

Biodiversity



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Main Messages

The pressure on biodiversity continues to increase. Habitat loss and degradation from agriculture and infrastructure development, overexploitation, pollution and invasive alien species remain the predominant threats. Climate change is increasing in importance and will have profound impacts, particularly in combination with other threats. Greater integration of policies and institutional responses, including effective engagement of local communities, is required to stop and reverse current trends. The world lost over 100 million hectares of forest from 2000 to 2005, and has lost 20 per cent of its seagrass and mangrove habitats since 1970 and 1980 respectively. In some regions, 95 per cent of wetlands have been lost. The condition of coral reefs globally has declined by 38 per cent since 1980. Two-thirds of the world's largest rivers are now moderately to severely fragmented by dams and reservoirs.

The state of global biodiversity is continuing to decline, with substantial and ongoing losses of populations, species and habitats. For instance, vertebrate populations have declined on average by 30 per cent since 1970, and up to two-thirds of species in some taxa are now threatened with extinction. Declines are most rapid in the tropics, in freshwater habitats and for marine species utilized by humans. Conversion and degradation of natural habitats is ongoing, with some having experienced declines of 20 per cent since 1980. Limited successes, such as saving particular species from extinction, reversing the decline of some populations, and restoring some habitats, are outweighed by continuing declines.

The benefits humans obtain from biodiversity are at risk. Conversion of natural habitats to large-scale, commercial agriculture has resulted in net benefits for human well-being. However, this has often been accompanied by reductions in other services,

such as carbon sequestration and flood regulation. Continuing ecological degradation, unsustainable levels of consumption and inequities in sharing of the benefits from biodiversity threaten the improvements in human well-being and health that have been achieved in recent decades.

There has been an increase in responses to the loss and degradation of biodiversity, although these have failed to reduce the decline, and more effort is needed. Successful responses include: increases in the designation of protected areas, now covering nearly 13 per cent of land area, and increasing recognition of indigenous and local community-managed areas; and adoption of policies and actions for managing invasive alien species and genetically modified organisms (GMOs). About 55 per cent of countries have legislation to prevent the introduction of new alien species and control existing invasives, but less than 20 per cent are estimated to have comprehensive strategies and management plans, and there is a lack of data on their effectiveness. Successful responses also include regulations that support sustainable harvesting and reduced pollution; successful species recoveries and habitat restoration; and some progress towards equitable access to and benefit sharing of genetic resources. International financing for biodiversity conservation is estimated to have grown by about 38 per cent in real terms since 1992 and now stands at US\$3.1 billion per year. But less than 1.5 per cent of the marine area is covered by protected areas.

An opportunity to develop a concerted global approach to stop and reverse the decline of biodiversity is provided by the recent adoption of the Strategic Plan for Biodiversity (2011–2020) including the Aichi Biodiversity Targets, and acceptance of the Nagoya Protocol on Access and Benefit Sharing.

INTRODUCTION

Biodiversity is formally defined by the Convention on Biological Diversity (CBD) as: “the variability among living organisms from all sources including, among others, 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” (UN 1992 Article 2).

In recent years the links between biodiversity and ecosystem services and the benefits people derive from these have received increasing attention (CBD 2010b; TEEB 2010; Sutherland *et al.* 2009; UNEP 2007; MA 2005a; 2005b). There is growing evidence that biodiversity has a vital role in attaining the Millennium Development Goals: it contributes to poverty reduction and to sustaining human livelihoods and well-being through, for example, underpinning food security and human health, providing clean air and water, and supporting economic development (UNEP 2007; MA 2005a). Given the importance of biodiversity and evidence of its ongoing decline (CBD 2010b), it is essential to chart progress in reducing and, as far as possible, reversing the rate of decline.

Recent assessments of the status of biodiversity have shown little evidence of improvement. The third *Global Biodiversity Outlook (GBO-3)*, was launched in May 2010 (CBD 2010b), and showed that biodiversity has continued to decline since publication of the Millennium Ecosystem Assessment (MA 2005a) and the last *Global Environment Outlook (GEO-4)* (UNEP 2007). This chapter builds on these recent assessments. The three objectives of the CBD, namely, the conservation of biological diversity, the sustainable use of its components, and fair and

equitable sharing of the benefits arising out of the utilization of genetic resources, as well as the missions and objectives of other biodiversity-related conventions are all considered.

The current chapter presents globally agreed indicators and goals for biodiversity, in particular the Aichi Biodiversity Targets (Box 5.1). The implications for human well-being of not achieving these targets are examined and gaps in achieving internationally agreed goals for biodiversity are identified, so as to frame key messages for the international community. Current knowledge of the pressures, state and trends affecting biodiversity and of the benefits of biodiversity to people is synthesized from past assessments and recent publications. Management responses that address these pressures are also examined so as to chart progress in safeguarding biodiversity. In particular, cross-boundary issues are tackled from both an ecological and an equity perspective. The links between biodiversity and traditional knowledge and cultural diversity are also considered before concluding with a look to the future.

INTERNATIONALLY AGREED GOALS

Goals and targets are one aspect of the policy agenda for assessing progress in meeting global commitments for biodiversity. Eighteen goals related to biodiversity have been identified (Table 5.1 and Box 5.2). These range from the Millennium Development Goal 7 to ensure environmental sustainability, to the most recent five strategic goals and 20 Aichi Biodiversity Targets of the Strategic Plan for Biodiversity 2011–2020 (Box 5.1). These biodiversity goals and targets have been clustered into themes and prioritized by taking into account the links between them and by reference to key biodiversity issues (Table 5.1 and Box 5.2).



Lake Nakuru National Park, Kenya, renowned as a sanctuary for more than 400 bird species, also offers refuge to large ungulates including waterbucks.

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Box 5.1 Strategic Plan for Biodiversity 2011–2020 and the Aichi Biodiversity Targets



Actor Edward Norton, UN Goodwill Ambassador for Biodiversity, addresses a press conference on the dangers of global biodiversity loss. © Rick Bajornas/UN Photo

The Strategic Plan for Biodiversity 2011–2020 (CBD 2010c), including the Aichi Biodiversity Targets (CBD 2010a), was adopted by the Parties to the Convention on Biological Diversity (CBD) in October 2010, following many regional consultations, expert workshops and high-level events organized in collaboration with numerous partners. The plan contains five strategic goals and establishes targets for achieving the vision of “a world living in harmony with nature and where, by 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people” (CBD 2010c Decision X/2).

It is envisaged that the plan will be implemented primarily through activities at the national or sub-national level, with supporting action at the regional and global levels. Countries have committed to developing national and regional targets, using the plan and its Aichi Targets as a flexible framework to integrate these targets into national biodiversity strategies and action plans, and to develop indicators to report on progress in 2014 and 2018.

Strategic goal A: Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society

Target 1: By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.

Target 2: By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty

reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.

Target 3: By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio-economic conditions.

Target 4: By 2020, at the latest, governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.

Strategic goal B: Reduce the direct pressures on biodiversity and promote sustainable use

Target 5: By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.

Target 6: By 2020, all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem-based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.

Target 7: By 2020, areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.

Target 8: By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.

Target 9: By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.

Target 10: By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.

Strategic goal C: Improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity

Target 11: By 2020, at least 17 per cent of terrestrial and inland water areas, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through

effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.

Target 12: By 2020, the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.

Target 13: By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.

Strategic goal D: Enhance the benefits to all from biodiversity and ecosystem services

Target 14: By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.

Target 15: By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.

Target 16: By 2015, the Nagoya Protocol on Access to Genetic

Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.

Strategic goal E: Enhance implementation through participatory planning, knowledge management and capacity building

Target 17: By 2015, each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan.

Target 18: By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.

Target 19: By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.

Target 20: By 2020, at the latest, the mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011–2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization, should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.



Delegates in Nagoya, Japan, during the tenth Conference of the Parties to the Convention on Biological Diversity, where signatories adopted a new UN Strategic Plan, including the Aichi Biodiversity Targets. © IISD/Earth Negotiations Bulletin

Table 5.1 Selected internationally agreed goals and themes related to biodiversity

Major themes from internationally agreed goals		Biodiversity			
		Pressures	State and trends	Benefits	Responses
		<i>Aichi Biodiversity Targets</i>			
		5,6,7,8,9,10	11,12,13	14,15,16	1–20
International Plant Protection Convention (IPPC) (FAO 1951) Article 1	Measures to prevent the introduction and spread of plant pests and to promote appropriate measures for their control				X
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES 1973) Preamble	International cooperation for the protection of species of wild fauna and flora against overexploitation through international trade			X	X
Ramsar Convention on Wetlands (UN 1973) Article 3	Promote conservation of wetlands included in the list and wise use of other wetlands in national territory		X	X	X
Convention on the Conservation of Migratory Species of Wild Animals (CMS 1979) Preamble	Concerted action by states within the national jurisdictional boundaries of which migratory species spend any part of their life cycle to conserve and effectively manage such species		X		X
Agenda 21 (UNCED 1992) Chapter 17 Paragraph 86	Identify priority marine ecosystems and limit use in these areas, through, inter alia, designation of protected areas	X	X		X
Convention on Biological Diversity (CBD 1992) Article 1	Conservation and sustainable use of biodiversity and the fair and equitable sharing of benefits arising from the utilization of genetic resources		X	X	X
Article 6	National strategies for the conservation and sustainable use of biodiversity and integration of such into relevant plans, programmes and policies		X	X	X
Article 8j	Maintain knowledge of indigenous communities relevant for the conservation and sustainable use of biological diversity, promote their wider application and encourage the equitable sharing of resulting benefits		X	X	X
Article 10	Sustainable use of components of biological diversity and encourage relevant cooperation, protect traditional cultural practices and support remedial action where biological diversity has been reduced	X	X	X	X
Decision VII/28 Paragraph 1.2.3	Sustainable use of components of biological diversity and encourage relevant cooperation, protect traditional cultural practices and support remedial action where biological diversity has been reduced	X	X	X	X
CBD COP 7 (2004) Decision VII/30 Annex II	Integrate protected areas into broader landscapes and seascapes through ecological networks, ecological corridors and/or buffer zones to maintain ecological processes and take into account the needs of migratory species	X			X
2011–2050 Vision (CBD 2010c)	Control threats from invasive alien species	X	X	X	X
Millennium Summit (2000) Millennium Development Goal (MDG) 7 (UN 2000)	Living in harmony with nature and where, by 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people	X	X	X	X
Johannesburg Plan of Implementation (JPOI) (WSSD 2002) Paragraph 44	Ensure environmental sustainability	X	X	X	X
Cartagena Protocol on Biosafety to the CBD (CBD 2000) Article 1	Sustainable use of biological diversity and fair and equitable sharing of benefits arising from the use of genetic resources	X			
International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) (FAO 2001)	Ensuring an adequate level of protection in transfer, handling and use of living modified organisms resulting from modern biotechnology		X	X	X
Article 1 Paragraph 1.1	Sustainable agriculture and food security through the conservation and sustainable use of plant genetic resources and the fair and equitable sharing of the benefits arising out of their use	X	X	X	X
World Summit Outcome (UNGA 2005)	Promote and safeguard the fair and equitable sharing of benefits arising out of the utilization of genetic resources; significantly reduce the rate of biodiversity loss by 2010	X	X	X	X

STATE AND TRENDS

Biodiversity is affected by multiple drivers and pressures that modify its ability to provide ecosystem services to people. The interaction of multiple drivers, including demographic, economic, socio-political, scientific and technological ones, as discussed in Chapter 1, is known to increase pressures on biodiversity, leading to further decline, degradation and loss. However, the mechanisms associated with such loss require further research.

Pressures

The principal pressures on biodiversity include habitat loss and degradation, overexploitation, alien invasive species, climate change and pollution (Figure 5.1) (Baillie *et al.* 2010; Viê *et al.* 2009; MA 2005a). These pressures are continuing to increase (Box 5.3) (Butchart *et al.* 2010; CBD 2010b).

Habitat loss

Habitat loss in the terrestrial domain has been caused largely by the expansion of agriculture: more than 30 per cent of land has been converted for agricultural production (Foley *et al.* 2011). Large-scale commercial agriculture has adversely affected biodiversity, particularly agro-biodiversity (Belfrage 2006; Rosset 1999). Moreover, the growing demand for biofuels has taken a toll, with expanses of forests and natural lands in South East Asia being converted into mono-crop plantations (Danielsen *et al.* 2009; Fitzherbert *et al.* 2008).

Direct habitat loss is a major threat to coastal ecosystems through aquaculture (Valiela *et al.* 2004). Wetlands in

Box 5.2 Biodiversity vision: a world in harmony with nature

Related goals

Reduce direct pressures on biodiversity; improve the status of biodiversity; enhance benefits from biodiversity; strengthen responses to safeguard biodiversity

Indicators

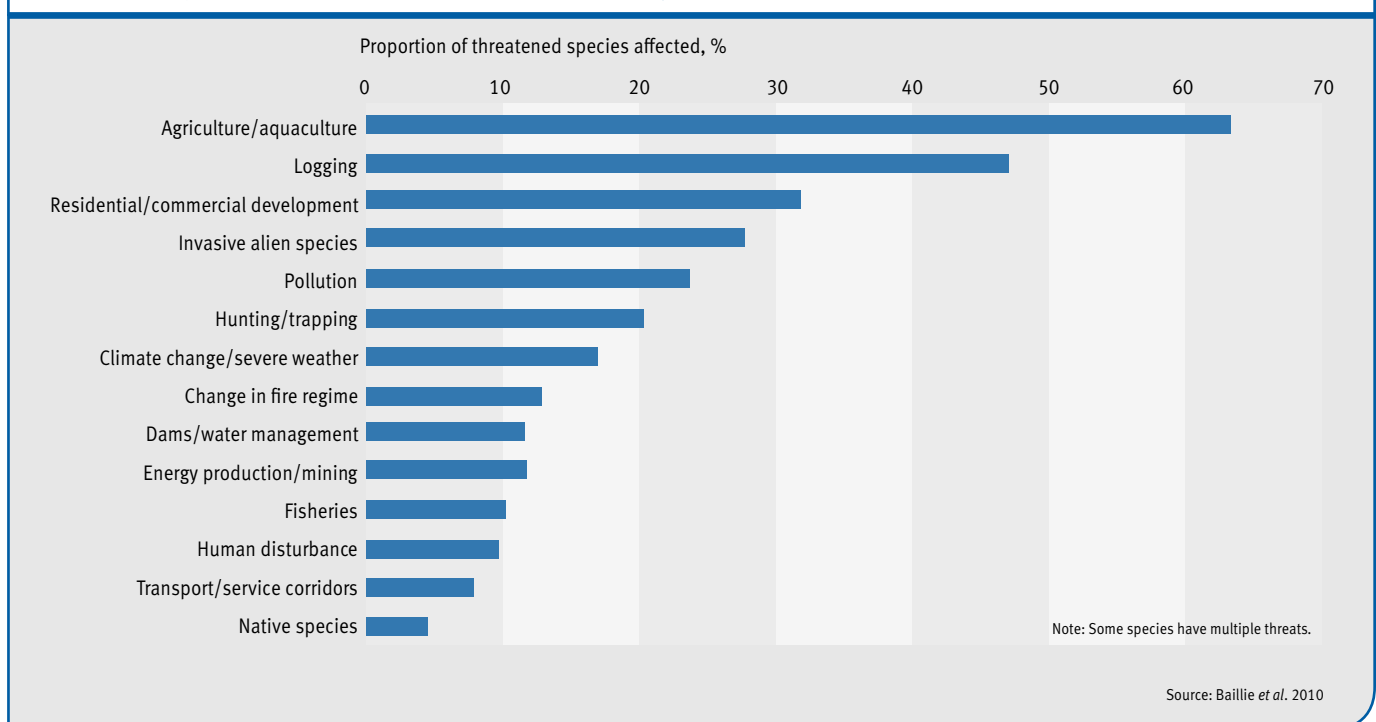
Trends in: invasive species and pollutants such as nitrogen deposition; extinction risk of species; extent, condition and integrity of biomes, habitats and ecosystems; status of species harvested for food and medicine; development and effectiveness of protected areas, indigenous and community-conserved areas, sustainable use management and payment for ecosystem services programmes; and in the number of languages and speakers as a proxy for traditional knowledge supporting sustainable resource use and conservation

Global status and trend

Pressures on biodiversity are expected to increase, and the status of biodiversity is expected to decrease, but encouragingly, responses are starting to increase

particular have faced a 50 per cent loss in the 20th century (MA 2005b). Freshwater ecosystems are severely affected by fragmentation (Nilsson *et al.* 2005) and floodplain ecosystems

Figure 5.1 Major threats to vertebrates listed as critically endangered, endangered or vulnerable on the IUCN Red List



Box 5.3 Global Biodiversity Outlook

The *Global Biodiversity Outlook* is a periodic report prepared by the Secretariat of the Convention on Biological Diversity. The third edition (*GBO-3*) was one of the main assessments of progress towards the 2010 Biodiversity Target of significantly reducing the current rate of biodiversity loss at global, regional and national levels, and was an important source of information in the development of the Strategic Plan for Biodiversity 2011–2020 and the Aichi Biodiversity Targets.

The main conclusion of *GBO-3* was that the 2010 Biodiversity Target had not been met. Specifically, the underlying causes of biodiversity loss have not been addressed despite increasing responses by governments. Pressures on biodiversity have remained high or continued to increase, leading to ongoing degradation of ecosystems, reductions in species populations and increasing extinction risks, as well as erosion of genetic variety (Figure 5.2).

Most future scenarios of biodiversity change project continuing high levels of population and species extinctions and loss of

habitats, with associated decline of some ecosystem services important to human well-being. There is a high risk of degradation of a broad range of such services if ecosystems are pushed beyond threshold levels.

While the conclusions of *GBO-3* give cause for concern, the report also provides a message of hope. Many actions in support of biodiversity have been taken, and have had significant and measurable results in particular areas and amongst targeted species and ecosystems. This suggests that, with adequate resources and political will, the tools exist for reducing the erosion of biodiversity. Preventing further loss in the near term will be extremely challenging, but it can be achieved in the longer term if effective action is initiated now in support of an agreed long-term vision. Initiating action to address the underlying causes of biodiversity decline is paramount. Failure to use this opportunity will result in many ecosystems moving into new, unprecedented states in which the capacity to provide for the needs of present and future generations is highly uncertain.

are also threatened (Tockner *et al.* 2008; Tockner and Stanford 2002). Benthic habitats have been degraded as a consequence of bottom trawling and other destructive fishing methods (Thrush and Dayton 2002).

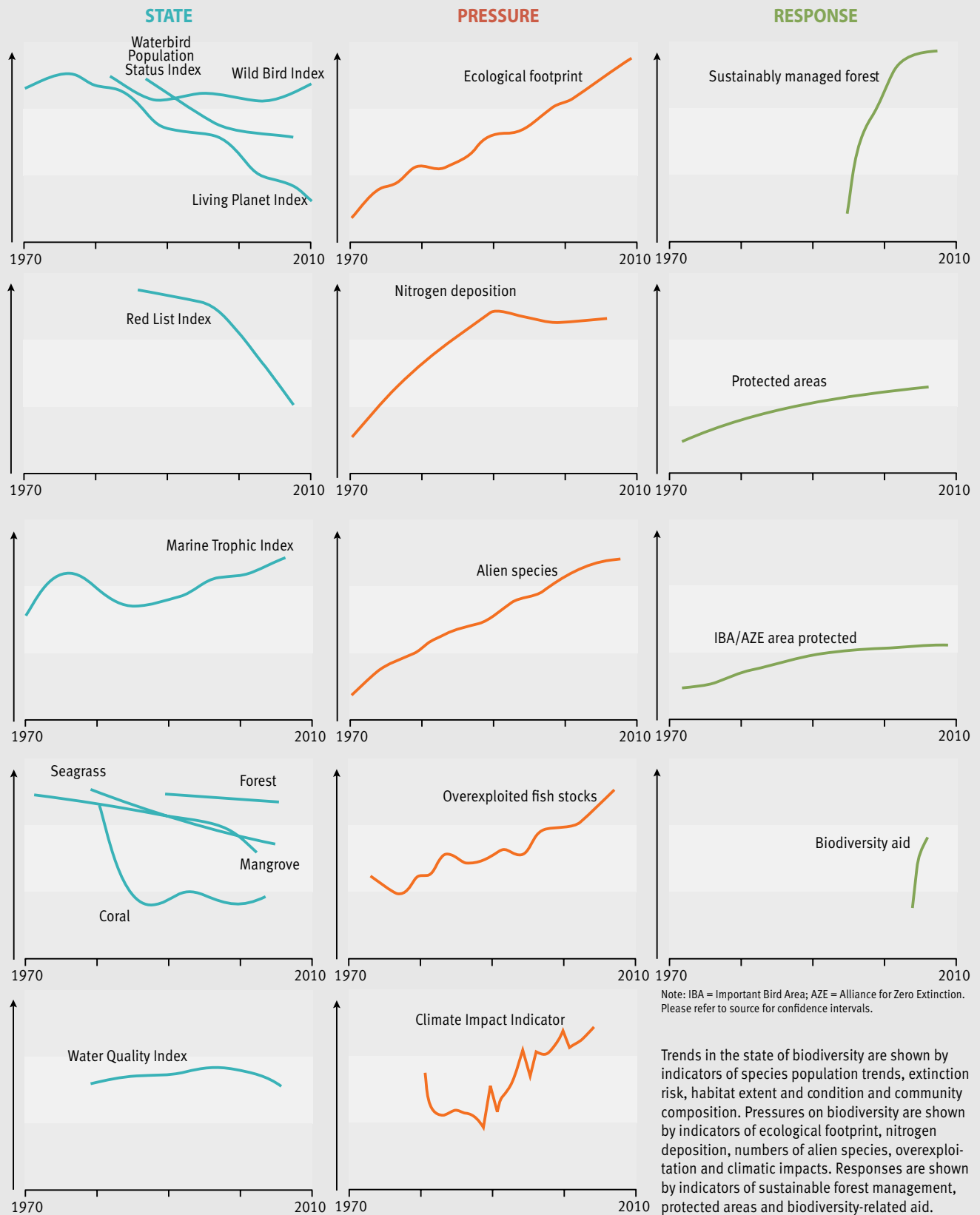
Overexploitation

Overexploitation of wild species to meet consumer demand threatens biodiversity, with unregulated overconsumption contributing to declines in terrestrial, marine and freshwater



Land conversion to oil palm plantations in Sabah, Malaysia, has encroached on the natural habitat of the orangutan, significantly threatening the species. © Johannes Refisch/UNEP

Figure 5.2 Biodiversity indicator trends



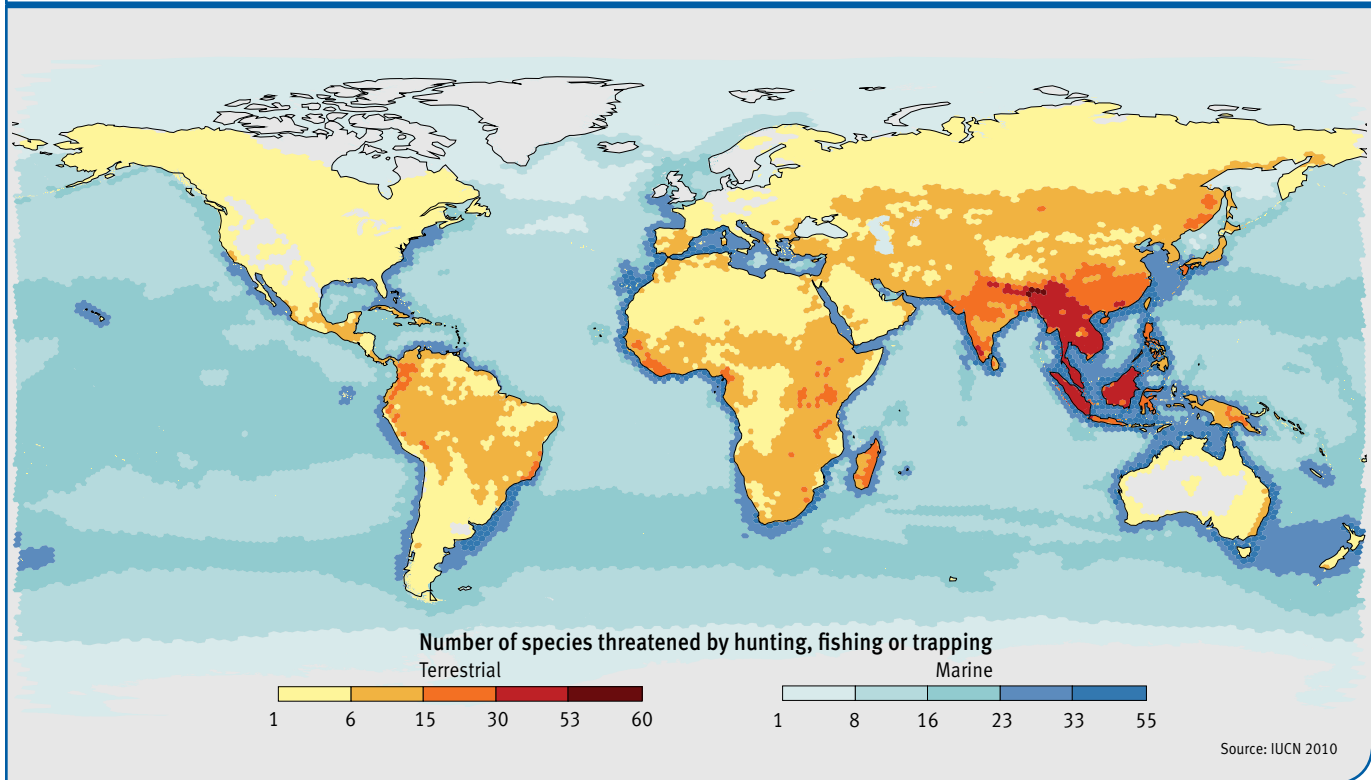
Vertical scales and units vary - see source for details

Note: IBA = Important Bird Area; AZE = Alliance for Zero Extinction. Please refer to source for confidence intervals.

Trends in the state of biodiversity are shown by indicators of species population trends, extinction risk, habitat extent and condition and community composition. Pressures on biodiversity are shown by indicators of ecological footprint, nitrogen deposition, numbers of alien species, overexploitation and climatic impacts. Responses are shown by indicators of sustainable forest management, protected areas and biodiversity-related aid.

Source: Adapted from Butchart *et al.* 2010

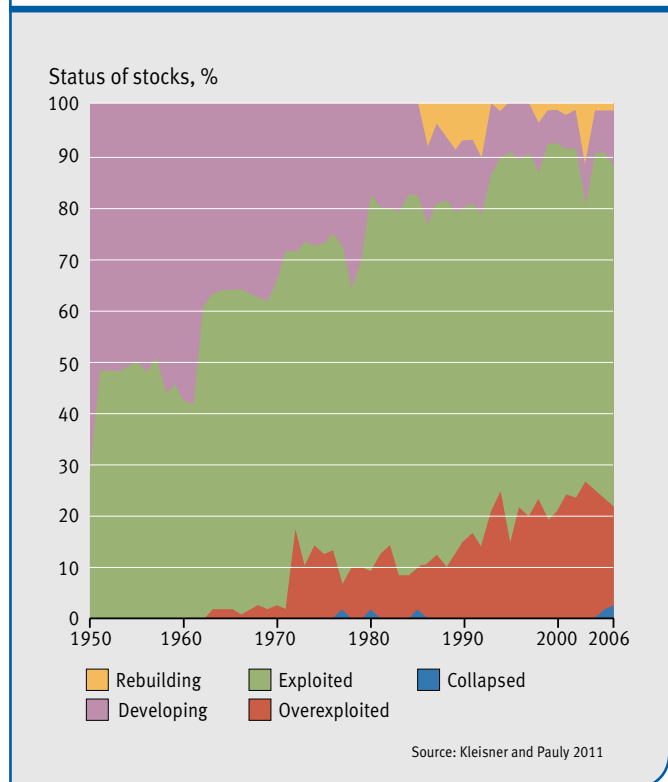
Figure 5.3 Numbers of vertebrates globally threatened by overexploitation, 2010



ecosystems (Figure 5.3) (Peres 2010; Vorosmarty *et al.* 2010; Kura *et al.* 2004; Dulvy *et al.* 2003). Although overexploitation is often difficult to quantify in terrestrial systems, major exploited groups include plants for timber, food and medicine; mammals for wild meat and recreational hunting; birds for food and the pet trade; and amphibians for traditional medicine and food (Vié *et al.* 2009). The threat to vertebrates from overexploitation is particularly severe, driven, in particular, by demand for wildlife and wildlife products from East Asia (Figure 5.3). Globally, utilized vertebrate populations have declined by 15 per cent since 1970 as indicated by the Living Planet Index (Butchart *et al.* 2010). Similarly, the extinction risk of utilized bird species increased during 1988–2008, driven in part by overexploitation (Butchart *et al.* 2010).

In the marine realm, capture fisheries more than quadrupled their catch from the early 1950s to the mid-1990s. Since then, catches have stabilized or diminished (FAO 2010b), despite increased fishing effort (Anticamara *et al.* 2011; Swartz *et al.* 2010). The proportion of marine fish stocks that are overexploited, depleted or recovering from depletion rose from 10 per cent in 1974 to 32 per cent in 2008 (Figure 5.4) (FAO 2010b; Worm *et al.* 2009). Of the 133 local, regional and global extinctions of marine species documented worldwide over the last 200 years, 55 per cent were caused by overexploitation, while the remainder were driven by habitat loss and other threats (Dulvy *et al.* 2003). Commercial fisheries are the principal threat to fish stocks, but overexploitation

Figure 5.4 Trends in the state of global fishery stocks, 1950–2006



in artisanal fisheries also occurs (Garcia and Rozenberg 2010). Such practices can ultimately lead to major shifts in community composition. For example, coral communities have been transformed into algal-dominated systems because of overfishing of herbivores (Mumby 2009).

The use of destructive fishing practices further amplifies the impacts of unsustainable fishing on marine biodiversity and habitats (FAO and UNEP 2009). Technology can enhance the intensity and range of human impacts on marine biodiversity although it can also play a significant role in making fishing practices less destructive. Moreover, abandoned and lost fishing gear is having negative ecological consequences on marine biodiversity (also known as ghost fishing) (Brown and Macfadyen 2007).

Overfishing is also a problem in freshwater wetlands, although in many cases adequate data are not available to quantify the extent of the loss (Kura *et al.* 2004). Recreational fishery practices such as stocking and selective take can also have important evolutionary impacts on freshwater fish stocks (Jorgensen *et al.* 2007). By-catch from fisheries can be a major threat to groups such as sharks, turtles and albatrosses.

Invasive alien species

Invasive alien species threaten native biodiversity and are spreading through both deliberate and unintentional introductions as a consequence of increasing levels of global travel and trade. Poorly planned economic introductions, air transport, hull-fouling and ballast water from ships, as well as trade in pets, garden plants and aquarium species, are significant pathways for the dispersal of invasive species (Reise *et al.* 2006; Bax *et al.* 2003). Invasive alien species affect native species principally through predation, competition and habitat modification (McGeoch *et al.* 2010; Vié *et al.* 2009; Strayer *et al.* 2006). Invasive species have major economic costs, estimated by one study to total US\$1.4 trillion annually (Pimentel *et al.* 2004). They are found in nearly all countries and habitats, including marine ecosystems – for example the red lionfish *Pterois volitans* affects coral reef fish in the Caribbean (González *et al.* 2009) – and freshwater ecosystems: the Nile Perch *Lates niloticus*, for instance, has an impact on native fish in Lake Victoria (Balirwa *et al.* 2003). Invasive species have particularly acute effects on the terrestrial biodiversity of small islands (McGeoch *et al.* 2010). Data from Europe show that the number of alien species has increased by 76 per cent since 1970 (Butchart *et al.* 2010), a pattern that is likely to be similar in other places. In another study, invasive alien species were a factor in more than 50 per cent of vertebrate extinctions where the cause was known, and were the sole cause of 20 per cent of extinctions (Clavero and García-Berthou 2005).

Climate change

Climate change is an increasingly important threat to species and natural habitats. There is widespread evidence that changes in phenology, including the timing of reproduction and migration, physiology, behaviour, morphology, population

density and distributions of many different types of species are driven by climate change (Rosenzweig *et al.* 2007). For example, trends in European bird populations since 1990 show a growing impact: populations are increasing among the species projected to benefit from climate change while population decline is documented for those projected to undergo range contraction (Gregory *et al.* 2009). In the Arctic, tundra habitats are shrinking owing to tree-line advance (Callaghan *et al.* 2005). In the marine realm, climate change is causing widespread die-off of coral reefs through rising temperatures and ocean acidification (Baker *et al.* 2008; Carpenter *et al.* 2008; Hoegh-Guldberg *et al.* 2007). The Arctic ice cap is also shrinking rapidly, with likely impacts on ice-dependent species (McRae *et al.* 2010; IPCC 2007), as well as shifts in phenology and distribution of marine species (Dulvy *et al.* 2008; Hiddink and Ter Hofstede 2008; Richardson 2008; Perry *et al.* 2005). Recent studies have also projected distribution shifts of 1 066 marine fish and invertebrate species polewards at an average rate of 40 km per decade (Cheung *et al.* 2009), leading to likely disruption of community composition and local extinctions.

For many wetlands, changes in rainfall and evaporation are expected to have major impacts on water regimes, affecting both migratory and residential species (Finlayson *et al.* 2006), while changes in flow in both the short and long term will impact many aquatic species (Bates *et al.* 2008; Xenopoulos and Lodge 2006). Climate change will also act synergistically with other threats, such as the spread of diseases and invasive alien species (Benning *et al.* 2002). However, in many instances it may be difficult to differentiate the effects of these different threats, as has been outlined for wetlands and rivers in Australia (Finlayson *et al.* 2011).

Pollution

Pollutants such as pesticide and fertilizer effluents from agriculture and forestry, industry including mining and oil or gas extraction, sewage plants, run-off from urban and suburban areas, and oil spills, harm biodiversity directly through mortality and reduced reproductive success, and also indirectly through habitat degradation (MA 2005a). Inland wetlands and coastal marine habitats face a major threat from waterborne pollutants (Chapter 6) (Finlayson and D'Cruz 2005). Meanwhile, atmospheric pollution in terrestrial systems, particularly the deposition of eutrophying and acidifying compounds such as nitrogen and sulphur (Chapter 2), is also important. Rates of nitrogen deposition increased sharply after 1940 but have levelled out since 1990, probably owing to an overall decrease in biomass burning, though there is regional variation (Butchart *et al.* 2010). Nevertheless, nitrogen deposition continues to be a significant threat to biodiversity, especially for species that have adapted to low-nitrogen habitats (Dise *et al.* 2011).

Additional threats

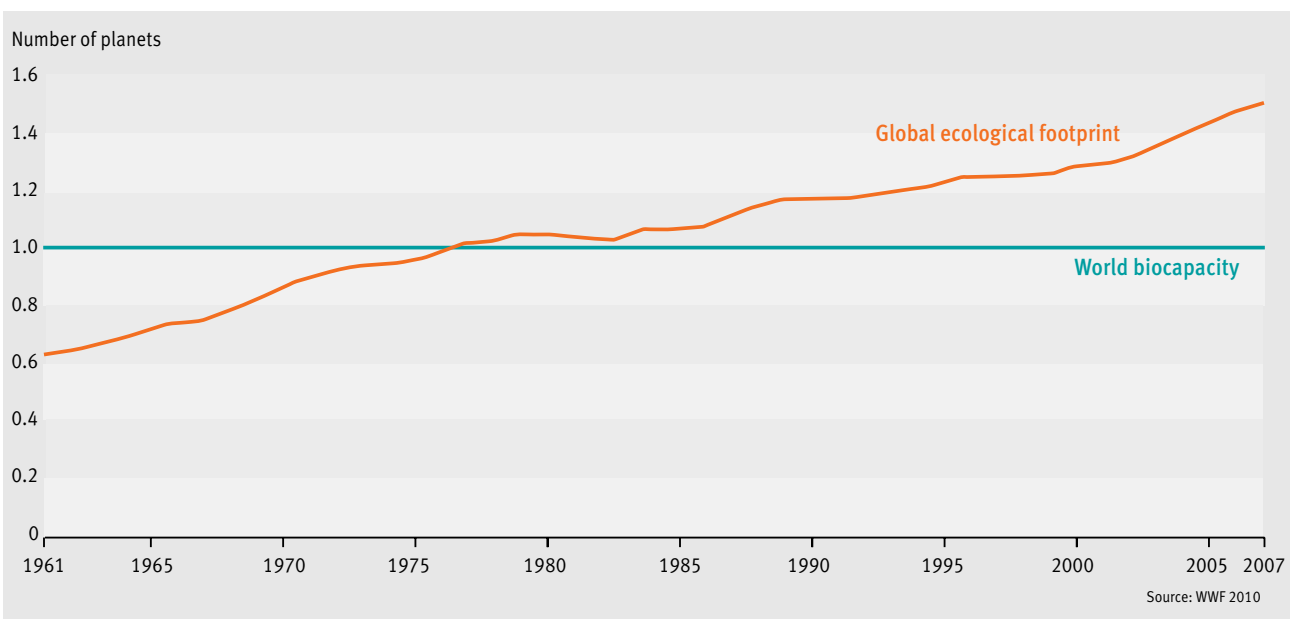
Additional threats to biodiversity include changes in fire regimes, problematic native species (Figure 5.1) and negative influences from human activities. Influences from human activities that may be harmful to biodiversity include artificial illumination,

Box 5.4 The ecological footprint: an indicator of the pressures on biodiversity

The ecological footprint is a resource accounting tool that measures how much biologically productive land and sea area – crop and grazing land, forests, fishing grounds and built-up land – is demanded by a given population or activity, and compares this to how much land and sea is available (Kitzes and Wackernagel 2009; Wackernagel *et al.* 2002; Wackernagel and Rees 1996). It has become an increasingly popular headline indicator of broad human pressures on the environment, although its methodology and application continue to be debated (Kitzes *et al.* 2009; Best *et al.* 2008; Fiala 2008).

Ecological footprint analysis shows that the global demand for biologically productive areas has approximately doubled since the 1960s (WWF 2010). In 2007, global society demanded more than 1.5 planets' worth of productive biological capacity, a deficit that can only be met through the depletion of stocks of renewable resources or the accumulation of waste product, most importantly carbon dioxide (CO₂) in the atmosphere (Figure 5.5). Together with other indicators (Butchart *et al.* 2010), this trend provides evidence of an overall increase in pressures on biodiversity. The continued growth of these pressures is likely to increase the difficulty of halting or reversing global loss.

Figure 5.5 The ecological footprint, 1961–2007



genetically modified organisms (Box 5.5), microplastics, nanotechnology, geo-engineering, and high levels of human appropriation of net primary productivity (Box 5.4) (Cole 2011; Gough 2011; Galgani *et al.* 2010; Hölker *et al.* 2010; Sutherland *et al.* 2009, 2008). Scientific understanding of the specific nature of threats to biodiversity from these influences is building. Meanwhile, the causes of some recent biodiversity declines remain unclear, and further research is required to elucidate the problems and identify solutions, for example for mammals in northern Australia (Woinarski *et al.* 2011) or trans-Saharan migrant birds (Moeller *et al.* 2008).

Patterns of biodiversity change

Biodiversity is deteriorating at the level of populations, species and ecosystems, and genetic diversity is also suspected to be declining, although trends remain largely

unknown (Box 5.3) (Butchart *et al.* 2010; CBD 2010b; Vié *et al.* 2009). Populations of vertebrate species recorded in the Living Planet Index have declined on average by 30 per cent since 1970 (Figure 5.6) (Loh 2010; Collen *et al.* 2008a). Declines in freshwater populations are steeper, at 35 per cent since 1970, than those for terrestrial populations, which have fallen by 25 per cent and marine populations by 24 per cent; those in the tropics are steeper than those in temperate latitudes. Habitat-specific trends are available for some regions for birds and show, for example, that European farmland bird populations have declined by 48 per cent on average since 1980 (Gregory *et al.* 2005). North American grassland and dryland species have declined by 28 per cent and 27 per cent respectively since 1968; but North American wetland bird species have increased by 40 per cent (Butchart *et al.* 2010; NABCI US Committee 2009).

At the species level, the proportion of species threatened with extinction – classified as critically endangered, endangered or vulnerable on the IUCN Red List – ranges from 13 per cent for birds to 63 per cent for cycads, and averaging almost 20 per cent for vertebrates (Baillie *et al.* 2010; Hoffmann *et al.* 2010). Furthermore, Red List Indices for mammals, birds, amphibians and corals show that considerably more species have become more threatened with extinction over recent decades than have become less threatened, and declines have been steepest for corals (Figure 5.7) (Butchart *et al.* 2010; Hoffmann *et al.* 2010). The composition of biological communities is increasingly disrupted by human activities, in particular through overexploitation. For example, in some oceans the community structure appears to have shifted to lower trophic levels owing to fisheries targeting predators and larger fish species (Branch *et al.* 2010; Pauly and Watson 2005). This phenomenon of fishing down the food web has been reported widely in many parts of the ocean, such as in Canada (Pauly *et al.* 1998), Brazil (Freire and Pauly 2010), India (Bhathal and Pauly 2008), Thailand (Pauly and Chuenpagdee 2003), the North Sea (Heath 2005) and the Caribbean (Wing and Wing 2001). However, the use of catch data to indicate fishing down the food web may be confounded by data quality and factors such as the spatial expansion of fisheries (Swartz *et al.* 2010), and may need careful interpretation if independent data on stock levels are unavailable (Branch *et al.* 2011). Other indicators, such as the Fishing-In-Balance (FIB) index, may be preferable in future (Kleisner and Pauly 2010; Bhathal and Pauly 2008).

At the level of habitats, losses include more than 100 million hectares of forest globally during 2000–2005, or 3 per cent of the 3.2 billion hectares in existence in 2000 (Hansen *et al.* 2010);

Figure 5.6 Living Planet Index, 1970–2007

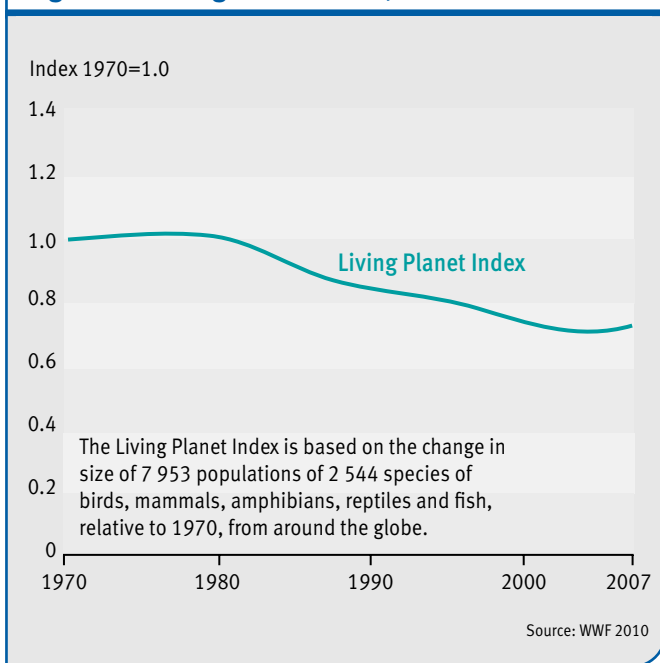
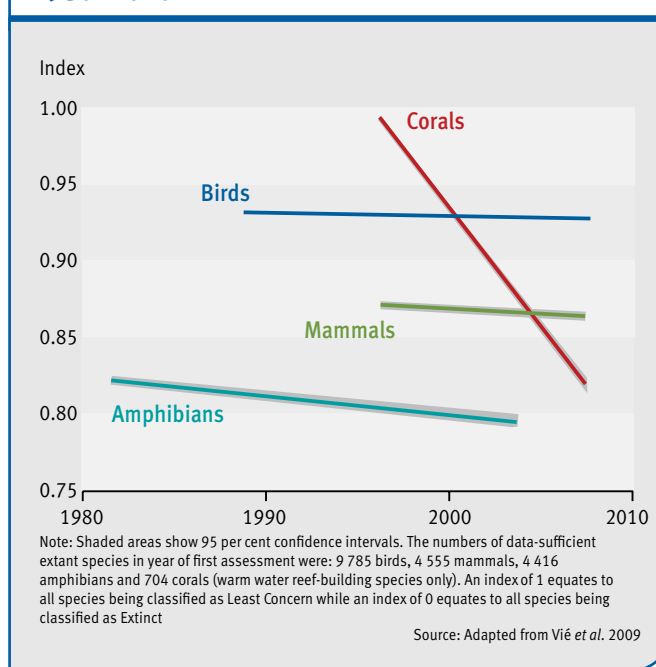


Figure 5.7 Red List Indices of species survival for all species of birds, mammals, amphibians and corals, 1980–2010



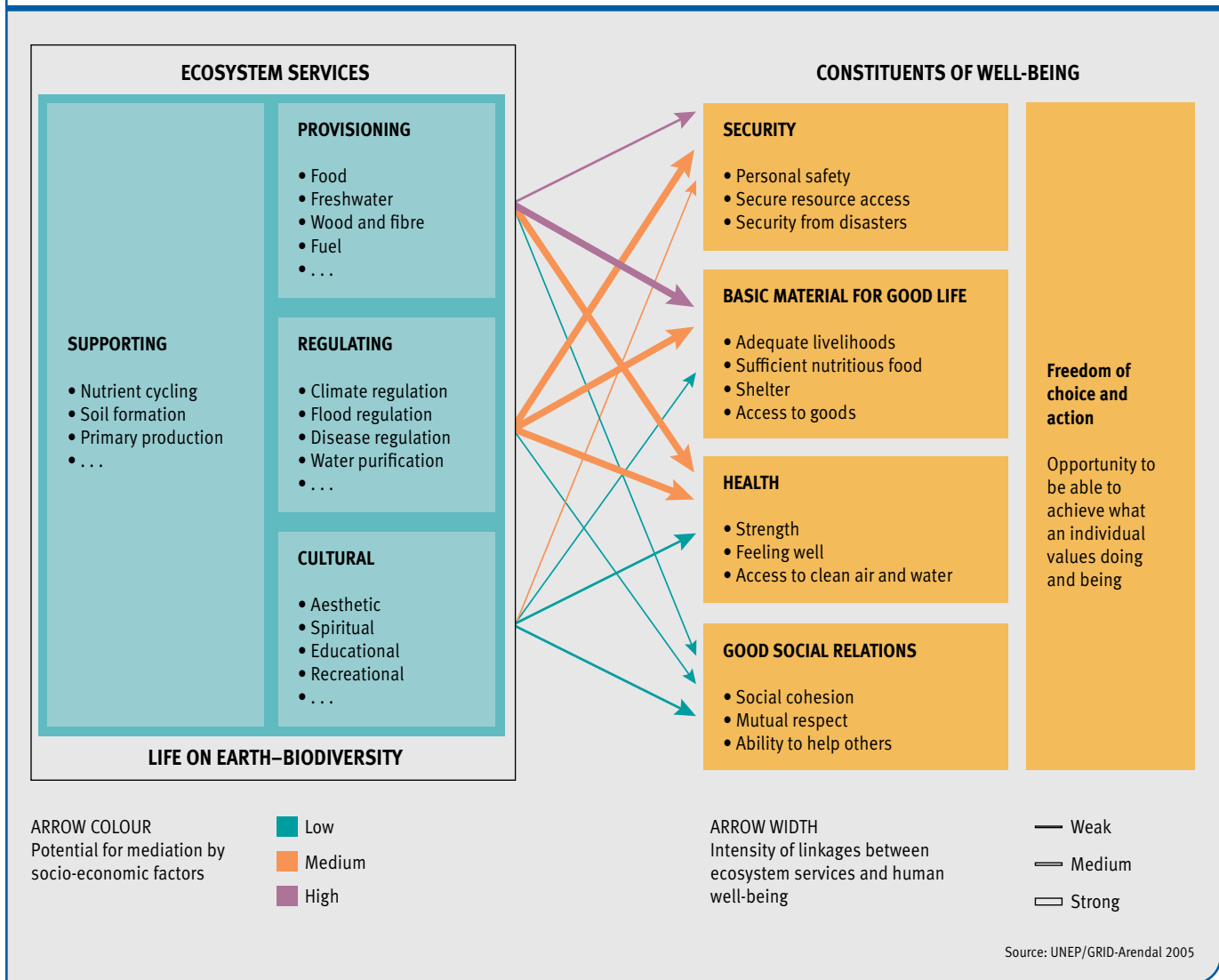
20 per cent of mangroves since 1980; and 20 per cent of seagrasses since 1970 (Butchart *et al.* 2010; Waycott *et al.* 2009). Remaining habitats are increasingly degraded – measures of net primary productivity, for example, show that around one-quarter of the terrestrial land area is degraded, including around 30 per cent of all forests, 20 per cent of cultivated zones and 10 per cent of grasslands (Bai *et al.* 2008). Similarly, coral reefs have declined globally by 38 per cent since 1980 (Butchart *et al.* 2010; Spalding *et al.* 2003). Natural habitats are also becoming increasingly fragmented – 80 per cent of remaining forest fragments in the Brazilian Atlantic Forest are now smaller than 50 hectares (Ribeiro *et al.* 2009), while two-thirds of the world’s largest rivers are now moderately to severely fragmented by dams and reservoirs (Nilsson *et al.* 2005).

CROSS-CUTTING ISSUES

Benefits to people from biodiversity

Biodiversity underpins the ecosystem services that supply benefits to people (UNEP 2007; MA 2005a). The deterioration or loss of biodiversity and ecosystem services tends to affect poor people most directly as they are the most dependent on local ecosystems and often live in places that are most vulnerable to ecosystem change (UNEP 2007). Because the precise mechanisms of human dependence on biodiversity are not fully understood and biodiversity is undervalued – especially for regulating services – maintenance of biodiversity is rarely fully integrated into policy. Progress has been made since the Millennium Ecosystem Assessment (TEEB 2010; MA 2005a), which strongly supported the concept of ecosystem services

Figure 5.8 Relationships between biodiversity, ecosystem services and human well-being



and their role in providing supporting, provisioning, regulating and cultural services (Figure 5.8). More recently, The Economics of Ecosystem Services and Biodiversity (TEEB 2010) and green economy approaches have quantified the value of biodiversity and ecosystem services (UNEP 2011). The Ramsar Convention on Wetlands has further outlined the direct links that exist between ecosystem services from wetlands and human health (Horwitz and Finlayson 2011; Horwitz *et al.* 2011).

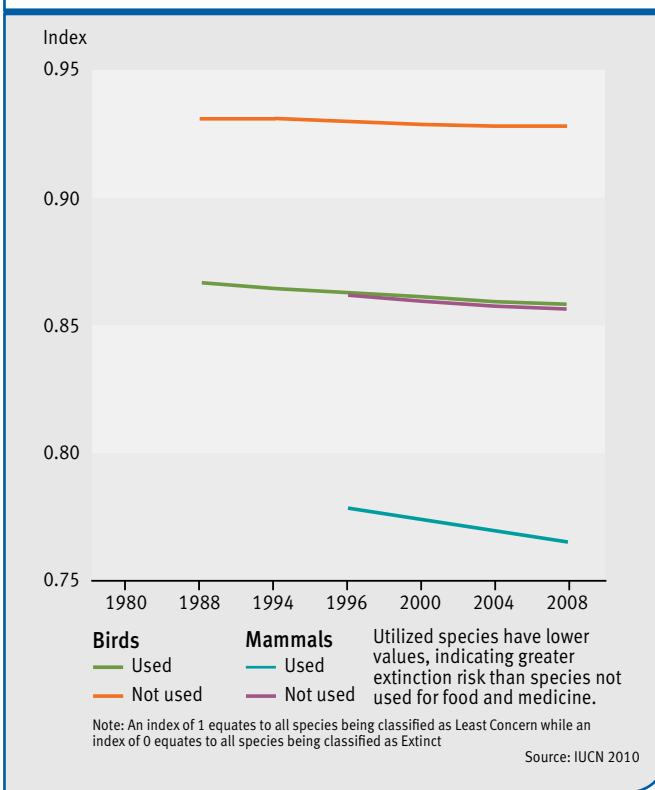
Biodiversity and human well-being

Biodiversity and ecosystem services provide food, medicines, fish and timber products as well as biomass, energy and water-related services that people need for their livelihoods and well-being. Too often, the use and management of these provisioning services has failed to focus on conserving the ecosystems providing them. This has resulted in the degradation of regulating and supporting services that are important for overall system functioning and long-term resilience to change and therefore

to human well-being, a point that has been well demonstrated when considering the effects of expanding agriculture and water management (Gordon *et al.* 2010; Falkenmark *et al.* 2007). Decreases in provisioning services may be a definitive signal that a biophysical threshold has already been passed with respect to an ecosystem’s ability to provide a service, as in the case of a number of fishery collapses (Westley *et al.* 2011).

Food and medicines produced from terrestrial and aquatic ecosystems include wild-harvested products, as well as farmed crops, livestock, fish and aquaculture products. Wild-harvested foods, such as wild meat, non-timber forest products, wild fruits and freshwater resources, remain important for food security, health, cultural identity and adaptation for many people (Golden *et al.* 2011; Nasi *et al.* 2008; Robinson and Bennett 2000). Likewise, in some Asian and African countries, up to 80 per cent of the population depend on traditional medicines (WHO 2003). Assessment of the status of birds and mammals used

Figure 5.9 Red List Indices of species survival for birds and mammals used for food and medicine, 1988–2008

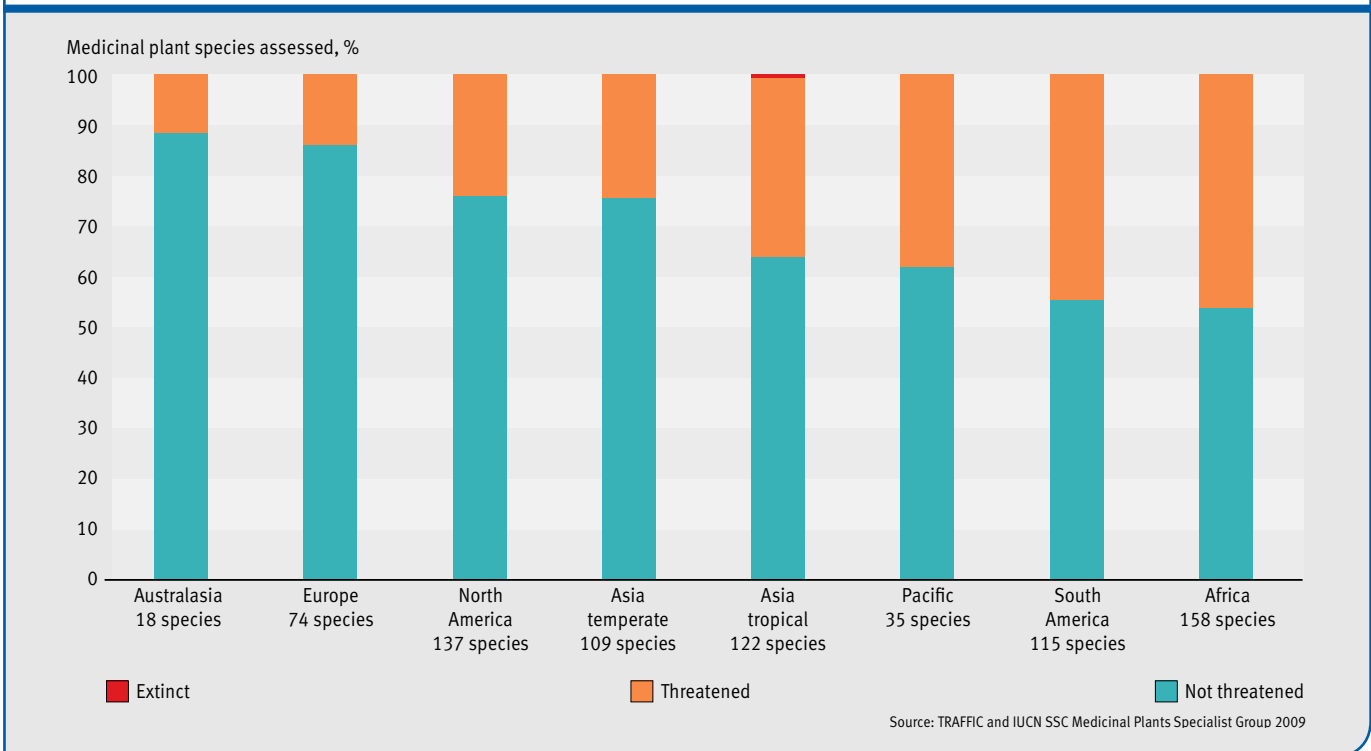


for these purposes indicates that they are on average facing a greater extinction risk than other species (Figures 5.9 and 5.10). Although global data for plants are not available, medicinal plants face a high risk of extinction in those parts of the world where people are most dependent on them. This emphasizes the threat posed by biodiversity loss to the health and well-being of people directly dependent on the availability of wild species.

Fisheries provide a major source of food, revenues and employment with globally over 80 million tonnes of biomass being captured annually from the ocean (Sumaila *et al.* 2010) and large amounts from inland waters (Kura *et al.* 2004). However, as fish stocks are depleted, this supply is becoming increasingly dependent on aquaculture, which itself can have many negative environmental and social impacts such as pollution, introduction of exotic species and displacement of small-scale fishing practices (Barnhizer 2001; Naylor *et al.* 2000; Emerson 1999). Recent estimates suggest that in 2000 alone, the potential global catch losses due to overfishing amounted to 7–36 per cent of the actual tonnage landed that year, resulting in a landed value loss of US\$6.4–36.0 billion. This amount could have helped prevent around 20 million people worldwide suffering from undernourishment (Srinivasan *et al.* 2010).

Agricultural production is also supported by biodiversity and ecosystem services (Altieri 1999), and agricultural diversity can in turn contribute to food security by supporting adaptation to a changing climate (Thrupp 2000). Small-scale livestock husbandry

Figure 5.10 Distribution and conservation status of medicinal plant species assessed for the IUCN Red List, by region, 2009





Large-scale dams and their associated reservoirs affect biodiversity by displacing species and restricting their movement up and down rivers.

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and pastoralism can both contribute to maintaining biodiversity and to sustainable local economies, adaptation to climate change, resistance to disease and cultural diversity (FAO 2009). Equally, overgrazing can cause soil erosion and desertification, thereby decreasing provisioning services. Threats from livestock production to biodiversity are likely to grow as demand for meat and dairy increases, requiring more livestock feed and more water (Thornton 2010). The complex issue of ensuring a sustainable food supply for an expanding human population has been addressed in recent assessments (IAASTD 2009; Molden 2007), along with the biodiversity benefits that can be obtained by balancing food production with the supply of other ecosystem services. Pressures on land, water and biodiversity from agriculture and aquaculture could be reduced in some countries by reducing overconsumption of food, shifting towards diets comprising less meat/fish, and reducing crop losses and food waste (Godfray *et al.* 2010; WHO 2005).

Energy for much of the world's population is derived from biomass. The most commonly used fuels for heating and cooking are wood, charcoal and plant and animal waste (Berndes *et al.* 2003). Hydropower depends on high volumes and regular rates of flow of water to dams from functioning ecosystems in the catchment area, but often contributes to widespread negative environmental and social impacts, particularly loss of biodiversity and displacement (WHO 2009; Greathouse *et al.* 2006; Ligon *et al.* 1995). The degradation or loss of ecosystem services that provide energy is evident in the siltation of reservoirs and loss of water volume associated with deteriorating catchment areas (Nilsson *et al.* 2005); in the deforestation

created by the overharvesting of woody vegetation; and in the overuse of agricultural waste and animal manure. The loss of ecosystem services associated with overharvesting, poor management, climate change and, for example, an increase in forest fires, is often felt by already marginalized groups who have to collect fuelwood and/or other forms of biomass for household energy needs (CBD 2010b). The development of renewable energy from marine and coastal environments, such as that from offshore wind farms, may result in trade-offs between energy production and habitat loss.

Freshwater from surface and groundwater ecosystems is a critical provisioning service used for drinking, sanitation, cooking and agriculture (Chapter 4). Wetlands and rivers regulate flows and material cycles that play indispensable roles in supporting human life systems and benefiting many sectors of society (Arthurton *et al.* 2007; Falkenmark *et al.* 2007; Finlayson and D'Cruz 2005). These ecosystems also provide important regulatory services in the form of water purification, erosion control and storm buffering (Morris *et al.* 2003). Meanwhile, groundwater ecosystems provide great social and economic benefits through the provision of low-cost, high-quality water supplies for both urban and rural areas (Bjorklund *et al.* 2009). Groundwater is also important for irrigation, with Siebert *et al.* (2010) reporting that 40 per cent of irrigated areas, some 300 million hectares representing about 20 per cent of total farmland, are supplied by groundwater.

Cultural and spiritual values from biodiversity are important to many communities (Posey 1999). Many have benefited from exploiting the recreational and cultural value of biodiversity

for ecotourism (Ehrlich and Ehrlich 1992). For example, lakes, wetlands, rivers and coastal ecosystems offer significant ecotourism potential with, for example, coral reef tourism in Belize estimated to be worth US\$150–196 million per year (Cooper *et al.* 2009). These aquatic ecosystems also supply water that is integral to many social, spiritual and religious activities. Examples include the sacred status of water sources and riparian zones for the Bantu-speaking peoples of Southern Africa (Bernard 2003) and the duty of care exercised by Maori in New Zealand for the life force exhibited by water (Williams 2006).

The wildlife and timber trade, comprising the sale or exchange of wild animal and plant resources, is prevalent within national borders. However, significant volumes can also be traded internationally, for example highly prized products such as caviar and medicines. The primary motivating factor for wildlife traders is financial, ranging from small-scale local income generation to major profit-oriented business, such as marine fisheries and logging companies. In some cases, harvest and trade of species can provide a significant proportion of local or national income. Overall, the legal trade in wildlife including live animals, animal products for clothing and food, ornamental and medicinal plants, fish and timber was estimated at over US\$300 billion in 2009 (TRAFFIC in prep.; Roe 2008). Furthermore, illegal trade is believed to be substantial, possibly worth US\$10 billion (Haken 2011). Timber and seafood are the most important categories of international wildlife trade in terms of both volume and value: around 90 million tonnes of fish were captured in 2008 with trade valued at more than US\$100 billion (FAO 2010b), while the trade in primary wood products in 2009 was valued at US\$189 billion (FAO 2010a).

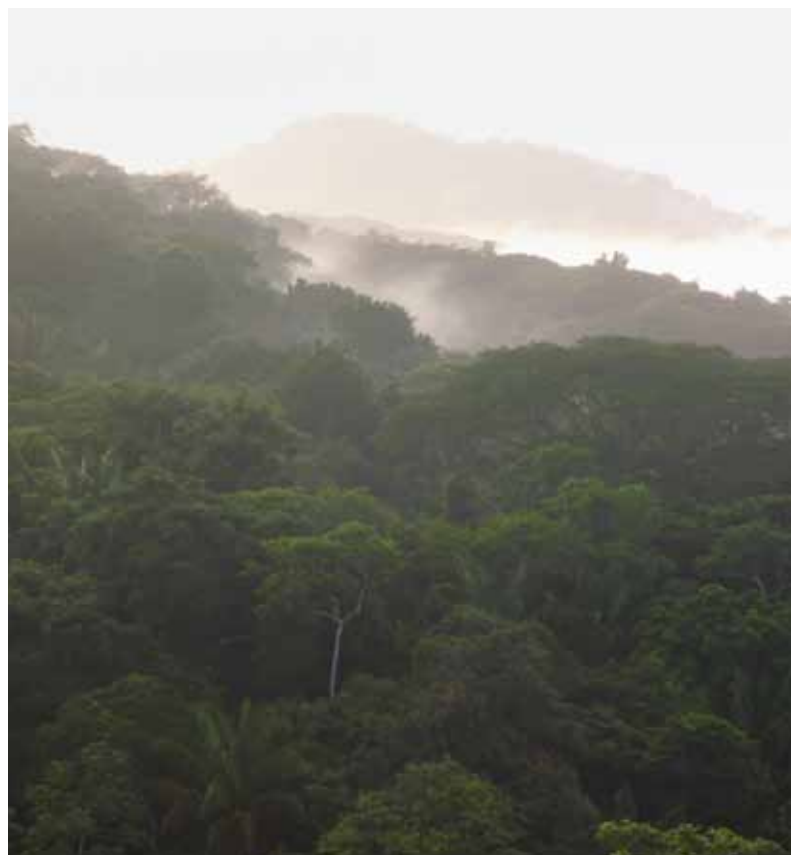
Biodiversity and climate change

Biodiversity plays an important role both in supporting efforts to mitigate climate change and in enabling societal adaptation to its effects. Ecosystems store and sequester carbon through biological and biophysical processes that are underpinned by biodiversity. About 2 500 gigatonnes (billion tonnes) of carbon are stored in terrestrial ecosystems, compared to approximately 750 gigatonnes in the atmosphere (Chapter 3) (Ravindranath and Oswald 2008). Almost 38 000 gigatonnes are stored in the oceans, of which about 37 000 gigatonnes are in deep ocean layers that will only feed back to atmospheric processes over very long time scales (Sabine *et al.* 2004). Around 1 150 gigatonnes are stored in forests, with 30–40 per cent in biomass and 60–70 per cent in soil. Significant carbon stocks are also found in other terrestrial ecosystems including wetlands and peatlands. Indeed, the latter cover only 3 per cent of the land area, but reputedly contain nearly 30 per cent of all global soil carbon (Parish *et al.* 2008). Marine ecosystems on average take up an additional 2.2 gigatonnes of carbon per year (Le Quéré *et al.* 2009; Canadell *et al.* 2007). The critical role of freshwaters in the global carbon cycle has only recently been demonstrated (Battin *et al.* 2009; Cole *et al.* 2007).

The importance of forests in storing almost half of all terrestrial carbon, and sequestering carbon from the atmosphere, means that they play a major role in climate change mitigation. Primary

forests are more biologically diverse, and also more carbon dense, than other forest ecosystems. Modified natural forests and plantations have less biodiversity and lower carbon stocks than primary forests under similar environmental conditions (CBD 2009a). Efforts to maintain forest health, for example through incentive mechanisms such as Reducing Emissions from Deforestation and Degradation (REDD+), have the potential to help mitigate climate change. These can also have multiple benefits for biodiversity if interventions ensure that environmental and social safeguards are respected, such as full and effective participation of indigenous and local communities (Cotula and Mathieu 2008), and if they avoid displacing deforestation and degradation from areas of lower conservation value to those of higher biodiversity value, or exerting pressures on other native ecosystems.

Many of the options available to help society adapt to the effects of climate change depend on and are enhanced by biodiversity. Ecosystem-based adaptation uses the range of opportunities for the sustainable management, conservation and restoration of ecosystems to provide services that enable people to adapt to the impacts of climate change. For example, intact, well-functioning ecosystems, with natural levels of species diversity, are usually more able to continue to provide ecosystem services, and resist and recover more readily from extreme



The tropical forests of Panama, which contain some 1 569 known species of amphibians, birds, mammals and reptiles, are also a valuable carbon sink. © Jason Jabbour

weather events than degraded, impoverished ones (CBD 2009a). Healthy ecosystems also play an important role in protecting infrastructure and enhancing human security, and therefore in reducing the risk from disasters (ISDR 2009). Ecosystem-based adaptation options are often more accessible to the rural poor than interventions based on infrastructure and engineering, and there can be multiple social, economic and environmental co-benefits for local communities from its use when designed and managed appropriately.

Responses to the threats to biodiversity

Managing agriculture and biodiversity

Successful management of agricultural landscapes requires a reduction of habitat loss and degradation whilst providing an adequate supply of food for a growing human population. Sustainable agriculture has received increasing attention because expanding agriculture is globally the principal driver of biodiversity decline (Brussaard *et al.* 2010; IAASTD 2009; MA 2005b). In recent years attention has been given to a new paradigm of ecoagriculture or integrated conservation-agriculture, which seeks to integrate biodiversity conservation with rural development. This paradigm is being explicitly considered in shaping conservation strategies with clearly identified economic and ecological relationships that include ecosystem services (IAASTD 2009; Scherr and McNeely 2008). The extensification of agriculture may require more land than

intensive agriculture to achieve the same production levels (Godfray *et al.* 2010; Phalan *et al.* 2011), but it may be more sustainable in the long term and have fewer impacts on wildlife and human health (Perfecto and Vandermeer 2010). New approaches that combine the most effective, least harmful practices from intensive and extensive farming, sometimes termed sustainable intensification, will be needed (Royal Society 2009). In this context the use of GMOs in agriculture and also in aquaculture potentially presents both threats and opportunities for biodiversity (Box 5.5).

Managing invasive species

Successful management of invasive species relies on preventing the introduction and spread of species to new areas, as well as controlling and eradicating established invaders. Ten different international agreements and organizations have some relevance, including the International Plant Protection Convention, the World Trade Organization, the International Maritime Organization, the Convention on International Civil Aviation and the Convention on Biological Diversity. Since 1970 there has been a significant increase in the number of parties to these agreements (Figure 5.11), with 81 per cent of the world's countries acceding to them (McGeoch *et al.* 2010). Although this signifies an international intent to manage biological invasions, no international agreement currently deals exclusively with the trade, transport or control of alien and invasive species (Stoett

Box 5.5 Genetic modification

Genetic modification (GM) remains controversial, both a potential threat and an opportunity for biodiversity conservation, depending on the context. The technology is widely used in pharmaceuticals and crop production, but many consider it an unwarranted risk to the environment and human health. A genetically modified organism (GMO) is defined by the Cartagena Protocol on Biosafety as any living organism that possesses a novel combination of genetic material obtained through the use of modern biotechnology (CBD 2000); generally by the transfer of genetic material from one species to another. The vast proportion of GM crops has been modified to be tolerant of broad-spectrum herbicides to allow more efficient weed control and/or to express a toxin (Bt) that acts against the caterpillars of butterflies and moths that live and feed inside the crop plants.

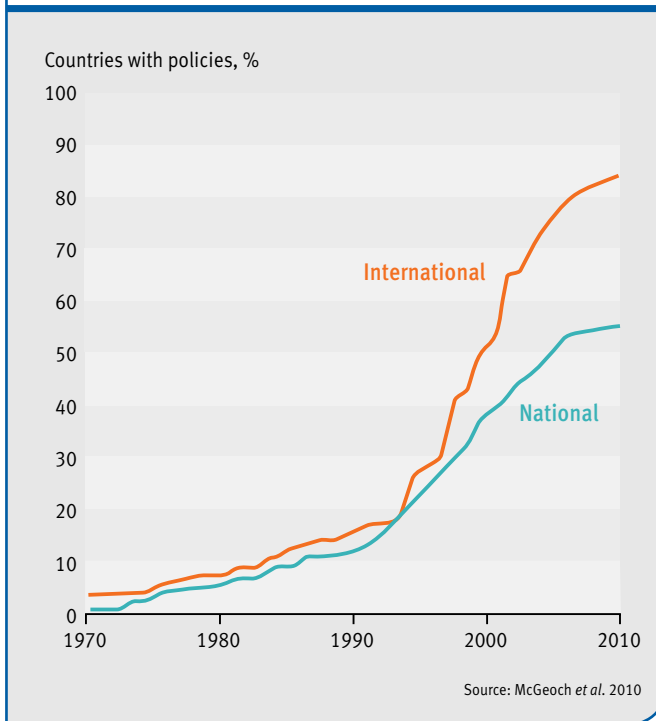
Genetically modified crops were first planted commercially in 1996, and by 2010 they covered 148 million hectares. Although the largest areas were in the United States, Canada, Brazil, China and Argentina, the greatest number of adopters – 14.4 million out of an estimated total of 15.4 million – were small farmers in developing countries (James 2010).

Genetic modification technologies are being developed to control malaria, both by making wild mosquito populations

less capable of carrying the malaria parasite (malERA 2011; Sinkins and Gould 2006) and by reducing mosquito numbers through introducing sterility, replacing the use of radiation (Bax and Thresher 2009).

Several environmental risks from GMOs have been identified, including the loss of genetic diversity of agricultural species and their wild relatives through gene flow, although this also occurs with non-GM crops (Piñeyro-Nelson *et al.* 2009). Another concern is the effects on organisms that are not the target of the GM trait, although Bt crops have few toxic effects on non-target species as the Bt toxins produced are highly specific and only expressed in the plant itself. Further, the effects tend to be outweighed by overall increases in invertebrate numbers because of lower levels of pesticide use (Marvier *et al.* 2007). Lower pesticide use also has benefits for human health in some areas (Raybould and Quemada 2010). In contrast, GM crops tolerant of broad-spectrum herbicides such as glyphosate often result in fewer weeds than conventional crops, and therefore make less food available to farmland birds (Gibbons *et al.* 2006). In addition, species are evolving resistance to both glyphosate and Bt (Powles 2010; Liu *et al.* 2010). These latter outcomes are examples that raise concern over the complexities of the environmental implications of GMOs.

Figure 5.11 Commitments to manage alien invasive species, 1970–2010



2010). At a national level, only 55 per cent of countries have legislation to prevent the introduction of new ones and to control existing ones, and less than 20 per cent are estimated to have comprehensive strategies and management plans. In many cases, information on existing management activities either does not exist or is not readily available (Stoett 2010).

To control threats from invasive alien species, the following actions are seen as necessary:

- integrated planning to prevent further introductions by managing priority pathways;
- focus on controlling established species and priority invaders with significant impacts on biodiversity (Hulme 2009); and
- investment in the knowledge generation, data collation and research needed for risk assessments (McGeoch *et al.* 2010).

Managing wildlife trade and use

Wildlife use and trade can be managed through a variety of measures, including regulatory measures such as policies and laws and voluntary ones such as certification schemes; formal measures such as positive and economic incentives, and informal ones such as influencing sustainable consumer behaviour; direct measures such as customs inspections and other enforcement actions, and indirect ones such as economic influences. These measures can be applied at a variety of levels from the local, such as delineating resource extraction zones in protected areas or establishing community-based natural resource management, to the global, such as through the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (Roe 2008).

Managing the impacts of climate change on biodiversity through mitigation and adaptation

Managing the impacts of climate change will be important, as recent studies show that the range shifts of terrestrial organisms towards the poles and higher altitudes as a result of climate change may be significantly faster than previously thought (Tewksbury *et al.* 2011). Minimizing the adverse impacts of climate change on biodiversity is dependent on:

- efforts to mitigate climate change itself (Chapter 3);
- measures to ensure that those activities and societal adaptation efforts do not themselves have adverse impacts on biodiversity; and
- application of best practice in conserving and restoring biodiversity in the face of climatic change.

Of the wide range of approaches, many are dependent on the conservation and sustainable use of healthy ecosystems, and offer opportunities for synergies in terms of climate change mitigation and maintenance of biodiversity. In particular, this concerns intact forests and wetlands, but also natural and semi-natural grasslands and many agricultural ecosystems. For example, some agricultural approaches, such as conservation tillage and agroforestry, can result in the maintenance and enhancement of terrestrial carbon stocks and also contribute to the conservation and sustainable use of biodiversity (CBD 2009a). Traditional knowledge and systems of small-scale livestock husbandry, farming, and forest product collection can greatly enable local mitigation and adaptation in culturally appropriate ways (RECOFTC 2010; IUCN 2008). However, ecosystem-based approaches also carry risks and these need



The rehabilitation of wetlands is an important tool for restoring biodiversity and building resilience to the impacts of climate change.

© J. Smith/Still Pictures



Considerable efforts have been made over the past decade to promote marine protected areas in Eastern Africa. © J Tamelander/IUCN

to be assessed and addressed. In the case of forests, the United Nations Framework Convention on Climate Change (UNFCCC 1992) and CBD have recognized a need for safeguards, particularly for biodiversity and human communities, to minimize risks associated with REDD+. There is also a risk of conflict between the goals of the Kyoto Protocol's Clean Development Mechanism for carbon sequestration and biodiversity conservation (Heiskanen 2009; Kneteman and Green 2009).

Other concerns about the impacts of mitigation activities include those related to artificial ocean fertilization through using nutrients such as iron or nitrogen to increase the uptake and sequestration of atmospheric carbon. The effectiveness of this approach is highly uncertain and increasingly thought to be quite limited. Potential negative environmental effects include increased production of methane and nitrous oxide and changes in phytoplankton community composition, which may lead to toxic algal blooms (CBD 2009b). Alternative sources of energy production, such as biofuels, hydropower, wind farms and oceanic tide generators have all been documented to have impacts on biodiversity if safeguards are not developed (Keder and McIntyre Galt 2009; McDonald *et al.* 2009). The most fundamental strategy for conserving biodiversity in the face of climate change will continue to be promoting the conservation

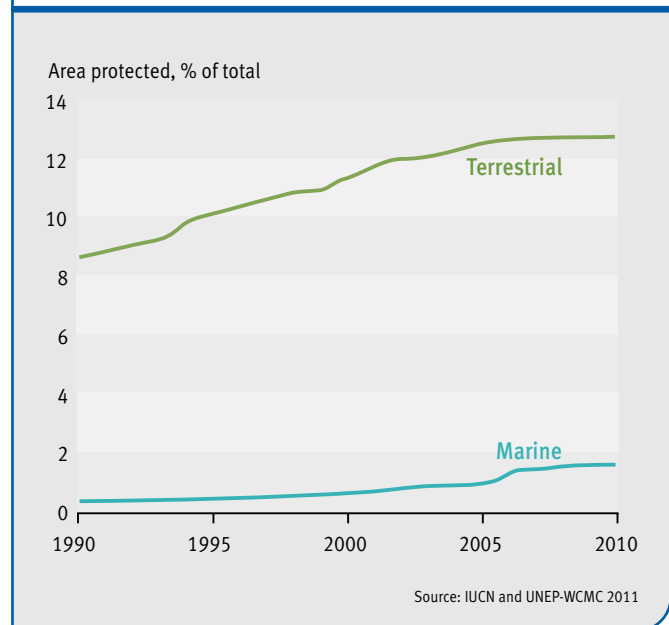
of intact and functioning ecosystems supported by restoration initiatives wherever possible (CBD 2009a).

Managing area-based conservation

Protected areas are seen by many as the core means of preventing ongoing losses of species and habitats. Protected areas have expanded over the past 20 years in both number and area (Figures 5.12 and 5.13) and now cover 13 per cent of the world's land area (IUCN and UNEP-WCMC 2011). However, coverage is uneven, and 6 of the 14 global biomes and half of the 821 terrestrial ecoregions do not meet the CBD target for 10 per cent of their area to be protected by 2010 (Jenkins and Joppa 2009). Furthermore, the expansion of the world's protected area network needs to be targeted at the most important sites for biodiversity. Some 51 per cent of the 587 sites identified by the Alliance for Zero Extinction as critical for the survival of hundreds of highly threatened species, and 49 per cent of the more than 10 000 important bird areas are still entirely outside the protected area network (Butchart *et al.* 2012). Even more importantly, the performance of protected areas in maintaining populations of their key species is poorly documented. Although some studies have found wildlife declines within some protected areas (Woinarski *et al.* 2011; Craigie *et al.* 2010), others demonstrate that protected areas have been effective in maintaining species that would otherwise have disappeared (Bruner *et al.* 2001). However, not all species may require protected areas to ensure their survival (Pereira and Daly 2006), and protected areas require complementary broad-scale conservation measures (Boyd *et al.* 2008).

Uneven protected area coverage of biomes is most evident in the marine realm, despite a CBD target to protect 10 per cent of the ocean by 2012. By the end of 2010 marine protected

Figure 5.12 Extent of nationally designated protected areas, 1990–2010



areas covered 1.6 per cent of the ocean area (IUCN and UNEP-WCMC 2011). Indeed, at the end of 2010, only 12 countries had designated more than 10 per cent of their waters, often through large areas, while 121 countries had yet to designate more than 0.5 per cent of their marine jurisdiction (Toropova *et al.* 2010). In response, the CBD has retained the 10 per cent target, with a revised achievement date of 2020.

Marine protected areas can be designated at a variety of levels of protection, but those with complete protection provide the greatest biodiversity benefits. A review of 112 independent studies in 80 different protected areas found significantly higher fish populations inside the reserves than in surrounding areas or in the same place before protection was established. Relative to reference sites, population densities were 91 per cent higher, biomass 192 per cent higher and average organism size and diversity 20–30 per cent higher, usually between one and three years after establishment of a reserve. These trends occurred even in small marine protected areas (Halpern 2003).

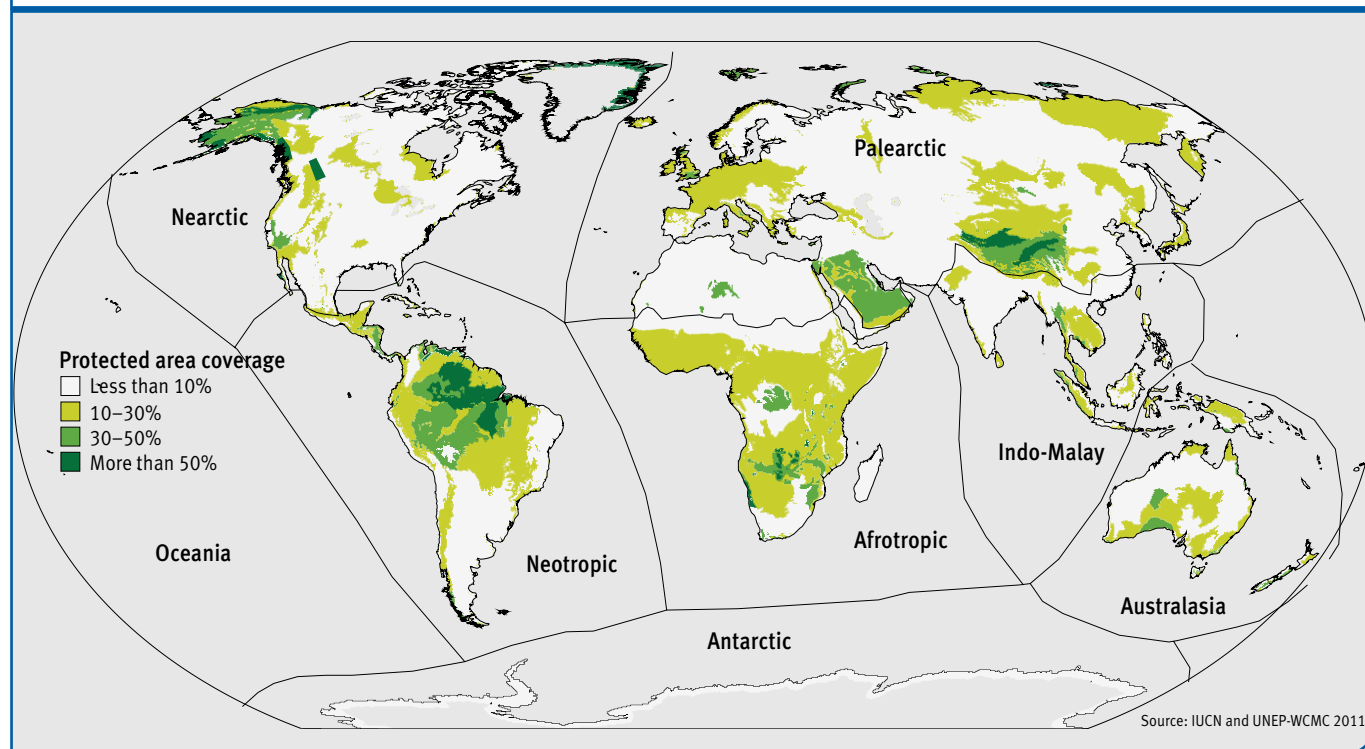
Protected areas can also play a key role in climate change mitigation and adaptation, preventing the conversion of natural habitats to other land uses and hence avoiding significant release of carbon (Dudley *et al.* 2010b). Emissions from land-use change, mainly forest loss, contribute up to 17 per cent of all anthropogenic greenhouse gas emissions (IPCC 2007). It has been estimated that about 15 per cent of the global terrestrial carbon stock is stored in the world's protected area network (Campbell *et al.* 2008), and the role that this can play in climate mitigation

is underlined by the fact that between 2000 and 2005, protected areas in humid tropical forests lost about half as much carbon as the same area of unprotected forest (Scharlemann *et al.* 2010).

Indigenous and community-conserved areas

Protected areas can be effectively managed by many groups, from government agencies to local communities and indigenous peoples, and from non-governmental organizations (NGOs) to private individuals. Recently, the full range of IUCN protected area categories has been brought into use for designating protected areas (Dudley *et al.* 2010a). For example, in Australia, protected areas established and managed by indigenous communities comprise nearly a quarter of Australia's national reserve system by area. Indigenous and community-conserved areas (ICCAs) and sacred natural sites (SNSs) have proven successful in conserving a rich biological and biocultural diversity by supporting the maintenance of traditional environmental knowledge and practices (Porter-Bolland *et al.* 2012; Sobrevila 2008). These community areas are extremely diverse, manifesting myriad ethical, economic, cultural, spiritual and political dimensions (Brown and Kothari 2011; Borrini-Feyerabend *et al.* 2010a, 2010b; Kothari 2006; Posey 1999). They include waterfowl nesting wetlands, roosting sites or other critical wild animal habitats, and landscapes with mosaics of natural and agricultural ecosystems such as the Potato Park in the Andean Highlands of Peru and the rice terraces of the Philippines. A number of studies demonstrate the wide range of values they provide (Box 5.6) (Mallarach *et al.* 2012; Verschuuren *et al.* 2010; ICCA 2009).

Figure 5.13 Proportion of each terrestrial ecoregion covered by protected areas, 2011



The number and extent of ICCAs and SNSs have not been comprehensively estimated. It has been, nevertheless, suggested that in some parts of the world their area is similar to that currently under government-managed protection (Box 5.6) (Molnar *et al.* 2004). Furthermore, it has been estimated that communities own or manage 22 per cent of all forests in 18 developing countries (White and Martin 2002). Recent analyses highlight the potential effectiveness of indigenous and community-managed areas in tropical forest conservation. For example, such areas can be more effective in reducing tropical deforestation than forest protected areas (Porter-Bolland *et al.* 2012), and indigenous and multiple-use protected areas can reduce the incidence of tropical forest fires as effectively as strict protection (Nelson and Chomitz 2011).

ICCAs and SNSs are increasingly recognized as legitimate and powerful tools for the security of both their custodians and the biodiversity they encompass, supported by a range of conservation, human-rights and development instruments. A preliminary survey of the laws and policies of 27 countries and one sub-national region showed that progress in national recognition of ICCAs and SNSs is patchy: some countries are moving rapidly, others slowly, and some not at all (Kothari *et al.* 2010). The biggest challenge, now that ICCAs and SNSs have global attention, is in gaining appropriate national recognition and support, particularly for tenure, customary practices and decision-making institutions, and other fundamental human rights (Stevens 2010). Activities relating to governance, participation, equity and benefit sharing in relation to protected areas merit increasing consideration.

Recognizing the value of cultural diversity and traditional knowledge

The recognition of human and natural systems as unified social-ecological systems is increasingly important for safeguarding biodiversity (Ostrom 2007). This growing understanding underscores the links between biological and cultural diversity and the role of local and indigenous peoples in the sustainable governance and management of biodiversity (Sutherland 2003; Moore *et al.* 2002). The Strategic Plan for Biodiversity and the Aichi Biodiversity Targets support greater respect of traditional knowledge and its full integration and reflection in CBD implementation at all levels, with the full and effective participation of indigenous and local communities (Aichi Target 18, Box 5.1). Information on the status and trends of linguistic diversity (Figure 5.14) has been used as a proxy indicator for traditional knowledge, innovations and practices, including those about biodiversity. Traditional knowledge is an invaluable and irreplaceable source of information about biodiversity and human relationships; its loss entails a loss of collective cultural heritage and capacity to adapt to and live sustainably within specific ecosystems and areas (Maffi and Woodley 2010; Swiderska 2009).

Access and benefit sharing of genetic resources and associated traditional knowledge

The fair and equitable sharing of the benefits of exploiting genetic resources is one of the three CBD objectives (Article 1), recognized as critical for biodiversity conservation. Through the recently adopted Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization, standards are established for regulating access to genetic resources

Box 5.6 Examples of community management

Globally:

Community-controlled or managed forests total some 400–800 million hectares (Molnar *et al.* 2004; White *et al.* 2004).

Africa:

Forty-seven of the approximately 70 Kaya forests, totalling about 6 000 hectares, have been legally recognized in Kenya and are being cared for in collaboration with local communities (Githitho 2003). In the Republic of Tanzania, a total area in excess of 2 million hectares is under community-based forest management (Blomley and Iddi 2009).

Europe:

In a small country like Estonia, there are estimated to be more than 7 000 sacred natural sites, although less than 500 are legally protected (Valk and Kaasik 2007).

Americas:

A fifth of the Amazon is classed as indigenous territory helping to achieve biodiversity conservation (Oviedo 2006), and more than 800 000 hectares of boreal forest and wetlands

have been declared protected traditional territory in Canada (Government of Manitoba 2011).

Asia:

Several thousand natural ecosystem sites, ranging from a hectare to several hundred square kilometres, are under community conservation in South Asia (Kalpavriksh 2011; Jana and Paudel 2010; Pathak 2009). At least 13 720 sacred groves have been reported in India and experts estimate the total number for the country at 100 000–150 000 (Malhotra *et al.* 2001). Across South East Asia and Japan, there are hundreds of community-managed marine areas oriented towards sustainable fisheries and coastal/marine ecosystem conservation (Yagi *et al.* 2010; Ferrari 2006; Lavides *et al.* 2006).

Oceania:

Forty indigenous protected areas cover more than 23 million hectares (DSEWPC 2011), and there are hundreds of community-conserved areas and locally managed marine areas in the South Pacific (Govan *et al.* 2009).



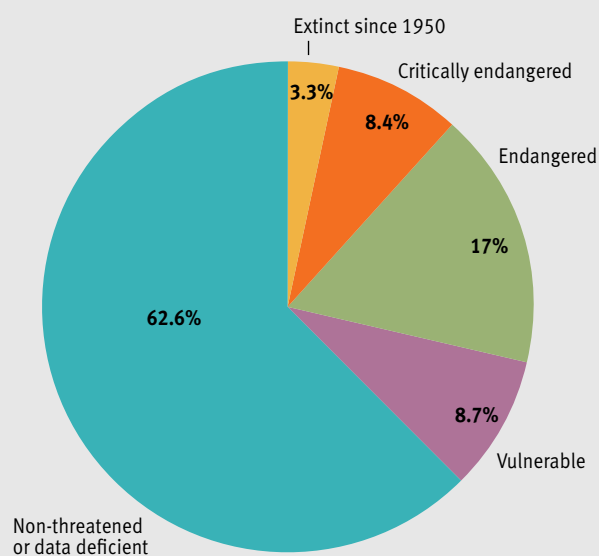
A Kenyan fisherman sets out in a traditional wooden boat to fish beyond the coral reef almost a kilometre offshore.

© Cheryl-Samantha Owen/ samowenphotography.com

and the distribution of benefits from their use, as well as the associated traditional knowledge. The principle underlying CBD

recognizes that states have a sovereign right to exploit their own resources pursuant to their own environmental policies (Article 3).

Figure 5.14 Language endangerment as a share of all languages, 2010

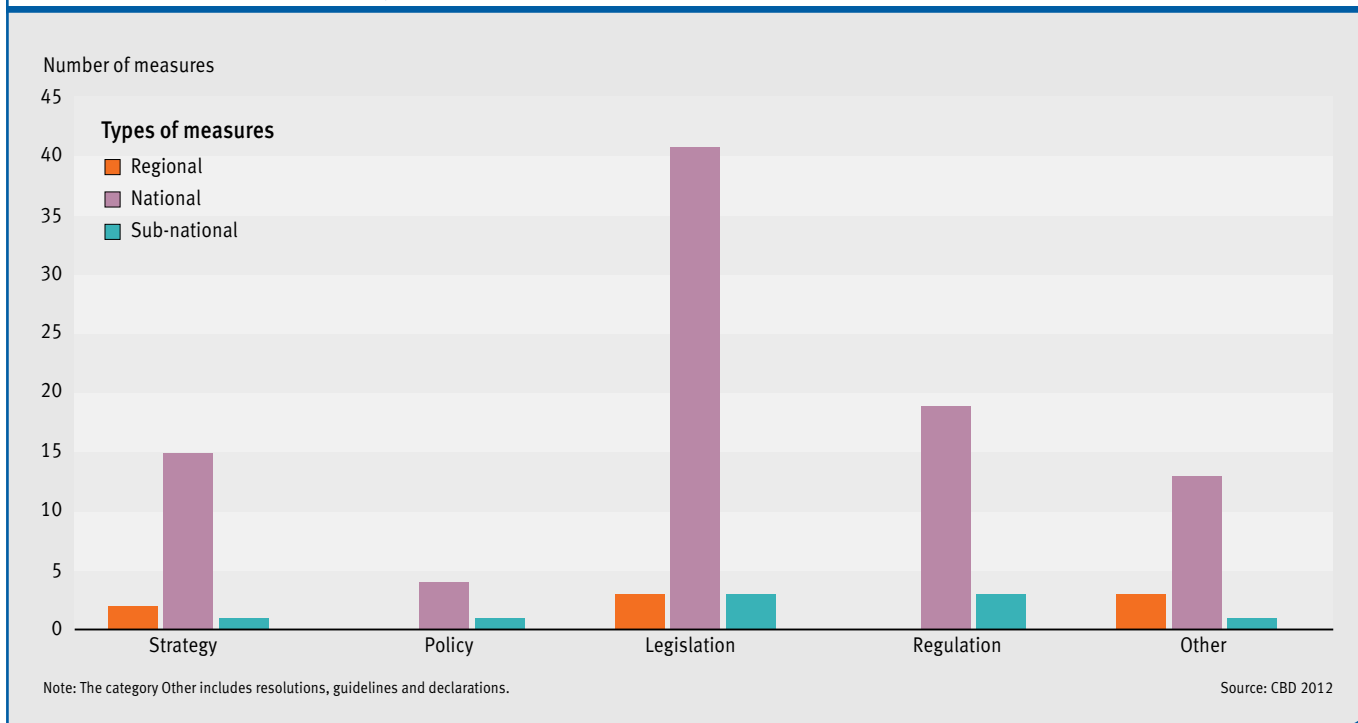


Source: Moseley 2010

Access to genetic resources has emerged as a major political rallying point in international negotiations. Much of the world's biodiversity is concentrated in the forests of developing countries in the tropics, but much of the technology and financial capital that can convert elements of biodiversity into commercial products rests with the developed countries. Hence, while unprecedented biodiversity loss is a global concern, commercial use and the associated issues of intellectual property fundamentally alter the nature of biodiversity as a global public good (Giraud 2008; Gupta 2006; Schuler 2004). The impetus behind the Nagoya Protocol arose from growing discontent amongst developing countries and indigenous and local communities regarding the lack of implementation of the benefit-sharing provisions of CBD since it came into force in 1993. This was compounded by only a handful of user countries undertaking any compliance measures to prevent bio-piracy despite the adoption of guidelines in 2002.

The Nagoya Protocol is an important milestone for rectifying the issues of equity associated with the commercial use of genetic resources and associated traditional knowledge. The protocol is also unprecedented in its recognition of the right of indigenous and local communities to regulate access to traditional knowledge associated with genetic resources in accordance with their customary laws and procedures. The protocol opened for signature in February 2011 and will not enter into force until 90 days after 50 countries have signed. A number of countries

Figure 5.15 The number and type of access and benefit-sharing measures, 2011



already have national legislation and regulations pertaining to issues of access and benefit sharing, and monitoring the further development of such regulations could provide a useful indicator of progress (Figure 5.15).

In the marine realm, ten countries own 90 per cent of the patents deposited with marine genes – with 70 per cent belonging to just three – but account for only about 20 per cent of the world’s coastline. These nations benefit from access to the advanced technologies required to explore the vast genetic reservoir of the oceans, leading to a call for policies targeting capacity building to improve access for other countries (Arnaud-Haond *et al.* 2011).

PROGRESS, GAPS AND OUTLOOK

Assessment of progress and gaps

Conservation strategies

Protected areas are one of the primary responses for maintaining biodiversity, particularly on land, but are generally deemed to be insufficient (Rodrigues *et al.* 2004). The exclusion of local communities from many state and private protected areas along with the failure to fully acknowledge their role in safeguarding biodiversity remains a challenge to real progress. Outside protected areas the proportion of sustainably managed production landscapes – for agriculture, forestry, fisheries and aquaculture, amongst others – is increasing, but only slowly. For example, the area of forest certified by the Forest Stewardship Council (FSC) as sustainably managed continues to grow, reaching 149 million hectares in 2012 (FSC 2012), and there are additional areas managed under the Programme for the Endorsement of Forest Certification (PEFC), but this remains a small fraction of the global

total of managed forests. Similarly, fish products certified by the Marine Stewardship Council (MSC) constituted only 7 per cent of global fisheries in 2007 (Jacquet *et al.* 2009).

National biodiversity strategies and action plans

The CBD requires all member states to develop a national biodiversity strategy and action plan as the primary mechanism for the implementation of its strategic plan. To date, 172 of the 193 signatory countries have adopted their plans or equivalent instruments (CBD 2011). The large number of plans is an achievement in itself, and more so where they have stimulated conservation action at the national level and contributed to a better understanding of biodiversity, its value and management. In spite of these achievements, national strategies have not been fully effective in addressing the main drivers of biodiversity loss. Only a few countries have used the plans as mechanisms for mainstreaming biodiversity and ecosystem services, and there is generally poor coordination with other relevant policies (Prip *et al.* 2010; CBD 2010c). However, Parties to the CBD are expected by 2014 to revise their plans in line with the new Strategic Plan for Biodiversity 2011–2020, which includes reference to improving mainstreaming.

Resource mobilization

Many national reports submitted to the CBD have identified the lack of financial, human and technical resources as the most widespread obstacle to implementation of national strategies and the CBD in general. Thus, the fulfilment of the Aichi Target to substantially increase resource mobilization will be crucial to enable the other targets to be achieved.

While documentation is lacking for both the current and the required level of financing to safeguard biodiversity, there is no doubt that the gap between the two is substantial. Estimates suggest that existing financing is in the order of tens of billions of dollars a year, while total needs are of the order of hundreds of billions a year (Rands *et al.* 2010; Berry 2007; James *et al.* 2001). International financing for biodiversity is estimated to have grown by approximately 38 per cent in real terms since 1992 and now stands at US\$3.1 billion annually (OECD 2010; Gutman and Davidson 2008). The Global Environmental Facility (GEF) will provide US\$1.2 billion for CBD implementation from 2010 to 2014, an increase of 29 per cent compared to the previous four years.

Increasingly, innovative financial mechanisms are considered essential tools to mobilize additional resources for biodiversity. These include payment for ecosystem services, biodiversity offsets, ecological fiscal reforms, markets for green products and biodiversity in new sources of international development finance. For example, further information on schemes such as Reducing Emissions from Deforestation and Degradation (REDD+) is available in Chapter 3.

Knowledge gaps for biodiversity monitoring

Although indicators of the state of biodiversity are predominantly showing declines (Butchart *et al.* 2010; CBD 2010b), there are considerable gaps in their geographic, taxonomic and temporal coverage (Pereira *et al.* 2010a, 2010b; Walpole *et al.* 2010; Collen *et al.* 2008a, 2008b). While biodiversity loss is a global phenomenon, its impact may be greatest in the tropics where available indicators and data coverage are the least complete.

Particular gaps in knowledge for state indicators include: grassland and wetland extent, habitat condition, primary productivity, genetic diversity of wild species, freshwater and terrestrial trophic integrity, ecosystem functioning and ocean acidification. Pressure indicators lack data on pollution, exploitation in terrestrial and freshwater ecosystems, wildlife disease incidence and freshwater extraction. The principal gaps in response indicators include sustainable management of agriculture and freshwater fisheries, and management of invasive alien species.

A prominent gap in knowledge concerns ecosystem services (UNEP-WCMC 2011; TEEB 2010). Indicators of the biodiversity that underpins these services should be tailored to the scales at which ecological processes that produce the services occur, such as the landscape scale for agriculture and biomass production, and the watershed for direct water use and hydroelectricity generation.

Other responses to biodiversity loss include policy action to tackle an array of issues including hunting and pollution, and enforcement of environmental impact assessments and mitigation measures for infrastructure development; however, global trend data are unavailable for these. Given that most global biodiversity targets, such as the Aichi Targets, require action at the national scale, national biodiversity data are crucial



Madagascar – a global biodiversity hotspot with many endemic species including lemurs – is using payment-for-ecosystem-services schemes to attract new funding for the protection of biodiversity and ecosystems. © Tdhster/iStock

for tracking progress towards global biodiversity targets, and to inform national strategies. National Red Lists of threatened species are one of the many examples of nationally relevant biodiversity data that may provide suitable input for reporting on progress towards these goals and for informing national conservation priority setting (Zamin *et al.* 2010), although there are others which are also suitable (Jones *et al.* 2011). The Group on Earth Observations Biodiversity Observation Network (GEO BON) is expected to make an important contribution to future monitoring efforts (GEO BON 2011), whilst the Biodiversity Indicators Partnership (BIP 2011) is supporting global and national biodiversity indicator development for the Aichi Targets and for national biodiversity strategies and action plans.

Projections, scenarios and horizon scans

While recognizing a time frame of increasing uncertainty, this section synthesizes biodiversity studies from short-term projections through to longer-term scenarios with a view to distilling relatively short-term policy implications. This relies heavily on the *GBO-3* analysis of biodiversity scenarios (Leadley *et al.* 2010; Pereira *et al.* 2010a), for which scientists from a wide range of disciplines came together to seek consensus on projections and scenarios for biodiversity change during the 21st century.

Although quantitative projections and scenario methods are well advanced, the range of projected changes reported by the studies

reviewed is rather broad, partially because there are significant opportunities to intervene through better policies, but also because of large uncertainties in the projections. The projections of global change impacts on biodiversity show continuing and, in many cases, accelerating species extinctions (Figure 5.16), loss of natural habitat, and changes in the distribution and abundance of species and biomes over the 21st century. Possible thresholds, amplifying feedbacks and time-lag effects leading to tipping points appear to be widespread and make the impacts of global change on biodiversity hard to predict, difficult to control once they begin, and slow and expensive to reverse once they have occurred. For many important cases, the degradation of ecosystem services goes hand-in-hand with species extinctions, declining species abundance or widespread shifts in species and biome distributions; however, the conservation of biodiversity and of some services, especially provisioning services, is often at odds. Strong action at international, national and local levels to mitigate the drivers of biodiversity change and to develop adaptive management strategies could significantly reduce or reverse undesirable and dangerous biodiversity transformations if urgently, comprehensively and appropriately applied.

Policy implications

The accumulated evidence, cited above, suggests that there is greater success in halting the negative changes in biodiversity and ecosystem services when a proactive attitude in support of a sustainable environment is adopted. Overall, the above synthesis, coupled with inputs from UNEP's Foresight Initiative (Peduzzi *et al.* 2011), suggests that:

- land must be used more efficiently to decrease the rate of habitat loss;
- mitigation of climate change is urgent and there is a significant risk of tipping points near or even before the 2°C mean global surface temperature target agreed at the UNFCCC meeting in Cancun in 2010;
- payments for ecosystem services and the greening of national accounts can help to protect biodiversity if appropriately applied;
- protected areas by themselves have not been adequate to achieve the target of reducing the rate of biodiversity loss by 2010;
- potential collapse of oceanic ecosystems requires an integrated and ecosystem-based approach to ocean governance; and
- recognizing the importance of local participation and community support, it is crucial to ensure that policies are integrated, sensitive and inclusive of local communities. This applies to conservation strategies, preservation of local cultures and languages, and access and benefit sharing of genetic resources and traditional knowledge.

Outlook summary

A summary of progress in achieving the main biodiversity goals is provided in Table 5.2. It also outlines gaps in data and policy and is based on expert opinion. The International Platform on Biodiversity and Ecosystem Services (IPBES) is expected to play an important role at the science-policy interface in future (Perrings *et al.* 2011).

Figure 5.16 Scenarios of species change

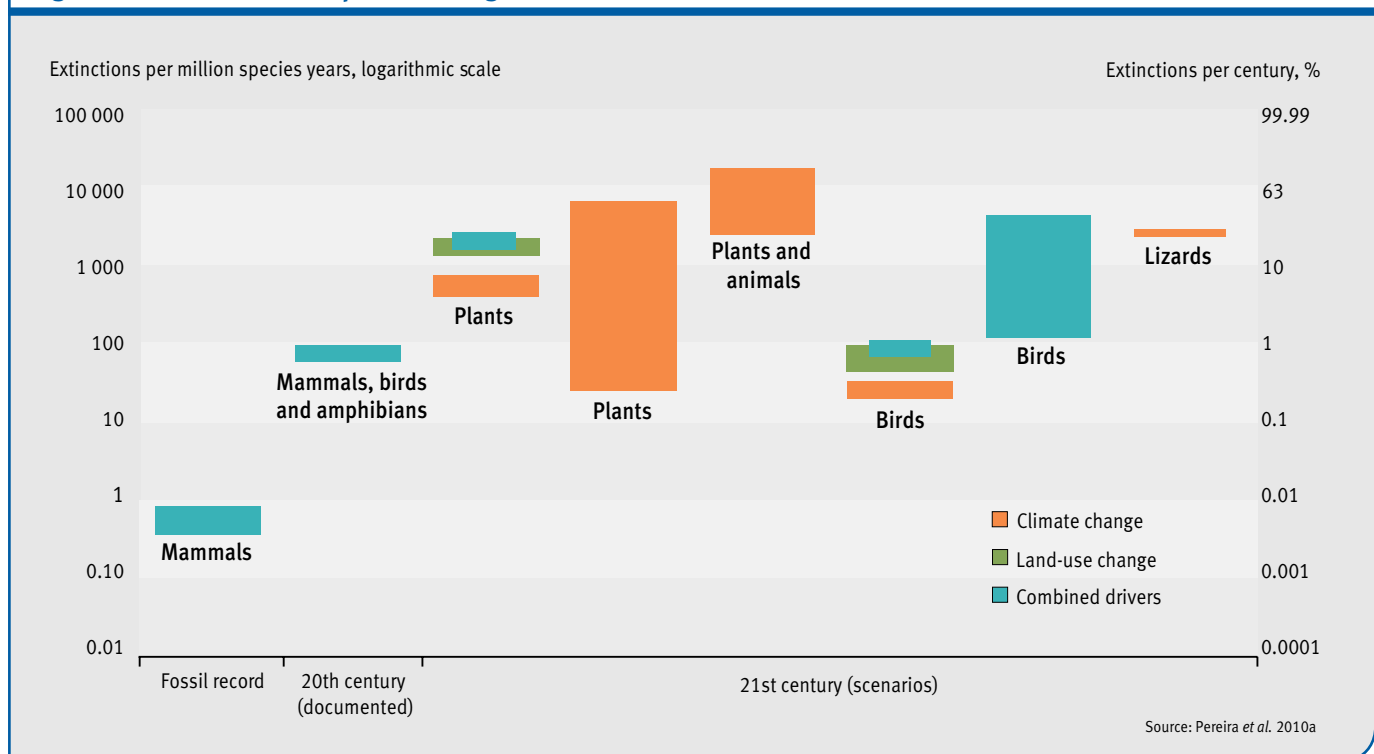


Table 5.2 Progress towards goals (see Table 5.1)

A: Significant progress B: Some progress		C: Very little to no progress D: Deteriorating		X: Too soon to assess progress ?: Insufficient data	
Key issues and goals	State and trends		Outlook	Gaps	
1. Reduce the direct pressures on biodiversity (Notes 4, 6, 7, 13; CBD Targets 5–10)					
Drivers of habitat loss and degradation	C	Continuing increases in pressures from, for example, agriculture and infrastructure development	Increasing pressure	Quantification of trends in habitat extent and condition resulting from different drivers	
Levels of exploitation	C	Significant proportion of species is threatened by overexploitation; legal international trade is successfully managed for a small number of species	Increasing pressure	More systematic measures of exploitation levels, particularly at local/national scale, including illegal trade	
Spread and impact of invasive alien species	B/C	Numbers and extent of invasive alien species are increasing where quantified; impacts have been successfully mitigated and the spread limited in some cases	Continuing spread and impact, with local exceptions	Numbers/impacts in developing countries, policy implementation and effectiveness at local/national scale	
Pressure from pollutants	B	Generally increasing pressures from pollution, but nitrogen deposition since the 1990s may be levelling off	Increasing pressure, with local exceptions for certain pollutants	Trends in levels of pollutants other than nitrogen	
Impacts of climate change	C	Increasing impacts on phenology, abundance, distribution and community composition in all ecosystems	Increasing pressure	Impacts on population trends and interactions with other threats	
2. Improve the status of biodiversity (Notes 1, 2, 3, 4, 7, 8, 9, 11, 12; CBD Targets 11–13)					
Genetic diversity of wild species	?	Genetic diversity of cultivated crops and domesticated animals has declined and, while unquantified in wild species, is likely to be declining	Continuing decline	Data collection on genetic diversity of wild populations	
Population abundance of species	C	Declining at the global scale, most rapidly in the tropics, freshwater habitats and for utilized marine species; there are some exceptions due to effective conservation action, for example North American waterbirds	Continuing decline	Trends for plants and invertebrates; tropical coverage patchy; systematic monitoring largely confined to birds in developed countries	
Extinction risk of species	C	13–63 % of species in different groups are threatened with extinction; trends, where known, are declining (most rapidly for corals)	Continuing decline	Trends for plants, invertebrates and remaining vertebrate classes; national scale extinction risk trends	
Extent, condition and integrity of biomes, habitats and ecosystems	C	Declines in all natural habitats with known trends, for example forests, mangroves, seagrasses and coral reefs; some exceptions, for example reforestation in some temperate countries	Continuing decline	Consistent and repeated remote-sensing monitoring, including for non-forest areas; metrics of condition and fragmentation	
3. Enhance sustainable benefits (ecosystem services) from biodiversity (Notes 1, 2, 3, 4, 9, 11, 12; CBD Targets 14–16)					
Status of species harvested for food and medicine	C	Extinction risk trends are worse for species harvested for food and medicine than for other species	Benefits currently unsustainable and likely to decline	Trends for plants and invertebrates; disaggregation of all data into small-scale subsistence use or large-scale and/or commercial use	
Equitable use of natural resources	C	For some countries the per-person ecological footprint is high and/or increasing relative to life expectancy, indicating inefficiency and often unsustainability in resource use	Potential for the global ecological footprint to be reduced while enhancing human well-being, requiring major adjustments in benefit sharing	Suitable data for footprint analysis, including spatial and temporal resolution data on the intensity and magnitude of natural resource use at global level	

Table 5.2 Progress towards goals (see Table 5.1) continued

4. Strengthen responses to safeguard biodiversity (Notes 1, 2, 3, 4, 6, 7, 8, 9, 10, 12, 13; CBD Targets 1–20)

Extent, biodiversity coverage and integrity of protected areas	B	Terrestrial coverage has reached nearly 13%, but marine coverage is less than 1.5%; representativeness at the scale of ecoregions is fairly high, but the proportion of fully protected key biodiversity sites is low	Protected area extent is likely to increase if governments fulfil their commitments; more careful site selection and better management will be required to protect biodiversity; jurisdictional uncertainties and conflicts need resolution	Data on trends in the effectiveness of protected areas and on jurisdictional uncertainties and conflict
Extent, biodiversity coverage and integrity of indigenous and community-conserved areas (ICCAs), sacred natural sites (SNSs) and other community-managed natural areas	B	Community-based governance and management approaches exist largely without state recognition or are newly developing; external drivers of biodiversity loss and/or other factors undermine the capacity of ICCAs, SNSs, and other such areas to conserve biodiversity	Likely to increase in importance; empowerment of local communities in decision making is needed, plus greater awareness amongst government protected-area officials	Data on the location, extent, legal status and effectiveness of these areas for biodiversity conservation; possible forms and modes of appropriate state recognition and support
Schemes such as REDD+ or payment for ecosystem services (PES), where biodiversity supports mitigation of, and adaptation to, climate change	B	The development of REDD+ and PES schemes is increasing	The area under REDD+ and PES schemes is likely to increase, providing both opportunities and potential threats for biodiversity conservation	Potential indicators such as number and area of community-managed REDD+ areas or number of national adaptation strategies with ecosystem-based components
Proportion of sustainably managed production areas	C	Area certified as sustainably managed increasing, but the proportional area remains minimal, with an uneven global distribution	Area of certified production increasing, especially in developed countries	Effectiveness for biodiversity conservation; impacts of these approaches in non-certified areas
Policy responses addressing invasive alien species	B	Proportion of countries with relevant legislation increasing, but implementation and transboundary cooperation are poor	Policy responses increasing but ineffective without considerably improved implementation	More data needed on implementation and effectiveness
Action for species recovery, site safeguarding and habitat restoration	B	Numerous local examples show that successful conservation programmes prevent extinctions, restore habitats and conserve sites; however, the scale of these efforts remains inadequate	Improvements in coordination and integration are expected, but on their own will remain insufficient	More data on species recovery and restoration needed
Number of countries with national mechanisms addressing access and benefit sharing	B	Agreement of Nagoya Protocol on access and benefit sharing is a significant step forward, with increasing numbers of signatories and countries with relevant legislation	Implementation of the Nagoya Protocol could address this issue effectively	Data required on access and benefit-sharing agreements and beneficiaries, and on the benefits and sustainability of utilizing genetic resources
Number of languages and speakers as a proxy for traditional knowledge supporting sustainable resource use and conservation	C	Number of languages and speakers is declining, suggesting less traditional knowledge in support of sustainable use and conservation	Appropriate mechanisms, including support for customary sustainable use of biodiversity and secure tenure, may help to halt the decline in traditional knowledge	Indicators to capture intergenerational transfer of traditional knowledge and provision of incentives; indicators on the retention of traditional knowledge to assess social-ecological resilience

Notes: 1. CBD Article 1; 2. CBD Article 6; 3. CBD Article 8j; 4. CBD Article 10; 5. CBD COP 7 Decision VII/28 Paragraph 1.2.3; 6. CBD COP 7 Decision VII/30 Annex II; 7. Agenda 21 Chapter 17 Paragraph 86; 8. CMS 1979 Preamble; 9. CITES 1973 Preamble; 10. ICPP Article 1; 11. Ramsar Article 3; 12. ITPGRFA Article 1 Paragraph 1.1; 13. Cartagena Protocol on Biosafety Article 1.

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