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Perspectives

Applying Ecosystem Services Approaches for Biodiversity Conservation: Benefits and Challenges

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Abstract

Ecosystem services as a concept and framework for understanding the way in which nature benefits people has led to a suite of approaches that are increasingly being used to support sustainable management of biodiversity and ecosystems. However, the utility of the ecosystem services framework and associated tools for supporting biodiversity conservation are the subject of ongoing debates among conservationists. In this paper, we discuss several general ways in which ecosystem services approaches are supporting biodiversity conservation, which may not have been possible otherwise. The new opportunities that ecosystem services approaches provide for biodiversity conservation include: the development of broader constituencies for conservation and expanded possibilities to influence decision-making; opportunities to add or create new value to protected areas; and the opportunities to manage ecosystems sustainably outside of protected areas. We also review areas in which ecosystem services approaches may not effectively conserve certain aspects of biodiversity. Areas of particular concern in this regard include: species without utilitarian or economic value; ecological processes that do not directly benefit people; and critical ecological functions that may be undermined in attempts to optimize a target service. Understanding the benefits and limitations of using ecosystem services approaches for achieving biodiversity conservation will help ensure that the finite resources available for biodiversity conservation and sustainable development are used as strategically and effectively as possible to maintain the multiple components of biodiversity and to support human well-being.

Keywords: ecosystem services, biodiversity conservation, conservation risks, conservation opportunities, conservation targets

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1. INTRODUCTION

Although scholars have long recognised the role functioning ecosystems play in maintaining biodiversity and human societies (Myers, 1983; De Groot, 1992; Daily, 1997; Costanza *et al.,* 1997), it is only over the last decade that the concept of 'ecosystem services' has been widely adopted (Goldman & Tallis, 2009). The Millennium Ecosystem Assessment (MA, 2005) served to define and popularize the concept and has contributed to a number of other major international initiatives including The Economics of Ecosystems and Biodiversity (TEEB) and the recently established Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES). Increasingly bilateral and multilateral donors, large foundations, and businesses are establishing well-funded programs primarily focused on protecting and/or restoring ecosystem services. For example, the global corporation *Dow Chemical* Company has recently announced its goal to mainstream ecosystem services into all of its business planning.[1]

While ecosystem services as a concept has been embraced by many members of the academic community, non-governmental organizations (NGOs), the private sector, and donors, the concept has been met with mixed enthusiasm within the biodiversity conservation community (Goldman & Tallis, 2009; McCauley, 2006; Redford & Adams, 2009; Reyers *et al.*, 2012). Many conservation scientists believe that there is an obvious, harmonious marriage between the two concepts of biodiversity conservation and ecosystem services: both are based on sustainable management and conservation of nature; seek to raise awareness of the importance of nature; and seek ways to balance human needs with the persistence of natural systems. However, the details of how biodiversity conservation fits within an ecosystem services framework and what 'ecosystem services approaches' mean for conservation (Mace *et al.*, 2012) have raised concerns among other members of the biodiversity conservation community (for an example of contrasting visions, see Redford & Adams, 2009; Karieva & Marvier, 2009). While it is clear that many overlaps exist between the two approaches, it is important to recognize that ecosystem services approaches and biodiversity conservation are not identical fields of thought or practice and may not always be compatible with one another (Naidoo *et al.*, 2008). Yet, critical analyses of the synergies and divergences between the two approaches remain few (but see Goldman & Tallis 2009; MacFayden *et al.*, 2012; Reyers *et al.,* 2012 for recent discussions on this topic). Thus, we believe it is important and timely to explore benefits and potential challenges in applying ecosystem services approaches for biodiversity conservation to ensure that both are used in complementary, effective manners to better support human well-being and to conserve more effectively the many different dimensions of biological diversity.

This paper reviews real and potential opportunities and challenges of applying ecosystem services approaches for biodiversity conservation. We first broadly define what is meant by ecosystem services and biodiversity conservation approaches, then, identify ways in which the application of ecosystem services approaches can contribute directly to biodiversity conservation, and, finally, identify situations in which ecosystem services approaches may not be helpful if applied as a substitute for other biodiversity conservation approaches.

2. BIODIVERSITY CONSERVATION APPROACHES AND ECOSYSTEM SERVICES APPROACHES

The modern conservation movement emerged in the late 19th century in response to fundamental changes in world views concerning the nature of the relationship between humans and the natural world (Jepson & Whittaker, 2002). In its early days, biodiversity conservation was motivated by a desire to preserve sites with special meaning for the intellectual and aesthetic contemplation of nature, and by acceptance that the human conquest of nature carries with it a moral responsibility to ensure the survival of threatened life forms (Leopold, 1949; Ladle & Whittaker, 2011). Over the past century a wide range of different conservation-oriented approaches have been enacted, from local and regional scale activities, such as protected area establishment, *ex-situ* conservation, recovery planning for species and ecosystems, specific threat management (*e.g.* disease, fire), and biodiversity off-sets, to global scale inter-governmental policy developments such as the Convention on Biological Diversity (CBD) and the Convention on International Trade on Endangered Species (CITES) (Redford *et al*., 2003; Whittaker *et al*., 2005). These approaches are based on multiple values of biodiversity, including those val-

1 Dow, 2011, http://www.dow.com/news/multimedia/media_kits/2011_01_24a/pdfs/dow-tnc_joint_press_release.pdf , accessed on April 15, 2012

ues not related to humans.

Compared with the conservation movement, the formal concept of ecosystem services (and the development of approaches that are aimed at protecting or restoring them) is relatively new, although many people were working on various aspects of ecosystem services long before there was an official term for it. "Ecosystem services" broadly refers to the benefits that people obtain from ecosystems (MA, 2005), although variations of this definition exist throughout the literature, along with multiple classification schemes for characterizing different ecosystem services (compare for example, Daily, 1997; Costanza *et al*., 1997; Boyd & Banzhaf, 2007; Fisher *et al*., 2009a). The approaches most commonly used to date in ecosystem service literature, policy, and practice broadly encompass the science of identifying, measuring, mapping and/or modelling the stocks and flows of different ecosystem services and the synergies and/or tradeoffs that may occur among them as a result of different decisions (*i.e.* Kremen, 2005; Luck *et al*., 2009; Tallis & Polasky, 2009; Aries, 2012[2]; NatCap, 2012[3]; UNEP-WCMC, 2012[4]); identifying and quantifying the social, cultural and/or economic values of ecosystem services (*i.e.* Costanza *et al.*, 1997; MA, 2005; TEEB, 2010; Daw *et al*., 2011; Chan *et al*., 2012; Norton *et al*., 2012); and the development of various incentives, such as Payments for Ecosystem Services (PES), to conserve ecosystem services (*e.g.* Pagiola *et al*., 2005; Wunder, 2005; Wunder *et al*., 2008; Clements *et al*., 2010). While the valuation of ecosystem services and market-based mechanisms such as PES are among the most widely cited and used ecosystem services approaches, they represent only several of many ecosystem services approaches that exist. It is also important to note that inherent in the MA (2005) is the idea that multiple ecosystem services are necessary to fulfil the multiple dimensions of human well-being and, as demonstrated through more recent initiatives such as the Natural Capital Project, tradeoffs among ecosystem services can occur as a result of different policies or resource use decisions. Identifying potential tradeoffs between/among ecosystem services so as to avoid potential negative impacts and unintended consequences of environment and development decisions is a distinct characteristic of many evolving ecosystem service frameworks and tools (*e.g.* Tallis & Polasky, 2009; Daw *et al*., 2011). Thus, ecosystem services approaches differ from historical siloed approaches to natural resource management in the development context because they provide a framework for anticipating a wide range of social and ecological consequences that may result from different decisions and provide tools for identifying, negotiating, avoiding, and managing potential negative tradeoffs (DeClerck *et al*., 2006; Ingram *et al*., 2012). However, this holistic understanding of and approach to managing ecosystem services is not always found in current "ecosystem service" projects or programs, even if it represents the latest thinking in the field.

We acknowledge that there are many formal and informal approaches to biodiversity conservation and ecosystem services management, and often approaches are used that are not classified as either, even though they may benefit ecosystem services, biodiversity, or both. Furthermore, we recognize that there are many overlaps between the tools and strategies used in the different sectors. It is beyond the scope of this paper to address or compare all of these approaches; rather, we discuss some of the most commonly used ecosystem services approaches and how they might influence biodiversity conservation objectives.

3. BENEFITS OF ECOSYSTEM SERVICES APPROACHES FOR BIODIVERSITY CONSERVATION

Because ecosystem services are provided by various elements and combinations of biodiversity that are important to people, there are many ways in which ecosystem services approaches can contribute to biodiversity conservation. Here we identify three distinct ways in which ecosystem services approaches are being and can be used to directly support biodiversity conservation: the development of broader constituencies for conservation and informing decision-making; opportunities to add or create new value to protected areas; and the opportunities to sustainably manage ecosystems outside of protected areas.

3.1 BROADENING CONSTITUENCIES FOR CONSERVATION AND INFORMING DECISION-MAKING

The ecosystem services framework has been embraced by a broad range of stakeholders, some of which have not engaged with the biodiversity conservation community (Slootweg & van Beukering, 2008; Goldman & Tallis, 2009; Houdet *et al*., 2012). This rapid uptake is most likely because broad understanding and appreciation of the value of ecosystem services makes them relevant to certain types of decision-making that might have previously ignored biodiversity on its own. For example, the for-profit sector is embracing the concept of ecosystem services because such a framework allows consideration of new business opportunities that might replace unsustainable practices, in contrast to only engaging with biodiversity in terms of regulatory compliance, impact mitigation, and/or reputational liability (*e.g.* Houdet *et al.*, 2012). However, analyses regarding the ways in which business practices and performance are actually changing as a result of adopting ecosystem services approaches are needed.

Ecosystem services approaches also present opportunities to build constituencies for biodiversity and ecosystem management with communities who live in rural areas, but who may not be willing to support biodiversity conservation. For example, outside of the Tarangire National Park in Tanzania, wildlife safari tour operators have established a Payments for Ecosystem Services (PES) contract with a Masaai community that requires them to help protect wildlife

2 ARIES (Artificial Intelligence for Ecosystem Services) http://www.ariesonline.org/
3 The Natural Capital Project, http://www.naturalcapitalproject.org/
4 UNEP-WCMC, http://www.unep-wcmc.org/developing-mainstreaming-ecosystem-service-indicators_554.html

and to maintain grasslands for wildlife and livestock grazing rather than converting them to agriculture (Nelson *et al*., 2010; Sachedina & Nelson, 2012). If the community upholds the contract, the tour operators pay the community for their efforts in maintaining a cultural ecosystem service — wildlife and their grazing areas — that is critical for their business. This cultural service has helped generate a new revenue stream for the community, which has helped compensate them for their efforts in engaging in natural resource practices that support conservation. Traditional biodiversity conservation approaches may not have worked here due to the villagers' suspicions about hidden conservation agendas; a suspicion not uncommon in this part of the world where some people believe conservationists have prioritized the needs of species over the needs of extremely poor people (Brockington, 2002; Sachedina & Nelson, 2012).

Another example of how ecosystem services can open the door to constituencies who are not interested in supporting biodiversity *per se* can be seen in the South African Municipality of uMhlathuze, which falls within a biodiversity hotspot. In these areas, pressures to expand development into sub-catchment areas were extremely high and politicians in the area were averse to biodiversity conservation due to the tension between conservation versus development issues. For this reason, the uMhlathuze Municipality opted to undertake a Strategic Catchment Assessment, focusing on the value of ecosystem services in the area. The study highlighted services that critical ecosystems were providing free of charge to the Municipality, such as nutrient cycling and waste management, water supply, water regulation, flood regulation, and drought management. The total value of services provided by all catchments in the area was approximately US$200 million per year. Politicians were more supportive of protecting the natural environment once they realized that the area's ecosystems, which had traditionally been prioritized for biodiversity, have considerable economic values. Thus, following the study, the Municipality embarked upon a negotiating process to identify sensitive ecosystems that should be conserved; linkages between ecosystems; areas that could be developed without negatively impacting ecosystem services; and management actions that should be implemented in order to conserve biologically important ecosystems and ensure sustainable use of biodiversity resources to benefit all residents of uMhlathuze (Slootweg & van Beukering, 2008). The ecosystem services approach applied in this case informed decision-making around development planning that resulted in actions aimed to support conservation of key ecosystems in a biologically rich area, in a situation where biodiversity alone did not present a sufficient reason to manage the area's critical ecosystems sustainably. However, it is important to note that while it was an effective strategy in this case, the use of economic valuation studies of ecosystem services has resulted in mixed outcomes with respect to their impact on policy and practice (Slootweg & van Beukering, 2008; Naidoo *et al*., 2009; Barbier, 2012). Valuation studies that are designed at the scale of decision-making and/or the scale of an imminent threat or problem, developed with local stakeholders in the context of prevailing social, cultural and political factors and challenges, and presented in ways that are useful to decision-makers, as demonstrated in the case of uMhlathuze, may have more traction with respect to influencing policies and practices. However, it is also important to note that the social importance and economic values of ecosystem services are a few among many factors that may influence negotiating and decision-making over the environment and development and, thus, regardless of how compelling the results of ecosystem service assessments or valuations may be, other factors may ultimately be given more weight.

Ecosystem-based management (EBM), with a primary focus on ecosystem services, can also help broaden constituencies and influence decision-making to support conservation. EBM is an integrated approach to natural resource management that considers the entire ecosystem, including humans, and has the goal of "maintaining an ecosystem in a healthy, productive and resilient condition so that it can provide the services humans want and need" (McLeod *et al.*, 2005). It differs from other approaches to conservation or natural resource management that focus on a single species or sector, by considering the complex interactions between humans and the living and non-living environment across multiple spatial and temporal scales (Clarke & Jupiter, 2010; Curtin & Prelezzo, 2010). While there are many ways in which EBM has been applied, a common element to EBM applications is an ecosystem services perspective (Agardy *et al.*, 2011). Thus, the protection of biodiversity for its own sake is not the primary focus of EBM, but biodiversity can benefit from the implementation of EBM approaches and, in fact, biodiversity conservation is often identified by stakeholders as an important goal of the EBM planning process. For example, the EBM framework has led to the implementation of community-based ridge-to-reef management plans in Fiji and has led to the expansion of marine protected areas throughout the Western Pacific, which have been implemented to benefit people through the ecosystems services they provide (see Clarke & Jupiter, 2010). However, these projects have also helped conserve biodiversity in places where the value of biodiversity alone may not have been sufficient to encourage conservation of critical areas. By emphasizing the social, cultural, and economic importance of ecosystems for people, the EBM approach has been shown to bring disparate groups together to collaborate (Price *et al.*, 2009) and develop management plans[5], and can persuade decision-makers to take actions that support conservation of ecosystems (Clarke & Jupiter, 2010).

3.2 OPPORTUNITY TO INCREASE THE VALUE OF AREAS PRIORITIZED FOR BIODIVERSITY

Areas can be prioritized to protect different biodiversity values such as endemism, species richness and rarity.(Brooks *et al*., 2004: Dietz & Czech, 2005; Dudley, 2008). Protected areas are specifically designated for a conservation purpose,

5 http://wcsfiji.org.fj/communities-cross-boundaries-for-conservation-in-cakaudrove/

but often generate other benefits due to the ecosystem services they provide (Dudley, 2008). Because many protected areas focus on restoring or maintaining unmodified or semi-modified areas, they are often sources of multiple ecosystem services that may be lost when natural systems are simplified. In particular, regulatory services, also known as "invisible services" because they are hard to measure and are not directly consumed by humans, tend to be among the services most impacted by such transformations and, if lost, may have high costs on society and may be extremely expensive to repair or recover (TEEB, 2010). Valuing these and other services provided by intact, functioning ecosystems can create another reason to fund and maintain protected areas, which is increasingly important as funding for biodiversity conservation becomes limited (Emerton *et al*., 2006; Turner *et al*., 2007; Turner *et al*., 2012) and growing population pressures make it increasingly difficult to maintain protected areas for the sake of biodiversity alone (Mora & Sale, 2011). For example, in a recent analysis of the economic value of one of the largest forest protected areas in the Netherlands, it was found that biodiversity conservation combined with six other ecosystem services resulted in a combined value of 2,000 €/ha/year, which was over three times the economic value generated by nearby agricultural land (Hein, 2011). During times of increasing land pressures, economic austerity, and a global human population larger than it has ever been historically, analyses such as this, that demonstrate the value of protected areas for providing multiple economic and social benefits to humanity, are critical for generating and/or maintaining broad support for their persistence.

3.3 OPPORTUNITY TO SUPPORT SUSTAINABLE MANAGEMENT OF ECOSYSTEMS OUTSIDE OF PROTECTED AREAS

Protected areas are one of the dominant tools for biodiversity conservation (Dudley, 2008), but because they cover only 12% of the planet's surface and are often under-funded, on their own, they will not conserve all of the world's biodiversity and ecological processes (Mora & Sale, 2011). Thus, we need additional approaches to complement the protected area system in surrounding areas that can sustain biodiversity and ecological processes, and also be compatible with human development.

In many cases, the importance of ecosystem services may help incentivize conservation and sustainable management of lands and waters outside of protected areas. For example, oyster reef restoration in unprotected waters has been undertaken on the east coast of the United States to improve productivity of the oyster fishery (a provisioning service), which has also enhanced other ecosystem services such as the regulation of water quality and increased the diversity of food and non-food fish species (Hicks *et al*., 2004, Grabowski & Peterson, 2007). Similarly, EBM aims to conserve ecosystem services through the sustainable management of land and water resources and by rebuilding or maintaining ecological connectivity across a site(s), which might not necessarily be configured, prioritized, or protected to maximize biodiversity as a primary objective (Leslie & McLeod, 2007), but may nevertheless benefit many species and ecosystems outside of areas prioritized for biodiversity conservation. Mechanisms such as PES also have been used to support and fund sustainable land-uses that benefit biodiversity outside of traditional protected areas. For example, the city of New York pays upland farmers in the Catskills to implement land-use practices that contribute to enhanced water quality, thereby saving the city, and hence taxpayers, millions of dollars that would have been spent on building a new water treatment facility (Daily & Ellison, 2002). While the main focus of this program is enhancing water quality through sustainable land-use management practices, improved land-use and water quality will most likely improve habitat with benefits for terrestrial and aquatic biodiversity — improvements that the biodiversity community does not have to fund (*i.e.* Pagiola *et al*., 2010).

4. CHALLENGES ASSOCIATED WITH USING ECOSYSTEM SERVICES APPROACHES FOR BIODIVERSITY CONSERVATION

Despite the increasing adoption of ecosystem services as a framework and suite of tools by the conservation community, there are still concerns over the application and efficacy of these approaches for conserving all of the components of biodiversity that the conservation community is charged with protecting. The fundamental reason for these concerns is that at their core, ecosystem services approaches prioritize those processes that contribute to *human* wellbeing. This is very different from a biodiversity conservation approach, which is concerned with identifying conservation management actions to promote the persistence of all biodiversity, including species or ecosystems that do not have an identified value for humans (biodiversity being defined as the variability among living organisms from all sources including inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (CBD[6], 2012; Margules & Pressey, 2000, Possingham *et al*., 2001). If ecosystem services approaches are applied by conservation planners and managers to achieve biodiversity conservation outcomes, three areas may require special attention: species without utilitarian or economic value; ecological processes that do not directly benefit people; and the ecological functions that may be undermined amidst attempts to optimize key services.

4.1 ECOSYSTEM SERVICES APPROACHES MAY NOT CAPTURE CRITICAL SPECIES

While the use of ecosystem services approaches can result in the sustainable management or protection of a considerable number of conservation 'targets' (*e.g.* species, ecosystems), it is unlikely to capture all of them. This is because valuing eco-

6 CBD, Convention on Biodiversity (2012), http://www.cbd.int/, accessed April 15, 2012

systems for the services they provide to people will likely result in enhanced conservation for only those species that are ecosystem service providers (Luck *et al*., 2009). While this will be beneficial for some species and habitats (*e.g.* species that are pollinators or pest regulators; species or habitats with cultural value), many taxa that do not provide services that are 'useful' or 'valuable' to people will not be prioritised and, as such, may not benefit from ecosystem services approaches. Research has shown that rare or endemic species often do not have an important functional role in a community as common species play the dominant role in the system (Cardinale *et al*., 2006; Naeem, 2012). These less common species may not receive adequate attention if ecosystem services approaches are employed, but these are the very species that are often viewed as the most important targets for biodiversity conservation (Garnett *et al*., 2011; Watson *et al*., 2011a,b).

Maximising species diversity is another common target in conservation planning (Klein *et al*., 2008; Watson *et al*., 2011a,b) and there is increasing evidence to show that while species richness is positively correlated to a number of ecosystem processes (and an increase in ecosystem processes leads to enhanced provision of ecosystem services), the increase in ecosystem processes often reaches a plateau at moderate levels of species richness (Balvanera *et al*., 2006). When considered spatially, there is also a lack of spatial concordance between some important ecosystem services (*e.g.* carbon, water) and species richness measures (Naidoo *et al*., 2008; Venter *et al*., 2009). The lack of clear, consistent spatial relationships between species richness and ecosystem services provisioning highlights a generic weakness in solely applying ecosystem services approaches because the most species-rich sites may not necessarily be those prioritised to maximise ecosystem services (as moderately species-rich areas may be of equal value) (Cardinale *et al*., 2006).

4.2 ECOSYSTEM SERVICES APPROACHES MAY NOT PRIORITIZE ECOLOGICAL PROCESSES THAT DO NOT DELIVER BENEFITS TO PEOPLE

A related concern is that the ecological processes that generate the goods and services valued by humans are not identical to those processes required for the long-term conservation of biodiversity (Dunn, 2010). Thus, approaches that solely value those ecological processes that provide services that support human wellbeing are likely to lead to situations where other critically important ecological processes are not prioritised. This may have serious ramifications for biodiversity. The management of fire for ecosystem services versus biodiversity conservation is a good example of this. In many countries, such as the United States of America, Australia, and Israel, fire is a serious threat to human life and infrastructure (Gill & Stephens, 2009), but it is also a critical ecological process for many species (Driscoll *et al*., 2010a,b). It has been shown that the fire regimes designed to reduce the chances of negative impacts on humans are often inappropriate for native biodiversity and can lead to major changes in community structure, including a substantial risk of extinction (Fisher *et al*., 2009b). Other examples include flooding and disease outbreaks – both of which play key roles in ecological dynamics but are often the subject of efforts to eliminate them (Brouwer *et al*., 2007).

4.3 OPTIMIZING A SINGLE SERVICE MAY UNDERMINE BIODIVERSITY OR CRITICAL ECOLOGICAL FUNCTIONS

A considerable concern exists around the fact that many PES programs have been implemented to enhance one rather than multiple services. If not planned well, with a consideration of potential trade-offs, this approach could come at the expense of biodiversity. For example, maximizing carbon sequestration through tree plantations could result in the loss of ecosystem functions related to water quantity (stream flows), soil health (salinization and acidification) and biodiversity (Jackson *et al*., 2005). While the policy mechanism known as Reducing Emissions from Deforestation and Degradation+ (REDD+) was designed to address many of the concerns associated with the perverse environmental impacts of the Clean Development Mechanism (CDM), many conservationists and practitioners have been concerned about the risks of REDD+ on biodiversity. These risks include the concerns that decreasing deforestation in high carbon forests may shift natural resource use to low-carbon forests or non-forest ecosystems of high biodiversity value; may result in agricultural intensification through methods that are harmful to biodiversity; and/or may result in the use of forest management methods that promote the growth of high-yield or non-native species (Epple *et al.,* 2011). However, at the 16th Conference of the Parties in December 2010, parties to the United Framework Convention on Climate Change (UNFCCC) adopted the decisions known as the Cancun Agreements, which include a list of safeguards for REDD+ that address the potential negative environmental impacts associated with REDD+ and affirm that the implementation of REDD+ activities should be carried out in accordance with these safeguards (UN-REDD, 2010). The broader ecosystem services community is also working to address potential perverse outcomes of single service PES programs on biodiversity through approaches like "bundling" and "stacking", which aim to create financial incentives for conserving multiple ecosystem services and/or biodiversity and to promote more holistic ecosystem management practices (Fox *et al.,* 2011; Cooley & Olander, 2011; Deal *et al.,* 2012) .

In general, PES programs that preserve existing ecosystems are likely to have the greatest positive impact on biodiversity, along with those programs that aim to restore degraded ecosystems. In contrast, PES programs that encourage the substitution of one agricultural land use for another may have lower benefits for biodiversity (Pagiola *et al.*, 2010). However, it is important to note that, as in the case with REDD+, the impacts of PES on biodiversity through leakage (*i.e.* displacement of activities from one site to another) could lead to potential negative impacts on biodiversity offsite. So, as with any natural resource management based approach, the benefits and risks of a tool, like PES, for ecosystem services management and biodiversity conservation must be considered carefully before being implemented. Ideally, a biodiversity and ecosystem services tradeoffs analysis would accompany the design of any PES project or other ecosystem services project aimed at enhancing one or several ecosystem services.

5. CONCLUSIONS

Many ecosystem services approaches represent new opportunities for the sustainable management of species and ecosystems. However, it is important to recognize that while biodiversity is intimately connected to ecosystems services through various relationships (Mace *et al.*, 2012), ecosystem services approaches and biodiversity conservation approaches may be complementary, but are not always identical pathways for achieving conservation or sustainable natural resource management. In many cases, the two approaches will be compatible and mutually reinforcing, delivering positive results for conservation targets, even if biodiversity was not the original or primary objective, and vice versa. However, it is important to understand the conditions in which these two approaches do not lead to the same outcomes so that increasingly scarce resources for biodiversity conservation may be used to target those elements of biodiversity that may not be conserved otherwise. This divergence in outcomes is most concerning with respect to species, ecosystems, and ecological process that may fall through the cracks of ecosystem services frameworks, particularly very rare or endemic species that may not play important functional roles in an ecosystem. When utilising ecosystem services approaches for conservation, planners and managers must be realistic and recognise that these approaches are not all-encompassing and there are going to be gap species, ecosystems, and ecological processes whose conservation will require tools tailored to address those issues.

Unfortunately, application of strict conservation approaches has not resulted in the achievement of many of the world's global conservation targets: none of the CBD targets for 2010 were met and species and ecosystems are declining more rapidly than ever. Thus, it is clear that in addition to the continued use of proven conservation tools such as protected areas, additional approaches will be necessary to achieve future conservation targets. Ecosystem services approaches have the potential to contribute significantly to achieving many conservation goals. The conservation and ecosystem services communities still have much to learn about the most effective and strategic application of these tools for conserving biodiversity and sustainably managing ecosystem services. But, at this stage, it is important to recognise the potential of ecosystem services approaches to contribute to biodiversity conservation and to complement other conservation tools and methods, while recognizing that there will be limitations to using ecosystem services approaches for achieving certain conservation targets, such as the protection of rare species, endemic species, and species or habitats without utilitarian value. Thus, we will continue to need focused biodiversity conservation approaches alongside new and evolving ecosystem services approaches if we are to conserve the full range of genes, species, and ecosystems that are important for all life on earth. .

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