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Current Opinion in Environmental Sustainability

Biodiversity targets after 2010

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The bold commitment made by the world's governments to reduce the rate of biodiversity loss by 2010 will soon be tested. On the basis of the continuing declines measured by most indicators, it now seems inevitable that the outcome will be that it has not been achieved. Here, in order to build on the momentum created by the 2010 target, we propose a shift away from a large set of static targets towards a smaller number of specific targets. Specifically, we present three categories of targets (red, green and blue) with examples of each. These relate respectively to (1) those biodiversity outcomes that must be avoided to avert situations that are deleterious for people, (2) the highly valued biodiversity conservation priorities, and (3) an improved scientific understanding necessary for adaptive management now and into the future.

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Current Opinion in Environmental Sustainability 2010, **2**:1–6

This review comes from a themed issue on Terrestrial systems
Edited by Anne Larigauderie and Harold A. Mooney

1877-3435/$ – see front matter

DOI 10.1016/j.cosust.2010.03.003

Introduction

The Convention on Biological Diversity (CBD) defines biological diversity as, 'the variability among living organisms from all sources including ... 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'. Biodiversity sustains all life processes and contributes directly to human well-being by supporting the production of foods, fuels, fibres and genetic material; by providing educational, intellectual and recreational opportunities, aesthetic and spiritual enjoyment; and by reducing the risks posed by environmental change. Biodiversity is necessary to keep open options needed to secure future human well-being. Of course biodiversity also affects human well-being in negative ways; weeds, pests and pathogens all impose significant costs on people. In general however, it is widely appreciated that biodiversity loss and ecosystem degradation jeopardize human well-being both now and in the future [1].

This problem was first formally recognized with the establishment of the CBD at the Earth Summit in 1992, and advanced substantially in 2002 when governments committed to work towards an international goal to reduce the rate of biodiversity loss by 2010 [2]. The '2010 target' has become an important political commitment by almost all nations for improved biodiversity conservation and management.

How is the world doing in relation to the target? As we enter the year 2010 it is becoming clear that the target will not be achieved, but also that we set a goal that was vague and difficult to measure, and was inconsistent with conservation and development trajectories. Here, we propose revisions to develop biodiversity targets that are more likely to stimulate constructive actions, are amenable to tracking using unambiguous metrics, that reflect priorities relevant to the health and well-being of people and that recognise that biodiversity change involves both costs and benefits.

Progress to 2010

A great deal of work has gone into promoting the 2010 biodiversity target, developing indicators, indicator measures and gathering data (see http://www.twentyten.net/). Biodiversity is a broad concept, and the headline indicators selected by the Parties to the CBD in 2004

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focused around seven focal areas within which the current set of indicators have been planned (Status and trends of the components of biodiversity, Sustainable use, Threats to biodiversity, Ecosystem integrity and ecosystem goods and services, Status of traditional knowledge, innovations and practices, Status of access and benefit sharing, and Status of resource transfers); six of the focal areas now have indicators and/or metrics developed or under development [3]. However, few of the selected indicators and measures have been assessed for rigour and relevance, and many have been selected primarily because the data are available [4]. New data gathering is underway, but often a 'quick-and-dirty' approach has been adopted in order to have something to report by 2010. A developing interest in the target from the scientific community [2] led to suggestions for new approaches and indicators [5–8] but these efforts could not be incorporated into the formal programme of the CBD, and so gaps remain [3]. Nor have preparations for reporting biodiversity change begun to take account of the developing body of work on indicators of the impact of biodiversity change on human well-being, or extending economic measures of performance, such as those associated with the system of national income accounts, to include changes in the value of environmental assets [9,10].

Given the rather short time since 2002 and the broad scope of the 2010 target, it is not surprising that as we reach the year 2010 reporting is likely to be somewhat limited in scope and relevance. While a great deal of data and activity has been generated, it is unclear whether we will really have better information to support improved biodiversity and ecosystem management after 2010. Yet crucially, and regardless of the measures used and the data to hand, evidence from various global and regional assessments shows that in most places and for most systems studied current rates of biodiversity loss are at least continuing and often accelerating, largely because the major drivers of biodiversity loss persist, often at increasing intensity [11]. Amongst these, climate change and the expansion of biofuel production are now adding to the burden already imposed by invasive species, overexploitation, pollution, and by habitat conversion and fragmentation caused by land use changes. The relative importance of different drivers and their impacts vary widely, but the positive feedbacks and synergies between them make it inevitable that the overall rates of biodiversity loss will continue to increase. Therefore, considering biodiversity overall we have to conclude that in the aggregate the 2010 biodiversity target will not be met at a global level [4,11] and indeed it is questionable whether the target, as stated, could be met anytime in the near future. Here, we review some problems with the 2010 target and then suggest a more constructive process for the post 2010 period.

Targets after 2010

The current CBD 2010 target is (in full), 'to achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level as a contribution to poverty alleviation and to the benefit of all life on Earth' (www.cbd.int/2010-target). There are several features that make this problematic as an objective for the global community. First, it is framed negatively; as stated the aim is to reduce the current rate of loss; in effect to simply stop doing quite so badly. Thus it is not necessarily going to encourage positive actions of the kinds that might have been in the minds of those that devised it. Apart from being negative, it is extremely vague about timescales, baselines, acceptable rates and measures, as well as having some perverse incentives and unintended consequences. For example, the target is hardest to achieve in the places where attention should be most strongly focused, such as those where high levels of biodiversity are just beginning to be converted or exploited. It is easiest to achieve in cases where biodiversity is already so depleted that rates of loss can only decline. For many reasons therefore, although it is a simple, bold and visionary goal it is difficult to work with in practice. Moreover, even if the target was shown to have been met in certain cases, it is not clear that this would necessarily indicate that the world was headed on a better path for biodiversity and ecosystem management.

Ideally, the target would be framed in terms of an agreed long term vision for global biodiversity [4,12,13]. The current target relates most closely to a vision that global biodiversity is maintained in the aggregate at some level close to what it was at the end of the 20th century. While this might be acceptable to some as a general conservation goal, it is almost certainly not achievable for several reasons. As with climate change, inertia in the system ensures that biodiversity loss will continue regardless of present decisions. Even if all deleterious anthropogenic impacts were now halted, the legacy of the recent past has yet to be realised [14]. Furthermore, continuing human population growth and development means that pressure on land and sea for provisioning ecosystem services such as food, fuel, and timber production will continue to increase [15]. Given these pressures, the demands for other ecosystem services such as regulating and cultural services from ecosystems will be even greater in the future than in the past, but the means to satisfy them will be reduced, especially under continuing environmental change [16]. Additionally, even if it were achievable, the formulation of the current goal does not embrace the possibility that for some taxa and systems, declines relative to the starting point might be necessary or desirable.

We suggest that key elements of a revised set of targets will be to establish mechanisms to ensure that the global interest in local biodiversity change is properly represented to avoid the type and magnitude of

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biodiversity change that threatens human well-being. This includes securing the current and future supply of ecosystem services as well as meeting broader needs that society has for biodiversity. We suggest that the overall target be reformulated along the following lines:

To avoid undesired and dangerous biodiversity change and to strengthen the role of biodiversity in securing and enhancing the benefits that people derive from ecosystems

This target includes both a reactive component that highlights the seriousness and the urgency of the situation pointing to what should be addressed first, as well as a positive aspiration, clearly reflecting what needs to be done. For society to move towards realising this target, we recommend the development of a small set of focused, relevant, efficient and achievable sub-targets. Each of these sub-targets should have scientifically and socially appropriate outcomes and timescales, support biodiversity's role in human well-being, be linked to legislative and regulatory processes, be relevant at global scales but reflect local and national interests, and be open to accurate and efficient reporting.

Design features for sub-targets

Societies value different aspects of biodiversity. Here we emphasise two key roles that are different though overlapping. The first is the role that biodiversity plays in underpinning ecosystem services—the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control, and cultural services such as spiritual and recreational benefits [17].

There are many demonstrated positive effects of biodiversity on the provision of ecosystem services, both direct and indirect through ecosystem processes [18,19] and diversity at several levels also provides insurance against the deleterious effects of environmental fluctuations [20–22]. There is now therefore abundant evidence that the biodiversity in an ecosystem significantly influences its ability to deliver a broad range of services. Under continuing environmental change the impacts of biodiversity loss will be more severe [16]. The precise ways in which different dimensions of biodiversity play a role in ecosystem processes and services are continuing to be better understood; recent work for example has showed the important distinction between the variability component of biodiversity, which is important for the resilience and adaptability of ecological systems, as well for many cultural benefits, compared with the role of the composition component of biodiversity (the presence and abundance of certain types of species) in many provisioning, cultural and regulating services [23]. But the strong conclusion is that biodiversity is central to maintaining ecosystem services [24].

The second role of biodiversity relates to the consequences of its loss for many who value nature for its own sake. Biodiversity conservation generally prioritises the protection and viability of wild species and habitats. While many of the goals of biodiversity conservation will certainly benefit ecosystem services, it is not clear that these two sets of priorities will necessarily be the same. For example, biodiversity conservation priorities generally focus on large-bodied species of birds and mammals, and on areas of high species richness and habitat diversity. Yet many ecosystem services may depend on cryptic organisms in soils and oceans, and on low diversity areas (such as the boreal and tundra regions). Many ecosystem services may also depend more on species composition, functional diversity or even biomass than on measures related to species richness which tends to underpin the conservation agenda. Rather than assuming that these two biodiversity roles will overlap, we recommend making the goals of each clear in order to encourage a positive discussion about how to establish and maintain the right balance between them.

A complication is the fact that while biodiversity is often managed and valued locally, the consequences of its alteration and loss are often felt more strongly regionally or even globally. Different societies place different values on the various elements of biodiversity and the current 2010 target does not distinguish between countries aiming at a different balance between conservation and development. The overall target needs to be sufficiently flexible that different countries can develop appropriate local and national sub-targets that meet their own aspirations and needs, yet contribute to agreed global priorities.

A difficult area concerns the insurance value of biodiversity. Many will argue that in an uncertain world, a key concern will be to maintain biodiversity so as not to foreclose any options open to future generations. This would entail a goal of no overall loss of biodiversity. While probably desirable we suggest this is unlikely to be achievable and as a goal it could conflict with other priorities. To a large degree the insurance value argument exists because of gaps in our understanding of biodiversity and ecosystem processes. Under uncertainty it is always prudent to be precautionary and to risk little. We anticipate that in the longer term, improved knowledge and understanding will enable biodiversity and ecosystem management strategies to be efficiently and effectively designed and will alleviate the pressure to maintain all options.

Examples of specific sub-targets

Considering the current focal areas supported by the CBD and the discussion about how and why biodiversity

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Box 1 Categories of biodiversity targets

Biodiversity matters to people in different ways. It directly underpins certain ecosystem functions and services, it contributes to aesthetic and cultural values, and it is a part of the sustainable life support system upon which all life ultimately depends. Urgent versus important priorities under each of these headings will not be the same. Choosing among them will benefit from a clear articulation about why certain choices have been made. Here we define the three different categories of sub-targets. These are not mutually exclusive, but can be used to classify targets according to their primary motivation. This classification should help decision-makers to clarify priorities among competing agendas, as well as to focus the science-based management strategies appropriately (see text for more details and examples).

1. **Red targets**—addressing biodiversity change that is directly harmful to people. Red targets are designed to avoid or avert urgent and unacceptable changes in biodiversity that will be damaging to people in the near term. They largely map onto the biosecurity agenda.
2. **Green targets**—conserving biodiversity components valued by society for non-utilitarian purposes. Green targets will focus on long term priorities for the conservation of biodiversity often focusing on species and habitats. They largely map onto the conservation agenda.
3. **Blue targets**—understanding and governing the system. In the long term, sustainable management of the biosphere depends on knowledge of the underpinning processes and an effective system to manage it. Blue targets focus on steps in progress towards this end.

matters to people, it is clear that there are some fundamentally different kinds of concerns. Here we describe three different categories of sub-targets that explicitly recognise these different agendas (see Box 1).

Red targets—addressing biodiversity change that is directly harmful to people

First, we consider cases where the current biodiversity change is directly and immediately harmful to people. Certain biological systems or processes must be maintained, restored or managed better in order to avoid deleterious or damaging consequences. We refer to this category of sub-targets as 'Red targets'. They are designed to avoid or avert unacceptable changes in biodiversity that will be damaging to people in the near term and that we need to urgently prevent. Some examples of cases where the impacts on people are already potentially dangerous include those relating to food; human, animal and plant health, and natural hazards. Case studies of dangerous changes have been well documented: for example, the collapse of marine fisheries [25,26], the loss of keystone species leading to trophic collapse and changes to particular ecosystems that affect people everywhere [27–29], the eutrophication of water bodies leading to freshwater fouling and dead zones in coastal regions [30], loss of coastal protection against storm or wave damage [31], the emergence of infectious zoonotic diseases that threaten global human health [32] and changes to intact functioning forests that contribute to regional and global climate change [33–35]. So far, responses have been largely reactive to deleterious biodiversity change, but a process comparable to that used to identify dangerous change by the UNFCCC [36] could help to clarify the important processes and manage them proactively. Sub-targets around these kinds of issues could be developed and have the advantage that they could be meaningfully reflected at regional or national levels.

Green targets—conserving biodiversity components valued by society

Second, there are a set of global concerns relating to conservation of biodiversity that are driven not by the immediate threat of harm, but by the positive long term value that biodiversity has and that transcends national boundaries. In some cases, natural area management and conservation practice is dedicated to protecting biodiversity that is valued by global society for its natural beauty, aesthetic value, inspirational or cultural importance, regardless of any economic or resource value. There are typically well defined biodiversity elements that each society has cared for and continues to cherish. We refer to this category of sub-targets as 'Green targets' and they include the elements of biodiversity that society values and wishes to retain.

Conservation targets need to be more ambitious than the rather modest general target to 'reduce the rate of loss', which in some circumstances may already be met, but is probably inadequate compared with what society would choose. We suggest developing targets that would attract international support, meet many people's aspirations for nature conservation, and also contribute to broader ecosystem-level management goals. Examples of green targets might include criteria for improved habitat condition in key existing protected areas of international importance (e.g. the Great Barrier Reef, the unique biota of Madagascar and the surrounding Indian ocean islands, the biodiverse south east Asian forests, or the Serengeti ecosystem), or enhanced conservation success in some key taxonomic groups. For example, a sub-target for no more bird extinctions is probably close to achievable, would attract wide support and if achieved would have many associated side-benefits, as would conserving the great whales, or terrestrial top carnivores or large mammalian grazers.

Blue targets—enabling understanding and governing the system

Finally, there are a set of enabling targets that are necessary to successfully define and manage the red and green targets. Managing any system ultimately relies both on understanding its components, processes and dynamics, and on a system of governance that makes it possible to use that understanding. The biosphere is currently neither well-understood, nor effectively governed. There are key gaps in knowledge that need to be filled. We

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suggest a set of research-based targets to prioritise and focus the science agenda and monitoring effort, and a set of targets for the governance of the biosphere. We refer to this category of targets as 'Blue targets'. They address the conditions needed to implement the overall goal of protecting the global public interest in biosphere change.

Among the scientific gaps are a set of key concerns around thresholds and tipping points in the earth's systems [37,38] and these concerns are especially important in the case of ecosystem processes and biodiversity [17,39]. Ecosystem change is inevitable and sometimes desirable, but ecosystem functions are often scale-dependent meaning there are limits in the extent, or the size of individual fragments, below which functions and services will be compromised. In many cases, ecosystem functions are crucially dependent on different aspects of biodiversity. While being quite commonly observed, the processes that lead to regime shifts and unexpected changes in ecosystems are poorly understood [40] though evidence emerging that they may be predictable at least in well-monitored systems [41]. Without the knowledge of the processes however it will always be hard to predict the minimum area, quality or intactness that specified ecosystems must retain in order to deliver the services we require of them. To maintain intact ecosystems safely above the minimum threshold for area or quality, or to restore the function when the threshold has already been transgressed will be possible only with improved knowledge and understanding of the dynamics of the system. Priorities for this research could for example focus on critical thresholds for local climate regulation feedback processes in forests [42,43], protected areas coverage and quality that are effective for wildlife conservation [44], or the features of lake systems that lead to altered ecological function in relation to biotic and abiotic changes where there may be scale-dependent reversibility [45].

Another area for blue targets would be to establish rates of change that exceed adaptive capacity with the ultimate aim of restricting the rate of extrinsic change to systems being within their adaptive capacities. Change is not always undesirable and importantly will support biodiversity generation. Biotic communities can persist in the face of change given the opportunity. The problem arises when the rate of change exceeds the capacity for components of the ecosystem to adapt [46]. Adaptation can occur by different processes, and biological, social and physical processes will have their own limits in terms of maximum sustainable rates of change [17,47]. Rates of change become especially dangerous when they jeopardise the ecological processes that support ecosystem services.

Conclusions

We hope that the these proposals will contribute to the international debate and policy development that lies ahead, and, in particular, to the on-going work towards the new strategic plan of the CBD. We recognize that the complexity of the technical issues as well as the intricacies of the intergovernmental and international processes which mean that progress will necessarily be quite slow. Nevertheless, the accelerating biodiversity crisis should demand urgent action. The development of achievable targets that provide rewards to society will require enhanced science-policy interactions [48], as well as improved mobilisation of relevant data and knowledge [17,49]. Importantly, however we suggest that the classification of targets presented here can help to distinguish the science needed to achieve the targets from the decisions over agreed priorities. To firmly ground such political action in biodiversity science, we believe that this framework provides a general science vision that can define a set of evolving targets that highlight urgent issues but also maintain public relevance, scientific and social interest, and which can be adapted to regional and national levels. Developing such a comprehensive new vision will be a key step towards maintaining biodiversity and sustainable ecosystems.

Acknowledgements

This paper arose from discussions led by DIVERSITAS. We thank the funding agencies, which through core support to DIVERSITAS made these discussions possible at meetings of the Scientific Committee of DIVERSITAS. We also thank David Cooper for constructive and informative discussions.

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Please cite this article in press as: Mace GM, et al. Biodiversity targets after 2010, Curr Opin Environ Sustain (2010), doi:10.1016/j.cosust.2010.03.003