose to $33 million. The valuation was supported by an independent audit by PriceWaterhouseCoopers [54, 56]. The U.S. Fish & Wildlife Service purchased the property at a cost in line with the traditional appraisal value of $16 million. Based on bargain sale provisions in the federal tax code, Allegheny Energy claimed a charitable contribution of the eco-asset value, yielding about $5 million in tax savings after staff time and expenses were accounted for. The transaction was reviewed by the Internal Revenue Service during a tax audit, and was approved without modification. "This agreement will be beneficial from all perspectives," says Jay Pifer, president of Allegheny Power, the energy delivery business of Allegheny Energy. "The Fish & Wildlife Service will protect the public interest by managing and preserving this exceptional area as a wildlife refuge, Allegheny Energy will continue to demonstrate its strong commitment to environmental stewardship and community, and we will maximize the value of the property for our shareholders [5, 57]."

Research and Technology Gaps

The electric power industry relies on ecosystem services for daily operation of power plants throughout the world. However, the industry does not always understand what services they rely on, the services they impact, or the economic consequences if those services were no longer free. Power plants rely on access to clean water, nutrient filtration and assimilation of wetlands, and a predictable climate. If the electric power industry

had to pay for these free ecosystem services, the cost of power generation would be impacted. EPRI is helping its members understand their role in using and protecting ecosystem services, thereby positioning the power industry to respond to regulatory initiatives and sustainability targets. While the focus within the industry has recently been on one ecosystem service, climate regulation, it is important to expand this focus to consider other vital life sustaining support systems.

To support the industry in more structured consideration of ecosystem services, EPRI is working on developing a decision-making framework to determine **what** ecosystem services are relevant in various corporate decisions (pollination, climate regulation, water filtration, etc), **when** it is important to consider ecosystem services (land purchases, sales, management decisions), and **how** this consideration should be done (models, site-visits, desk studies, etc). With continued funding and development, EPRI anticipates that such a decision support framework will facilitate a more quantitative business case for consideration of ecosystem services in day-to-day decisions at power plants.

Conclusions

The electric power industry relies on ecosystem services for daily operation of power plants throughout the world. Access to clean water for cooling and flushing, reliance on a stable climate, watershed nutrient assimilation capacities, all affect how power companies operate. The industry also holds lands that host these ecosystem services. The relationships between these services and the industry are important to understand as public agencies and other organizations develop and implement guidelines for the management of ecosystem services. It is clear that the preservation of ecosystem services is a global priority. Therefore the industry should expect that management policies may soon be placed into regulation, and that corporate sustainability will be judged according to performance indicators surrounding the management of corporate ecosystem services.

Markets are emerging that can provide the industry with opportunities and flexibility. Companies may be able to buy credits for cost-effective compliance, sell valuable ecosystem-rich lands to increase revenue; or in some cases to sell credits to others. It is important to understand these systems and policies, as well as the tools and guidelines for measuring and reporting. Advancement of this knowledge will enable industry leaders to strategically manage their ecosystem services, and to link these outcomes to financial business benefits, along with any regulations that may develop.

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