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Biodiversity Monitoring and Conservation

Bridging the Gap Between Global Commitment and Local Action

Edited by Ben Collen, Nathalie Pettorelli, Jonathan E. M. Baillie and Sarah M. Durant

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Biodiversity Monitoring and Conservation

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1

Biodiversity Monitoring and Conservation: Bridging the Gaps Between Global Commitment and Local Action

Ben Collen[1], *Nathalie Pettorelli*[1], *Jonathan E.M. Baillie*[2] *and Sarah M. Durant*[1]

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Why a book on biodiversity monitoring and conservation?

As the impacts of anthropogenic activities increase in both magnitude and extent, biodiversity is under increasing pressure. Habitats available to wildlife have undergone dramatic modifications, and significant biodiversity has already been lost over modern times, while we are yet to experience the full impacts of anthropogenic climate change (Mace *et al*., 2005; Dawson *et al*., 2011; Pereira *et al*., 2010b). Over the past few hundred years, humans have increased species extinction rates by as much as 1000 times compared with background rates that were typical over Earth's history (Regan *et al*., 2001; Millennium Ecosystem Assessment, 2005), and accelerating increases in anthropogenic pressures on biodiversity may further increase species extinction rates (Balmford and Bond, 2005). In developing means to address these challenges, scientists are hampered by a lack of information on biological systems, particularly information relating to long-term trends, which is crucial to developing an understanding of how these systems may respond to global environmental change. Such serious knowledge gaps make it very difficult to develop effective policies and legislation to reduce and reverse biodiversity loss.

A further impetus for conservation action has been gained through an increasing realization that declines in biodiversity have detrimental impacts on ecosystem structures and functions as well as human well-being, particularly for the world's most

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marginalized and impoverished communities (Millennium Ecosystem Assessment, 2005). Biodiversity provides many products – often plants, animals, and fungi – that directly contribute to incomes and human livelihoods. Biodiversity also provides genetic resources for the pharmaceutical industry, which can be key in maintaining human health, while the growth of nature tourism has meant that biodiversity conservation has become a major contributor to many national economies, including those of some of the world's poorest countries. As well as delivering these ecosystem services, biodiversity underpins the functioning of ecosystems, and hence the delivery of services such as access to fresh water or climate regulation. Biodiversity is therefore key to security, resilience, social relations, and human health and hence affects people not only by way of material livelihoods and macroeconomics.

In order to counter global biodiversity loss and consequent impacts on human well-being, there have been several recent high-profile international political commitments to improve biodiversity conservation. These have mainly consisted of goal setting, in the form of conservation targets to which governments, decision-makers, and the international community are committed; the most notable example of which are the targets set by the Convention on Biological Diversity (CBD; Convention on Biological Diversity, 2011; UNEP, 2002). However, because of the complexity of biological systems, and a lack of long-term biodiversity data, nations are hampered not only in assessing progress towards such targets, but also in developing appropriate policy and legislative responses to reverse biodiversity declines.

Global commitments to stemming biodiversity loss have contributed to the development of methods to track changes in many metrics of biodiversity, and addressing biodiversity information requirements has become one of the fastest growing areas of research in the field of conservation biology. This information is critical for increasing our understanding of the manner in which biodiversity is changing, and how changes can be influenced and reversed. It is also required for setting priorities for biodiversity conservation, such as protected area placement (e.g., Araújo 1999; Possingham *et al.*, 1993; Rodrigues *et al.*, 2004), species and ecosystem priority setting among the many deserving causes of conservation attention (e.g., Isaac *et al.*, 2007; Myers *et al.*, 2000), and for the biodiversity assessments required to provide the data for such activities (Baillie *et al.*, 2008; Collen *et al.*, 2012; Mace *et al.*, 2008; Pereira *et al.*, 2010a).

The process of reversing decline in biodiversity, at the outset, might appear straightforward. We should simply measure what is happening to the components of biodiversity that we wish to conserve; put in place conservation actions to counteract declines in the taxa and places that are changing most rapidly, or which we are least willing to lose; monitor and evaluate the impacts of these actions; and continue to manage adaptively. Yet our first collective attempt to measure and slow biodiversity change (the Convention on Biological Diversity 2010 Target) met with almost universal agreement that we had failed (Butchart *et al.*, 2010; Convention on Biological Diversity, 2010). That there were only eight years between the agreement of that target ('to achieve, by 2010, a slowing in the rate of biodiversity loss') by parties to the CBD, and the deadline by which a change should have taken place, must at least partly explain why we failed to meet this target. Even with the strongest political will, a substantial slowing in biodiversity declines would not have been possible in the timeframe, unless the many and complex underlying drivers of decline were effectively tackled.

It has become clear though, in the myriad of post-2010 papers, reports, and evaluations, that there are some problems in the overall approach. First of all, the target set was not action orientated, nor tied to appropriate activities from which the impact of changing pressures on biodiversity could be measured. This has to some degree been addressed in the newly agreed Aichi Target and Strategic Plan for 2020. Secondly, there appeared to be a disconnection between these laudable global commitments to improving the status of biodiversity, and the local-scale action required to ultimately ensure their achievement. From a research perspective, there has been a focus on identifying the most effective means to generate the metrics of biodiversity required to measure significant change (Dobson, 2005; Mace and Baillie, 2007), and how best to fill the many gaps in biodiversity data (Collen *et al*., 2008; Pereira and Cooper, 2006). However, from a policy perspective it remains unclear how global targets should be harmonized with the many national responsibilities to biodiversity conservation and vice versa (Jones *et al*., 2011; Nicholson *et al*., 2012). Moreover, from a practical perspective there is a need to better coordinate biodiversity monitoring and conservation, at all scales, for increased efficiency and greater impact.

As the Aichi Target becomes agreed and implemented, it is extremely timely to reflect not only on lessons learned from the 2010 targets, but also on how we might better integrate national and global biodiversity monitoring and indicators over the coming decade. Such complex policy objectives present many challenges to conservation scientists and policy-makers alike. A key issue is how best to monitor progress towards such global-scale targets. There is also growing recognition of a need for biodiversity monitoring at a national, as well as a global scale, and better coordination between different monitoring approaches so as to make optimal use of all forms of biodiversity data. Although several indicators have been developed for use at the global scale, the data on which these indicators are based frequently come from monitoring schemes carried out with quite different objectives than monitoring global biodiversity change. While a dedicated global monitoring system may be ideal, would it be prohibitively expensive? Might a more cost-effective solution be to implement monitoring at a national scale, according to national priorities, and aggregate national measures to a global indicator? The scale at which monitoring takes place may need to be taken into account when assessing progress towards both global and national targets. At the local level, the theory of optimal monitoring is advancing fast; focusing on how best to allocate limited resources in the face of the inevitable trade-offs between monitoring and intervention, and explicitly considering uncertainty. This approach could potentially be applicable to promote more cost-effective monitoring across larger regional or national scales.

In this book, which results from a symposium held at the Zoological Society of London in summer 2009, we have addressed two key themes in biodiversity conservation and monitoring, bringing together insights from science and policy spheres: evaluating a variety of approaches to biodiversity monitoring that could help to provide indicators at national to global scales, and the steps needed to reduce the barriers for successful implementation of such approaches. Specifically we have focused on addressing challenges faced by countries in meeting their obligations under the biodiversity conventions, particularly CBD, and to help bridge the gap between international commitments and local action. We have structured this book around four areas: first, we examine the use of species-based indicators, and what they can tell us about the status and trends of several important metrics directly related to the overall health of biodiversity (Balmford *et al.*, 2005; Green *et al.*, 2005). These chapters describe how each measure of change in status might be appropriately used at the national level. Second, we evaluate indices of the extent and magnitude of threatening processes and the drivers of biodiversity loss, and how they might provide knowledge of how and where to prioritize conservation action (Mace and Baillie, 2007; McGeoch *et al.*, 2010). These indicators are in general far less well developed than their biodiversity counterparts, and these chapters identify opportunities for their further development and implementation over the coming decade. Third, we examine indices of important components of biodiversity that are amenable to monitoring but are not yet being widely measured, and how they can contribute to future understanding of biodiversity change. Finally we explore how best to ensure that global commitment to biodiversity conservation and monitoring is aligned with local and national action. We focus on terrestrial biodiversity for this book, although many chapters are also relevant to the marine environment.

Biodiversity and human well-being

Societies value many different aspects of biodiversity. We concentrate here on two roles. Firstly, there is a view that biodiversity should be valued for its own sake. The simple existence of species, populations, and habitats is deemed a sufficient enough justification for their continued protection. Secondly, there is a growing more utilitarian view of our natural world. Biodiversity underpins the functioning of the ecosystems on which humans depend for a variety of services including food and fresh water, health and recreation, and protection from natural disasters. Current trends of biodiversity loss are thought to be endangering these services, such that continued loss may bring us to a point where the capacity of ecosystems to provide these essential services is catastrophically reduced (Diaz *et al.*, 2006; Mace *et al.*, 2012). Marine biodiversity loss, for example, is increasingly impairing the ocean's capacity to provide humans with food, maintain water quality, and recover from anthropogenic perturbations (Worm *et al*., 2006). As well as being detrimental to human well-being, biodiversity loss is costly for society as a whole, particularly for economic actors in sectors that depend directly on ecosystem services. For example, insect pollination in the European Union (EU) has an estimated economic value of €15 billion per year. The continued decline in bees and other pollinators could have serious consequences for Europe's farmers and agribusiness sector (Gallai *et al*., 2009; TEEB, 2010), and, ultimately, for our ability to feed ourselves. The conservation of biodiversity also makes a critical contribution to moderating the scale of climate change and reducing its negative impacts on the functioning of ecosystems. This makes biodiversity loss the most critical global environmental threat alongside climate change; and these two threats are inextricably linked.

It has been suggested that effective conservation requires addressing three fundamental questions (Salafsky *et al*., 2002), namely:

- what should our goals be and how do we measure progress in reaching them?
- how can we most effectively take action to achieve conservation?
- how can we learn to do conservation better?

The effectiveness of biodiversity conservation therefore depends on our ability to define, measure, and monitor biodiversity change, and on adaptive responses to biodiversity loss of a wide group of stakeholders and actors, including governments, local communities, and international society. Yet ensuring that appropriate monitoring systems are in place and translating monitoring results into effective conservation on the ground remains a major global challenge for a number of reasons, including financial and technical capacity constraints and policy and legal barriers.

It should also be noted that biodiversity conservation is ultimately implemented by humans for human society, be it for economic, cultural, or other reasons. Biodiversity conservation is thus inextricably linked to human behaviour. Its effective implementation therefore also depends on a sound understanding of the influence that social factors (such as markets, cultural beliefs and values, laws and policies, or demographic change) exert on human interactions with the environment and choices to exploit or conserve biodiversity (Mascia *et al*., 2003).

Species-based indicators of biodiversity change

Biodiversity comprises a range of features that are important for evolution and the effective functioning of ecosystems. These features include species richness, ecological diversity, genetic diversity, phylogenetic diversity, and functional diversity. It can be argued, however, that the natural units of biodiversity conservation are species (Agapow *et al*., 2004), and the severity of the extinction crisis is frequently expressed in terms of number of species lost (e.g., Collen *et al.*, 2010; Regan *et al.*, 2001), threatened (Hilton-Taylor *et al.*, 2009), or depleted (Loh *et al.*, 2005). There are three key metrics that are generally thought to reflect the conservation health of a given species, or set of species. These are geographical range size, population abundance, and variation in genetic diversity. During biodiversity indicator development, all have been evaluated to some degree or another. However, the lack of broad-scale data on genetic diversity has meant that indicators of genetic health have been largely limited to a handful of domestic species (Walpole *et al.*, 2009), while indicators of change in geographical range size while feasible, have been fraught with the vagaries of primary occurrence data, and moreover have limited sensitivity to population change (Boakes *et al.*, 2010). Abundance data, be they one-off measures of population size, or measures of change in abundance over time, are particularly appropriate for use as relatively sensitive measures of change (Collen *et al.*, 2009; Pereira and Cooper, 2006). While the compilation and development of indicators of such metrics has been mixed, many are a component of aggregated measures of extinction risk of species. Measuring the relative risk of extinction of a species or set of species is a measure that has been tackled by many, but pioneered by the International Union for the Conservation of Nature (IUCN) for its Red List (IUCN, 2001; Mace *et al.*, 2008; Mace and Lande, 1991). By evaluating the symptoms of risk, a composite measure of relative risk of extinction can be evaluated, regardless of the taxonomic affiliation of the species.

The three chapters in Part I of this book consider three different aspects of indicators of change currently used to assess the status of species. Chapter 2 evaluates how an index of relative extinction risk of species can be used as a biodiversity indicator at the national level. Using the widely applied IUCN Red List as a metric for extinction risk, and evaluating change in extinction risk over time (Butchart *et al.*, 2004, 2007), Collen *et al.* in Chapter 2 evaluate how the growing number of national-level Red List Assessments (Miller *et al.*, 2007; Zamin *et al.*, 2010) could be harnessed to develop national indices, which can be used to track species of national and global conservation concern. Chapter 2 concludes with two national case studies, Venezuela and South Africa, and provides lessons learned from the two decades of species extinction risk assessment carried out in these countries.

Risk assessment relies on relatively coarse measures of population change in order to place species in categories of risk, as changes between categories of risk reflect large changes in population size. A more direct measure of absolute or relative abundance provides a potentially more sensitive indicator. In Chapters 3 and 4, two different indicators that track indices of abundance over time are evaluated as scaleable indicators of biodiversity change. Drawing on an increasingly widely used technology, O'Brien and Kinnaird in Chapter 3 evaluate how remote-triggered camera traps are being used to understand trends in wildlife, particularly in tropical forest and savanna habitats. The authors argue that the technology can integrate local-scale vertebrate monitoring in a cost-effective standardized manner, to meet national responsibilities to biodiversity reporting, which can in turn feed into measuring progress to global-scale targets. While the method monitors only one component of biodiversity (ground-dwelling vertebrates), this component is often of economic and cultural significance to local communities and national governments.

Finally in Part I, Collen *et al.* in Chapter 4 evaluate the approaches of the Living Planet Index to develop national-level indicators of biodiversity change. The technique aggregates a variety of measures of population change into a single index, and is already widely used as an index of global and regional change in biodiversity. The chapter evaluates the use of the indicator of change in wildlife abundance at a national level. Using examples from Uganda, the authors explore the different levels at which meaningful measures of change in abundance can inform global, national, and sub-national biodiversity targets. The authors make the case that the loss of populations is a prelude to species extinction, and tends to reduce taxonomic, genetic, and functional diversity, and therefore is integrally related to many different elements of biodiversity. A national Living Planet Index has an additional key attribute in that it is generally likely to be well aligned to national and local biodiversity conservation priorities.

Indicators of the pressures on biodiversity

Indicators of pressure can encompass both positive and negative alterations in the direct and indirect causes of biodiversity loss (Mace and Baillie, 2007) and provide useful measures for assessing changes in ongoing threats to biodiversity. Changes in pressure may be detectable before change can be perceived in metrics of the state of biodiversity, and hence indicators of pressure can be particularly useful for instigating timely and effective conservation interventions (Failing and Gregory, 2003; McGeoch *et al.*, 2010). However, impacts of threats on biodiversity are often complex, and the removal of a threat does not necessarily lead to an immediate increase or recovery of biodiversity, hence there needs to be a clear understanding of the mechanistic links between biodiversity state and pressure (Jones *et al.*, 2011). For these reasons, it is often not sufficient to monitor pressures alone, and such monitoring should ideally be supplemented either by fully independent measures of state or studies to confirm causal linkages between pressure and state (Mace and Baillie, 2007). The development of national and global indicators of the pressures of biodiversity has lagged behind the growth of those of status, though there are good sub-national-level examples (e.g., measures of snaring). Nevertheless, several indicators are becoming available, and further development is likely to be catalysed by the focus of six of the 20 Aichi targets under goal B, which is to 'reduce the direct pressures on biodiversity and promote sustainable use' (Convention on Biological Diversity, 2011). In Part II of this book we therefore consider the development of indicators of pressures on biodiversity.

The greatest driver of threats to species has consistently been shown to be habitat loss (Hoffmann *et al*., 2010; Millennium Ecosystem Assessment, 2005). In Chapter 5, Pettorelli examines how satellite technology and remote sensing information might be used to track changes in ecosystem distribution and functioning, and provide measures of habitat degradation and loss. In particular, Pettorelli demonstrates how satellite-derived vegetation indices, such as the Normalized Difference Vegetation Index (NDVI), can not only provide indicators of pressure, but also help predict spatio-temporal trends in species distribution and abundance, and provide important information for decision-makers. The author argues that the accessibility of satellite data means that satellite-based indicators can be both cheap and sustainable.

Climate change is one of the most rapidly growing threats to species persistence, and will likely be one of the greatest drivers of biodiversity change over the coming decades (Thomas *et al*., 2004). Our collective understanding of the nature and extent of the susceptibility of species to climate change lags far behind that of many of the other indicators (Dawson *et al*., 2011; Foden *et al*., 2009; Gregory *et al*., 2009). In Chapter 6, Foden *et al.* assess the possible ways of attributing and measuring climate change impacts to species. The authors argue that given the limited empirical information on species' responses to climate change, it is necessary to consider alternative ways for measuring how species are being or will be affected, and crucially, the degree to which these are positive or negative effects. They show how, to date, four different kinds of methods are in common use, and develop a theoretical framework for climate change indicators. They conclude that evaluating the veracity of model-based studies is central to further development, though attributing cause and effect remains problematic due to complex and poorly understood interactions between multiple threats to species.

Genovesi *et al.* in Chapter 7 address the issue of measuring the impact of invasive alien species (IAS). The problem is enormous; IAS are cited as a factor in over 50% of animal extinctions where the cause is known, and are the second most important threat to birds (BirdLife International, 2010; Hilton-Taylor *et al*., 2009). With the number of documented impacts of IAS rising, the need to combat IAS grows. Among their recommendations, the authors contend that, alongside more direct measures of management effectiveness, detailing the economic consequences of IAS, and their impacts on ecosystem services and human health and well-being, will aid arguments for better control.

Direct unsustainable exploitation of natural resources is a key pressure on ecosystems. Wild animals and plants are essential for human livelihoods and well-being. According to the United Nations Food and Agriculture Organization (FAO), 40% of the world's economy is based directly and indirectly on the use of biological resources. However, as the world's human population increases, our use of species is having a greater and greater impact on both the species being targeted and the ecosystems in which they live, and in many cases this impact is becoming unsustainable. Almond *et al.* in Chapter 8 show how indicators of sustainably managed forests and marine fisheries can be calculated. They argue that to be nationally relevant, these indicators should provide a measure not only of the sustainable use of a natural resource, but also of the value of the resource to lives and livelihoods. They propose a pressure-state-response framework for evaluating exploitation of species, developing and adapting a number of existing indicators, to provide more complete insights into exploitation and sustainable use.

Finally, in Chapter 9, Sanderson evaluates how combinations of different measures of aggregated anthropogenic pressures can be represented in conceptual ‘footprints’ of consumption. Sanderson combines two key measures of human impact on the biosphere: the human footprint (Sanderson *et al.*, 2002), and the ecological footprint (Wackernagel and Rees, 1996). The former is calculated by combining spatial measures of human impact (e.g., human population density, land use, access from roads) and is presented in a mapped form. The latter is calculated at the level of the individual, through combining consumption patterns derived from where a person lives. By demonstrating how these two footprints might be combined, Sanderson provides a framework for a powerful tool that can act as a surrogate for human consumption patterns at national and global scales.

The next generation of biodiversity indicators

Parts I and II cover many of the indicators of biodiversity state and pressures currently in use. While it is increasingly widely accepted that biodiversity loss and ecosystem degradation jeopardize human well-being, not all of the relevant parts of biodiversity that matter are currently systematically measured, and the short time period between the date that the CBD 2010 target was set, and the breadth of the target, has meant that many indicators were not developed in time (Walpole *et al.*, 2009). In order to better understand and address negative human impact on biodiversity, it is important to continue to develop the field of biodiversity monitoring; taking advantage of new technologies, methods and approaches that are likely to enable the development of new indicators. As the CBD and its technical bodies, scientists, and policy-makers navigate the path towards the Aichi Target and Strategic Plan for 2020, in Part III of the book we ask what the next generation of biodiversity indicators might be. Although it is generally accepted that it is impossible to monitor all aspects of biodiversity state and pressures, we identify three key themes that are likely to be important for achieving the new target: new technologies and metrics for biodiversity, socioeconomic impacts, and how best to establish effective linkages between biodiversity information and policy.

Chapters 10 (Jones *et al.*) and 11 (McKenzie and Reardon) assess how two new metrics that might be used to monitor aspects of biodiversity to fill gaps in the current set of national and global biodiversity indicators, have so far been neglected. Jones *et al.* explore how acoustic monitoring might be used to develop measures of biodiversity change. Using the echolocation calls of bats, they show how this metric could provide a catch-all for a number of important aspects of biodiversity (abundance, geographical range, habitat and foraging niches). Given that bats comprise one-fifth of all mammal species (Simmons, 2005), their relative scarcity in monitoring schemes to date is cause for concern. The authors' argument that the need for bat monitoring due to their provision of a range of ecosystem services (e.g. pollination, seed dispersal, and insect regulation) is convincing. Yet even more powerful is the framework they set out for implementing a sustainable citizen science-based acoustic national monitoring scheme. They use examples from Romania, Bulgaria, and Hungary to illustrate their approach.

McKenzie and Reardon (Chapter 11) sustain the theme of new metrics in their evaluation of the use of occupancy, a measure of the proportion of an area occupied by a species, to develop an index of abundance. The authors carefully designed a methodology for the use of occupancy methods to monitor the slender loris, a species of primate from Sri Lanka. This animal is small and nocturnal and, like most small nocturnal mammals, has previously been very difficult to monitor. They make a compelling argument for how less labour-intensive metrics of abundance, such as occupancy, might be useful in obtaining reliable estimates of population change over time. Crucially, they establish that in order to account for imperfect detection of animals, a key requirement of these methods is that the monitoring programme is designed such that there are repeated opportunities of detecting the species at each location within a relatively short timeframe.

Strategic goal D of the Aichi targets emphasizes the need to enhance benefits to all, from biodiversity and ecosystem services (Convention on Biological Diversity, 2011). While access and benefits sharing has been widely discussed both in political forums and the scientific literature, little progress has been made as yet towards its integration into biodiversity target setting. The social and economic impacts of conservation projects on local communities in the developing world have been the subject of substantial debate. In Chapter 12, Homewood focuses on evaluating why and how socioeconomic monitoring for conservation initiatives should be carried out, appraising both rapid light-touch, and more in-depth quantitative analytical options. The conclusions reached are, in essence, that no single tool will effectively monitor socioeconomic impact, and that, like other areas of biodiversity research, a range of metrics are required, and these need to be tailored to each situation. Moreover, unlike plant or animal subjects, humans (including the researcher) are prone to bias and influence, and hence particular care must be taken to ensure monitoring is truly independent.

Finally in Part III, Chapter 13 (Mace *et al.*) looks at how creating targets that are likely to have more impact, by enhancing the links between science and policy, are central to biodiversity conservation. The authors argue that scientists tend to evaluate targets objectively in relation to their scientific relevance, how measurable they are, and how those measures meet the policy goal. This approach might not always align with that of governments, managers, and policy-makers, who are understandably sensitive to what it might mean if targets are not met. The authors make out a clear case for a need to adopt a small set of focused, relevant, efficient, and achievable targets, using an iterative process, in which targets are adapted as underlying conditions change. This process needs to exploit the existing science base while involving key decision-makers. The authors provide a colour-coded categorization system for different types of targets to aid this process.

Biodiversity monitoring in practice

Biodiversity targets, such as those set by the Convention on Biological Diversity in Aichi, can only be met through effective conservation action that is monitored appropriately and evaluated to track progress towards targets. However, there remain a number of major challenges to effective biodiversity conservation, monitoring, and evaluation. These include financial constraints, lack of technical capacity, policy and legal barriers, and perverse incentives. The final part of the book explores these practical constraints and challenges confronting biodiversity conservation and monitoring. In this the authors bring together several of the themes explored in this book to evaluate how some of the recommendations made in previous chapters might play out in the real world.

Durant argues in Chapter 14 that any global target is likely to be difficult to achieve without national-level buy-in. This chapter demonstrates that, in order to be sustainable and long-term, biodiversity monitoring needs to be firmly embedded within a national context. This is best achieved when monitoring is aligned with local and national priorities, and engages managers and policy-makers from the beginning, to ensure ownership of a biodiversity monitoring plan. The chapter outlines the different stages that should be considered in an effective monitoring plan that is grounded in good science but focused on clear conservation goals. Durant presents a framework where local capacity lies at the centre of biodiversity monitoring, and argues that local ownership and effective institutionalization of biodiversity monitoring is key to long-term sustainability.

Conservation management involves a number of difficult decisions, and in Chapter 15 Jones presents a further reality check. The resources available for conservation are insufficient to prevent the loss of much of the world's threatened biodiversity during this crisis (Vane-Wright *et al.*, 1991). Conservation planners are therefore forced to prioritize their activities under this reality, and this also in the context of great uncertainty about future change – this has become known as 'the agony of choice'. Practitioners are unlikely ever to have sufficient funds to monitor and protect everything, and Jones argues that monitoring programmes must be designed with sufficient power to detect the desired level of change in the metric of interest; at times the best decision might be not to monitor but rather to put the money into more direct conservation action.

The problems caused by financial constraints to all scales of biodiversity monitoring is a thread that runs through many chapters in this book. Bashir examines this issue in Chapter 16, drawing on the example of the key financier of biodiversity conservation projects, the Global Environment Facility (GEF), for insight. Since 1991, it has provided US$3.1 billion in grants, and $8.3 billion in leveraged co-financing to support the implementation of around 1000 biodiversity projects in more than 155 developing countries and countries with economies in transition (GEF, 2010). Although biodiversity monitoring is not a requirement of GEF, many GEF-funded projects include some form of biodiversity monitoring. One of the main conclusions of the chapter is that there is substantial scope to increase the contribution of GEF projects to broader national or international biodiversity monitoring efforts. The author recommends that GEF build on this potential, together with established monitoring capacity within the GEF, to enable GEF projects to contribute to a standardized biodiversity monitoring database. This would enable better monitoring of the biodiversity conservation contribution played by GEF as well as better overall biodiversity monitoring. The author argues that this could be achieved at relatively low cost, by improving coordination and collaboration with the scientific community and establishing mentoring programmes.

National-level biodiversity monitoring and reporting will be central to our collective efforts to stem global biodiversity loss. Yet limited attention has been paid to integrating the two processes. Bubb in Chapter 17 evaluates how linkages between these two apparently rather separate entities might be exploited. While there are conceptually two directions in which indicators could be built (disaggregating global indicators to the national level, and aggregating national-level indicators to create a global index), Bubb argues strongly for the latter. Only with national integration of biodiversity target setting into a set of streamlined biodiversity indicators, is significant progress likely to be made.

We must accept that we live in a target-driven world. Perhaps the greatest challenge for biodiversity conservation is integrating care for wildlife, the environment, and ecosystems and the benefits that humans derive from them, into the mindset of other sectors. In the final chapter, Stuart and Collen (Chapter 18) draw on some of the lessons learned from both the process that was undertaken, and wording of the CBD 2010 target, and set out a vision for how the pitfalls identified in that process can be avoided in the run-up to 2020. These include a better understanding of the complex relationship between biodiversity and ecosystem services (Mace *et al.*, 2012), quantifying the economic costs of inaction, and reconnecting the public with wildlife. Only by linking targets to actions can the rapid decline of biodiversity be halted.