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ADEQUACY OF BIODIVERSITY OBSERVATION SYSTEMS TO SUPPORT THE CBD 2020 TARGETS

Information note by the Executive Secretary

1. The Executive Secretary is pleased to circulate herewith, for the information of participants in the fifteenth meeting of the Subsidiary Body on Scientific, Technical and Technological Advice, an information document entitled "Adequacy of Biodiversity Observation Systems to support the CBD 2020 Targets" submitted by the Group on Earth Observation Biodiversity Observation Network (GEO BON), the International Union for Conservation of Nature (IUCN) and the UNEP-World Conservation Monitoring Centre in support of the meeting of the Ad Hoc Technical Expert Group on Indicators for the Strategic Plan for Biodiversity 2011-2020.

2. The document is being circulated in the form and language in which it was provided to the Secretariat.

Adequacy of Biodiversity Observation Systems to support the CBD 2020 Targets

A report prepared by the Group on Earth Observations Biodiversity Observation Network (GEO BON),

for the Convention on Biological Diversity

May 2011

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Executive Summary

This report constitutes the first attempt to assess the adequacy of global observation systems for the monitoring of biodiversity, specifically in relation to the information needs of the twenty 'Aichi targets' defined by the Convention on Biological Diversity (CBD) for the period 2011–2020. The report was prepared, at the request of the CBD, by the Group on Earth Observations Biodiversity Observation Network (GEO BON) in collaboration with a range of biodiversity-related organisations, and is based on inputs from over 120 specialists.

Strategic goal A of the CBD addresses the drivers of biodiversity change. The global adequacy of existing systems for quantifying Targets 1, 2 and 3 under this goal, relating to public awareness, the valuation of biodiversity and the presence of biodiversity-damaging policies respectively, is low. The presence of some national or regional observation system and databases, and work in non-biodiversity fields suggest that an adequate observation system could be achieved for these targets within five years. The fourth target on sustainable consumption already has some global observation systems, with potential for improvement.

Goal B contains five targets related to the state of biodiversity. All have significant global-scale observation systems, typically with national or better resolution, already in place. There are deficiencies in the evenness of global coverage and data quality, and some of the observations are too narrow in scope, but in the opinion of the experts, fit-for-purpose adequacy is technically achievable in all cases if sufficient resources are made available.

Goal C contains three targets that look at the effectiveness of actions taken to protect biodiversity. Global observation systems with national resolution exist for all three. Ongoing, but relatively minor and well-understood improvements to the observations are needed to bring them to full adequacy, especially with respect to accompanying data in Target 11 (on protected areas) and taxonomic coverage in Targets 12 (threatened species) and 13 (genetic diversity of valuable species).

Goal D contains seven somewhat diverse targets relating to the benefits derived from biodiversity. Target 14 (ecosystem services) does not yet have a globally adequate observation system, but is rapidly working towards one for key services. Target 15 seeks to relate biodiversity and climate change in both directions. Observation systems are technically feasible and some global-scale databases exist that could serve as pilots.

Goal E contains Targets 16 to 20 which largely relate to the CBD mechanisms. No observation systems currently exist, but achieving adequacy should in principle be relatively straightforward. In some cases (e.g. Target 16 on access and benefit-sharing) the basis for an information-gathering system are planned to emerge from the coming into force of a protocol. In others, the information should be part of national submissions to the CBD, but an information extraction process and database mechanism are yet to be developed.

There is fair alignment between the biodiversity observation needs determined from the Aichi targets, those derived from the GEO BON implementation plan, and those identified by the biodiversity observation community as essential biodiversity variables, with some exceptions. The GEO BON and essential variables approaches underemphasise social, economic and policy observations, while the Aichi targets call for less detail and sustained accuracy of biological observations than is required by the research community.

Introduction and Background

At the tenth meeting of the Conference of the Parties (COP-10) to the Convention on Biological Diversity (CBD) held in Nagoya, Japan, 18–29 October 2010, a decision was taken to establish an Ad Hoc Technical Expert Group (AHTEG) on Indicators to advise on the development of a coherent framework to assess progress in relation to the Strategic Plan for Biodiversity 2011–2020. In the revised and updated Strategic Plan for Biodiversity adopted at COP-10 (see www.cbd.int/doc/meetings/cop/cop-10/information/cop-10-inf-12-rev1-en.pdf), the twenty headline Aichi biodiversity targets are organized under five strategic goals. Subsequently the Executive Secretary of the CBD invited the Group on Earth Observations Biodiversity Observation Network (GEO BON) and its constituency, *inter alia*, the United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) and the International Union for Conservation of Nature (IUCN), to prepare an evaluation of existing observation capabilities relevant to the twenty 'Aichi targets' contained in the Strategic Plan. The 'Adequacy Report' (this document) is to be provided to the AHTEG prior to their meeting 20–24 June 2011, as well as to a meeting of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) prior to the eleventh meeting of the Conference of the Parties (COP-11).

A workshop was convened by GEO BON together with UNEP-WCMC, Global Biodiversity Information Facility (GBIF), IUCN and DIVERSITAS, and hosted by Alterra in Wageningen, 1–3 March 2011. Support for the workshop was provided by EU FP7 (via the European Biodiversity Observation Network (EBONE) project) and the policy-supporting research funds of the Dutch Ministry of Economic Affairs, Agriculture and Innovation. Fifty two experts, representing 40 organisations from all parts of the world and covering many disciplines, attended the meeting (Appendix 2). They were invited for their ability to assess one or more of the twenty targets. The emphasis of the meeting was on the adequacy of current observation systems to measure progress towards the targets.

Discussions were held in five working groups, each addressing one the five Strategic Goals. A draft report for each of the targets was completed by 'champions' selected by the groups, according to a more-or-less standard format. The reports were collated and circulated for comment after the meeting, to the participants, members of the GEO BON working groups and to a broader group of interested parties and experts for peer review. An additional 262 individuals, not including participants and GEO BON working groups, were invited to comment, and 77 did so (Appendix 3). The champions revised their sections in response to the comments, leading to a second draft of the report. Participants were offered a final chance to comment on the revised document. Taking these comments into account, this final version of the report was prepared for delivery to the AHTEG, convened by the CBD for the purposes of advancing the indicator process, in May 2011.

A process to identify the variables needed to track changes in biodiversity beyond the immediate needs of the Aichi targets, i.e. *Essential Biodiversity Variables*, was run in parallel. The results of this exercise can be found in the section titled *Essential Biodiversity Variables.*

An extensive glossary and acronym list can be found in Appendix 1.

Strategic Goal A

Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society

"The Millennium Ecosystem Assessment identified the following indirect drivers of change: economic, demographic, socio-political, cultural and religious, and science and technology. While drivers such as population increase or patterns of consumption (for example, of meat, energy, water and raw materials) are generally not susceptible to rapid reversal, ultimately total consumption of resources, goods and services must be brought within safe ecological limits if the 2050 Vision of the Strategic Plan is to be achieved. Therefore, strategic actions should be initiated immediately to address, over a longer term, these underlying causes of biodiversity loss. This requires policy coherence and the integration of biodiversity into all national development policies and strategies and economic sectors at all levels of government (local/municipal, state/provincial, and national/federal). Key strategic approaches to achieve this include communication, education and public awareness, appropriate pricing and incentives, and the broader use of tools such as strategic environmental assessment. Stakeholders across all sectors of government, society and the economy, including business, will need to be engaged as partners to implement these actions. Consumers and citizens must also be mobilized to contribute to biodiversity conservation and sustainable use, to reduce their ecological footprints and to support action by governments. At the international level, action to implement the Convention could be strengthened through synergies among intergovernmental bodies" (SCBD 2011).

Target 1 – Awareness of biodiversity values

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.

Key concepts

Awareness of biodiversity in society is important for the broad acceptance of and support for National Biodiversity Strategies and Action Plans (NBSAPs), as well as other biodiversity conservation and sustainable development interventions. There is a difference between awareness (knowledge of specific biodiversity content areas), attitudes (values and beliefs related to biodiversity) and behaviour (habits, practices and activities impacting on biodiversity). To measure awareness adequately, it has to be defined: awareness of the word biodiversity, of the scientific meaning of biodiversity, of the importance of species, of ecosystems, of ecosystem services, of Access and Benefit-sharing (ABS; see Target 16), of the current rate of extinction, of biodiversity's life support role. It is also important to define among whom the awareness is measured (e.g. general public, youth, business, consumers, policy makers, educators). Finally it is important to note that paradigms and perspectives on biodiversity are very different between cultures, and between urbanised and rural populations. The matrix below provides a first indication of what is needed to track awareness of biodiversity values.

Table 1: An initial list of variables/datasets/indicators for monitoring progress towards Target 1.

Observation dataset (OD)	Sources and Organisational Holder/s	Start year [end year if interrupted]	Frequency of update	Geographical Coverage	Spatial Resolution
Visitation rates and nature experiences e.g. to natural areas/natural history museums, herbaria, botanical gardens, zoos, aquaria etc.	World Association of Zoos and Aquariums (WAZA) and national statistics; World tourism organisations; The United Nations Educational, Scientific and Cultural Organization (UNESCO); International Council of Museums (ICOM)	Ongoing	Annual	National	Site level, national
Citation of biodiversity in media	Google trends; Meltwater; International Centre for Integrated Mountain Development (ICIMOD[1])	Ongoing	Continuous	Regional, Global	Various
Participation/membership in wildlife/environment interest groups	IUCN; World Wide Fund for Nature (WWF); BirdLife International; Non-Governmental Organizations (NGOs); Youth organizations etc.	Ongoing	Annual	National	National
Public contributions to citizen science observation systems	Sites statistics e.g. GBIF; Ocean Biogeographic Information System (OBIS); observado.org; World Birds; EBird; DiveBoard; BirdLife International (e.g. Audubon Christmas Bird Count and similar initiatives in other countries)	Ongoing	Continuous	National	National
Public involvement in conservation initiatives	Conservation International (CI); WWF; National Parks Authorities; Marine Protected Areas etc.			National, Sub-national	National, Sub-national
Information or Surveys and opinion polls about knowledge and value of biodiversity and	The European Commission (EC); Environmental Protection Agency (EPA); Lincaocnet;	Ongoing	Irregular	National, Regional	National

[1] At the regional scale, ICIMOD is playing an important role in awareness generation activities through different knowledge generation projects as well as dissemination on topics like citation on biodiversity in media.

ecosystem services	Ministries of Environment; Statistical bureaus; ICIMOD[2]				
National and international polling by *private companies* about attitudes to environment and biodiversity	E.g. see: http://www.gallup.com/poll/126716/environmental-issues-year-low-concern.aspx	Ongoing but unsystematic	Irregular	Various, often national	Local to national
Number of school curricula that include environment/biodiversity & teachers organizations that train members	Ministries of education; UNESCO; Organisation for Economic Co-operation and Development (OECD)	Ongoing	Irregular	National	National
Absolute/relative number of viewers/readers/listeners of environmental programmes, magazines and websites	Companies like Reuters; Thompson; British Broadcasting Corporation (BBC); National Geographic; TV5MONDE; Geo Magazine; Discovery; Website statistics (e.g. GBIF, Encyclopaedia of Life, BioNET (Global Network for Taxonomy), Lincaocnet, European Distributed Institute of Taxonomy (EDIT) etc.)	Ongoing	Monthly	National and global	Various
National, intergovernmental and global environmental awareness campaigns/events (incl. sustainable use and habitat or species specific)	Larger NGOs; National governments	Ongoing	Annual	National and global	National
Inclusion of Biodiversity in Annual reports on Corporate Social Responsibility	The World Business Council for Sustainable Development (WBCSD); WWF	Ongoing	Annual	Global	Various
Consumer preferences for 'greener' products/ produce	National consumer organisations; Consumer international; Eurobarometer; Union for Ethical BioTrade (UEBT); Independent certification organisations (e.g. The Forest Stewardship Council (FSC))	Ongoing; 2009 for Eurobarometer and UEBT	Annual	National and global	National
Number of products/ companies with 'Biodiversity friendliness' certification[3]	No international database or registry exists, but national associations do	Does not yet exist	Continuous	Global	National
Participation in re-use and recycling (see Target 4)	National statistics	Ongoing	Annual	National	National
Number of parliamentary debates on Biodiversity[4]	National parliamentary records	Ongoing	Annual	National	National
Number of citations of biodiversity in socio-economical reports	National government agencies	Ongoing	Irregular	National	National

Gaps and data limitations

Attitudes to and awareness of ecosystem services and the relationship to biodiversity and human well-being are hardly known at all at the global level, using consistent approaches. There is thus no global baseline to measure against. The European Union (EU) has set up a regional baseline (EEA 2010), which could be the basis for additional global work.

This target differs from the majority of the other targets in its reliance on social data. The body tasked with coordination, needs to ensure it has the required capacities in this area. Creating a global system for assessing awareness of biodiversity in a representative way is vital and highly recommended. To make data globally relevant and comparable across cultural and language groups, careful thought will be needed in the indicator planning phase, and advice and input from a wide

[2] ICIMOD disseminates information on dependency of people on biodiversity and ecosystem services and people's perception on the importance of biodiversity for their livelihood.

[3] E.g. In Australia they developed methods for including a biodiversity component in product life-cycle analysis. 'Biodiversity friendliness' is now a standard element of product descriptions, similar to the energy efficiency ratings introduced in the 1980s.

[4] This could also help track how discussions and biodiversity awareness are being translated into polices.

range of communication and attitude assessment experts from CBD member states needs to be gathered. The IUCN Commission on Education and Communication is an expert network that could be consulted in this regard.

Adequacy assessment

The data are inadequate in an absolute sense, i.e. as a measure of world-wide attitudes to biodiversity. They are in some cases adequate in a relative sense and for some regions, e.g. baseline data from EC questionnaires and trending data from Gallup polls. Some social scientists may argue that absolute social data is unattainable, and that a relativist stance to results concerning human phenomena is more realistic. As long as the population being studied is adequately described, there should be no problem regarding generalisation of relativistic results. Fine scale, detailed and well designed surveys of awareness of specific issues would be ideal.

However, the goal is not only to monitor awareness about biodiversity, but - even more challenging - about the values of biodiversity. People may be aware of the diversity of life on Earth, but that does not automatically translate into awareness of the values of biodiversity. Some of the indicators might be used as proxies for 'value' e.g. "Participation/membership in wildlife/environment interest groups" or "Number of citations of biodiversity in socio-economical reports". Others measure awareness only. In creating a global system for assessing awareness care should be taken to include suitable measures for value.

Estimated costs

No cost estimate for reaching adequacy has been attempted. Conducting an adequately-representative one-time global opinion survey would cost several hundred thousand Euros.

Target 2 – Integration of biodiversity values

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.

Key concepts

There is a large range of perceptions among different academic disciplines about what the term "value" encompasses, and as to why biodiversity is of value. For instance, reference has been made in the context of the Convention to the "intrinsic value, ecological, genetic, social economic, scientific, educational, cultural, recreational and aesthetic values of biological diversity and its components" (SCBD 2010a). In the context of development policy and poverty reduction strategies, the contribution of biodiversity to sustainable livelihoods and development opportunities is of particular interest. Integrating and adequately reflecting the contribution of biodiversity and ecosystem services in national and local development strategies, policies, programmes, and reporting systems is an important element of the mainstreaming agenda addressed under goal A of the strategic plan.

A variety of economic and non-economic valuation tools exist for this purpose. They have been developed, tested and refined over many years and in many different contexts. When applied correctly, these tools can measure a wide range of values with considerable precision[5]. The choice of tools depends on which biodiversity values are thought to be most relevant in a particular context. The increasing reliability of valuation tools has led governments and other stakeholders to apply them more frequently and to give increasing weight in decision-making to the estimates derived from using these methods. Valuation tools may be combined or used in parallel to assess different biodiversity values within a single study or for sensitivity analyses.

Table 2: An initial list of variables/datasets/indicators for monitoring progress towards Target 2.

Observation dataset	Sources and Organisational Holder/s	Start year [end year if interrupted]	Frequency of update	Geographical Coverage	Spatial Resolution
Number of countries which apply SEA (Strategic Environmental Assessment) and EIA (Environmental Impact Assessment) on a systematic basis and, among those, the number of countries which have an integrated guideline for the evaluation of biodiversity and ecosystem services into guidelines for EIA – Strategic Impact Assessment (SIA)	IUCN Environmental Law Centre (ELC); The Netherlands Commission for Environmental Assessment (NCEA)[6]; IAIA (International Association of Impact Assessment)	No globally-harmonised database yet exists	Annual	Global	National
For all countries already applying economic appraisal tools (cost-benefit analysis, cost-effectiveness analysis): number of countries having included in pertinent guidelines the requirement to undertake the valuation of biodiversity and ecosystems within economic appraisals whenever	National governments/ministries; SCBD (Secretariat of the Convention on Biological Diversity) (through national reports?)	No globally-harmonised database yet exists	Annual to 5-yearly	Global, regional	National

[5] Chapter 5 of the TEEB (The Economics of Ecosystems and Biodiversity) report (TEEB 2010) provides an overview and assessment of valuation tools available. A synthetic overview and assessment, based on the Millennium Ecosystem Assessment (2003), as well as concrete examples, are also provided in CBD Technical Series No. 28 (SCBD 2007).

[6] The Netherlands Commission for Environmental Assessment provides institutional support and training to governments on Strategic Environmental Assessments.

appropriate					
Number of countries having reflected the role of ecosystem services and associated biodiversity in national and local development and poverty reduction strategies, sector development plans, landscape level planning, as well as National Adaptation Programmes of Action (NAPAs) and National Action Plans (NAPs)	National governments/ministries; SCBD (through national reports?)	No globally-harmonised database yet exists	Annual to 5-yearly	Global, regional	National
Green infrastructure such as ecological networks, forest corridors, fauna viaducts, natural water flows	European Environment Agency (EEA); IUCN; other NGOs (e.g., ICIMOD); CMBP (Circumpolar Biodiversity Monitoring Programme)	1990	Irregular	Wide coverage but some gaps	National and sub-national
Number of countries incorporating physical measures of stock and flow of natural capital into national accounting	National statistical bureaus	No global database yet exists. Several countries have natural capital accounts since ~2000	Annual	Mostly missing	National
Number of countries implementing natural resource accounts within the System of Environmental-Economic Accounting (SEEA), and among those, number of countries having included ecosystem service accounting	UNCEEA (United Nations Committee of Experts on Environmental-Economic Accounting); UN (United Nations) statistical division	1993	Yearly probably from 2012 onwards	Wide coverage from the obligation date (but unclear whether it will be an obligation)	National
National development/ Millennium Development Goals (MDG) plans include biodiversity values	National Ministries	2001	5 years		National
Budget for biodiversity conservation and environmental pollution control	National Statistics Bureaus; National Governments	No global database	Yearly	Global	National (and sub-national)
Wild Bird Indices[7]	BirdLife International; Wetlands International (water birds)	1980	Annual	Global (ready for regional use)	National and sub-national

Gaps and data limitations

The wide range of value 'types' referred to by different disciplines, as well as the plethora of valuation tools, may result in a lack of confidence among decision-makers. There is limited knowledge and understanding by decision-makers of what valuation tools can (and cannot) achieve. Most valuation tools are fairly sophisticated and their correct application requires considerable technical capacity, as well as time and financial resources. Absence of capacity and resources constitute major gaps.

Many countries are more concerned with immediate short term financial gains than with mid to long term economic value issues (such as natural capital) that go beyond the financial realm and short-term political cycles. There is a tendency to view development as directly opposed to environmental conservation.

Adequacy assessment

No existing database fulfils the need expressed by this target. The technical capability to derive measures of biodiversity value, often based on ecosystem services, are maturing to the point that

[7] Sometimes used as a biodiversity 'value' proxy, largely because the data are available and widespread.

several countries are now implementing some form of 'natural capital' in national accounts, and many others are contemplating doing so. Under the assumption that the broader the biodiversity foundation on which such value assessments are based, the better the estimate for any given country will be, the existing data shared to date are barely adequate either taxonomically or spatially. On the positive side, data exist for every country to start the process.

In terms of suitability, the different observations listed tend to reflect the degree of development of a country. An increasing number of developed countries are thinking about sustainability issues, but have a much larger impact on the environment than less developed countries, who may not yet be considering biodiversity values in a formal sense.

Estimated costs

No global cost estimate for reaching adequacy has been attempted. The costs of implementing natural capital accounting at the national level are not insignificant (several full-time professionals are required per country, assuming that the underlying data are adequate).

Target 3 – Incentives

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 and safeguards 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.

Key concepts

The connection between policy and biodiversity must be established. Policies influence the incentives facing decision-makers. Influence can be direct and intended, or indirect and perhaps unintentional. General positive economic incentives, including subsidies, direct payments, and other investments, often have the consequence of encouraging the use of (natural) capital (though they could be set up to promote biodiversity protection), whilst negative incentives, including regulations, taxes, standards, quotas and fees are intended to discourage or regulate use.

Currently, there are a number of important policies that have the effect of reducing or masking the true cost of using natural capital and harming biodiversity (see, for example, TEEB 2010). Policies in the agriculture, fisheries, forestry, and mining sectors as well as broader incentives for fossil fuel production and use, have been highlighted in TEEB (2010). The reduction of these incentives and eventual removal of these policies is an important step towards providing appropriate incentives for the sustainable use of natural capital. Moreover, the value of biodiversity and natural capital are not often well reflected, even in undistorted markets. Generally speaking, goods and services that have or can be made to demonstrate more market-like characteristics (i.e., exclusivity, rivalry and low transactions costs of exchange) are more likely to have their value well reflected in markets. For example, reasonably good markets exist for many provisioning services and market signals can be derived in a straightforward manner for some regulating services. Goods and services with increasingly public-good attributes (e.g., many cultural and supporting services) are less likely to be well reflected in markets. As a result, creating biodiversity friendly policies and incentives corrects these market signals for the value of biodiversity and natural capital to society.

One important concern is that the removal of agricultural policies (for example) harmful to biodiversity in the developed world, will result in a shift of agricultural production to biodiversity-rich developing countries and may result in a net loss of biodiversity globally. This highlights the need for stronger governance in developing countries and facilitation of international policies that reward biodiversity stewardship in developing countries on behalf of the rest of the world. Inducing greater economic opportunity in developing countries should not create a barrier to removing perverse subsidies. Simultaneously creating economic opportunities in developing countries that are biodiversity positive should be the solution. The paradox that policy to improve biodiversity in one area may have negative effects on biodiversity in another can be extended to land use, transportation, energy and fuel, water, trade, and financial policies, among many other potentially overlooked indirect (or scale or unintended) policy effects. The integrated cycle of an activity or process, plus its wider impacts on the natural and human worlds, need to be understood.

Table 3: An initial list of variables/datasets/indicators for monitoring progress towards Target 3.

Observation dataset	**Sources and Organisational Holder/s**	**Start year [end year if interrupted]**	**Frequency of update**	**Geographical Coverage**	**Spatial Resolution**
Fossil fuel production subsidies (€ total/year).	Energy ministries; fossil fuel companies	Variable, but last few decades	Annual	Global and adequate	National
Biodiversity-damaging agricultural policies (e.g., frontier expansion) (€ total/year)	World Trade Organization (WTO); The Food and Agriculture Organization of the United Nations (FAO);	Variable, but last few decades	Annual	Global and adequate	National

	Development agencies				
Biodiversity- damaging fisheries policies (€ total/year)	FAO; The International Commission for the Conservation of Atlantic Tunas (ICCAT); Common Fisheries Policy of the EU	Variable, but last few decades	Annual	Global and adequate	National
Biodiversity-friendly certification programmes (total value, value as a percentage of total market)	Certifiers (e.g. FSC, Marine Stewardship Council (MSC), Rainforest Alliance)		Annual	Wide coverage, but some gaps	Sub-national/project level
(I)PES ((International) Payment for Ecosystem Services), including Reducing Emissions from Deforestation and Forest Degradation in Developing Countries + (REDD+), biodiversity banking, etc.) (number of agreements, total budget/transaction value)	OECD; FAO; Centre for International Forestry Research (CIFOR); Ecosystem Marketplace - www.speciesbanking.com	1995	Annual	Wide coverage, but some gaps	Sub-national/project level
Investments/subsidies for sustainable renewable energy and infrastructure (€/year)	National ministries of energy	Variable, but last few decades	Annual	Wide coverage, but some gaps	National
Carbon taxes (number of countries implementing, value of tax (€/country-year)	National ministries of energy or finance	Since about 2000	Annual	Wide coverage, but some gaps	National

Gaps and data limitations

The connections among biodiversity, ecosystems and policy are logically consistent, but have yet to be fully investigated by the scientific community in a comprehensive manner, despite increasing efforts toward these ends. The reduction and eventual removal of long-standing policies constitutes a substantial political challenge and requires commitment to change. Clearly, establishing the connection between incentives and ecosystem processes is essential to making the case for policy change. Many such solutions require near term investments for longer term rewards. Short term benefits of resource exploitation can often weigh heavily in decisions.

Adequacy assessment

The elements for creating an indicator or indicators for this target exist, but no existing, globally-consistent observation system exists. The policy databases maintained by global organisations such as the WTO and the FAO would need to be customised and repurposed.

Estimated costs

No cost estimate for reaching adequacy has been attempted. The costs would be incremental to the existing policy databases.

Target 4 – Sustainable production and consumption

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.

Key concepts

Historically there has been a lack of focus on the underlying causes of pressures on ecosystems and threats to biodiversity and an absence of adequate measures and mechanisms in the decision-making processes. Information on these underlying causes exists but their relevance for biodiversity has not been made explicit. There is a need to provide a comprehensive assessment of human society's use of resources (renewable and non-renewable) and how that squares with ecological limits and biodiversity. This has to be tracked in both absolute terms - via a description of total pressure generated - and relative terms - by looking at variables such as efficiency and performance over time (European Topic Centre on Sustainable Consumption and Production (ETC/SCP) 2010, 2011).

Moreover, it has to be understood (and tracked) that the impacts of consumption sometimes occurs far away, in the regions of production, resulting in a need for clear tracking of production and consumption trends as well as trends in trade. A set of Sustainable Consumption and Production (SCP) indicators is hard to select. Examples of criteria for the selection of SCP indicator frameworks can be found in ETC/SCP (2010). Specific guidelines for the development of SCP frameworks for developing countries can be found in UNEP (2008). Footprint indicators are useful in monitoring SCP activities given their unique capacity to provide complementary production and consumption information, and they are also widely available, conceptually well-founded and easy to communicate (Galli et al. 2011). Future Footprint scenarios are also available in the scientific literature (Moore et al. *In press*; OPEN:EU project). Human Appropriation of Net Primary Production (HANPP) is also a useful indicator (Imhoff et al. 2004; Haberl et al. 2007) as it can be used to map the difference between global biomass production and consumption (Erb et al. 2009) and the implications for biodiversity (Haberl et al. 2004, 2005).

Further information on the environmental and resource impacts of production and consumption activities can be found in the work of the UNEP's International Panel for Sustainable Resource Management (http://www.uneptie.org/scp/rpanel/).

Table 4: An initial list of variables/datasets/indicators for monitoring progress towards Target 4.

Observation dataset	Sources and Organisational Holder/s	Start year [end year if interrupted]	Frequency of update	Geographical Coverage	Spatial Resolution
Energy statistics (e.g., electricity production mix and associated emission, energy consumption, uptake of alternative fuels, etc)	International Energy Agency (IEA) ENERDATA - Global Energy Intelligence Balanço Energético Nacional (BEN; produced by Empresa Brasileirade Pesquisa Energética (EPE))	1960-2008 2006	Annual Annual	Global and adequate National (Brazil)	National National
Greenhouse gas (GHG) emissions per unit of Gross Domestic Product (GDP) GHGs per unit of product produced	Multiple sources (IEA, EEA, ENERDATA, etc.)	Around 1960	Annual	Wide coverage but some gaps	National
Participation in re-use and recycling (also in Target 1) as measured via total recycling	EUROSTAT for EU countries (http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env	Ongoing	Annual	National	National

amounts, recycling rates and % of recycled material in key material streams consumed.	_wastrt&lang=en) and National statistical bureaus				
Changes in diet composition	FAO (http://www.fao.org/economic/ess/ess-data/ess-fs/en/)	1990	Every 5 years	Global and adequate	National
Ecological Footprint of Production, Imports, Exports, and consumption activities	Global Footprint Network (www.footprintnetwork.org)	1961-2007	Annual	Global and adequate	National
Carbon Footprint of Production, Imports, Exports, and consumption activities	Norwegian University of Science and Technology (NTNU) (http://www.carbonfootprintofnations.com/) Data for 8 EU countries (for years 1995, 2000 and 2005), plus 1 country for 2005 only are also available from EUROSTAT. Results soon to be published for the whole EU for the period 2000-2006. Maritime Transport (International Maritime Organization (IMO) www.imo.org)	2001 and 2004 1958	Conducted twice (2001; 2004) Results available for the period 1992-2004 for UK – Source: SEI. Annual	Wide coverage but some gaps	National National, regional, global
Water Footprint of Production, Imports, Exports, and consumption activities	Water Footprint Network (WFN)	1996-2001 (average of the 5 years) 1996-2005 (average of the 10 years)	Conducted twice (2004; 2010)	Global and adequate	National
Nitrogen Footprint of Production, Import, Export and Consumption activities	N-Print Initiative	2005	Conducted for 1 year only	Mostly missing (data available for USA, The Netherlands, Germany – India, Tanzania, Brazil, China, UK expected to be ready by 2012)	National
Human Appropriation of Net Primary Production (HANPP)	Institute of Social Ecology (Vienna) (http://www.uni-klu.ac.at/socec/inhalt/1851.htm) The National Aeronautics and Space Administration (NASA)	2000	Conducted for 1 year only	Global	Regional
Material flow data (extraction and consumption) for three main categories of material: biomass, fossil fuels and minerals.	Sustainable Europe Research Institute (SERI) (http://www.materialflows.net/); EUROSTAT (for the period 2000-2007 for EU countries only); OECD; Individual companies could have information that is not publically shared.	1980-2007	Annual	Global and adequate	National
Adjusted Net Savings and related indicators (e.g., sector specific estimates).	World Bank	1970-2008	Annual	Wide coverage (about 140 countries) but some gaps	National
Trends in environmental assets' value. This could be monitored by extending SNA aggregates on	National statistical bureaus perhaps		Yearly	Wide Coverage from the obligation	National

consumption of fixed capital to account for depletion and degradation of natural capital (SEEA, 2003).				date (2012?)	
Percentage of food purchased by Europeans which is wasted	The European Topic Centre on Sustainable Consumption and Production (ETC/SCP) will be piloting data collection for such an indicator later on this year		Yearly	Few EU countries to start	National
Total Material Requirement (TMR) and related concepts. TMR data available for 5 main material types, including biomass.	ETC/SCP; EUROSTAT	2000-2006 (results will be available by summer 2011)	Annual	Data exists only for EU-27 as a whole and few EU countries	Regional and National

Gaps and data limitations

There is a need to improve both the geographical and temporal coverage of some of the observation datasets reported in the table above and to fill the knowledge gap regarding the relationships between human activities and their contribution to biodiversity loss. Such relationships are only qualitative and there is a lack of quantitative assessments, though a number studies have been published recently, making a first attempt at quantifying such inter-linkages (e.g. Streamlining European 2010 Biodiversity Indicators (SEBI 2010) project; GLOBIO project; also see Alkemade et al. 2009). As a consequence it is hard to quantify the potential loss of biodiversity due to given activities or the potential recovery of biodiversity due to implementation of SCP practices. Further research is essential to gain a better understanding of these relationships.

Indicators included in the table intentionally track progress in SCP activities and not progress in Government and/or businesses adoption/implementation of such measures. Measures of inclusion of environment/biodiversity considerations in governments are included in Targets 1 and 2.

Conversely, indicators have been listed here that can link the production and the consumption side to highlight where environmental impact of consumption might really take place (e.g., Footprint-type indicators). Specific indicators for sustainable agricultural (e.g., fertiliser use) or fishing practices (e.g., population trends of exploited vertebrates) were not included as they should be used to track progresses in Targets 6 and 7.

Adequacy assessment

Some global indicators and underlying observation systems exist, at least in the research domain. Their continuity is not assured, and their global representivity can be improved. The breadth of the factors considered is currently inadequate, but could be expanded.

Estimated costs

Financial resources are needed to maintain and improve existing datasets. Most of the datasets reported in the table have good geographical and temporal coverage and are already available; however some of these datasets are provided by bodies that need funding to maintain them. For example, it is estimated that some €345,000 a year are needed to annually update Ecological Footprint values and the same amount is expected to be needed for Water Footprint values. With regards to the Nitrogen Footprint, results are currently available for a single year and for the USA, The Netherlands, and Germany only; improving Nitrogen Footprint would require approximately €10,000 per country per annum. Extending the temporal coverage of Carbon Footprint analyses is expected to have at least the same cost (€10,000 per annum per country), though additional funds would be needed to update the Global Trade Analysis Project (GTAP) model upon which the calculation depends. An estimate of the costs involved in improving the spatial resolution and temporal coverage of HANPP data is currently not available. Finally, financial resources would be needed to conduct new research on the link between human activities and biodiversity loss (approximately €3 million over the next 2–3 years as a start).

Strategic Goal B

Reduce the direct pressures on biodiversity and promote sustainable use

"It is only possible to reduce or halt the loss of biodiversity if the drivers and pressures on biodiversity are themselves reduced or eliminated. With rising human population and income, the demand for biological resources is increasing, and without action this will translate into increased pressures on biodiversity. Thus, efforts are needed to decouple the indirect and direct drivers of biodiversity loss by means of technical improvements and more efficient use of land, sea and other resources, through better spatial planning. This way, the inevitable tradeoffs between production on the one hand and maintaining ecosystem functions and resilience on the other can be minimized, easing the process of securing the necessary political support and engagement of stakeholders and helping to meet legitimate human development objectives. Further, such efforts can help to identify those situations where significant biodiversity gains can be made for relatively little cost. Where multiple pressures are combining to weaken ecosystem structure, functioning and resilience, decisive action to reduce those pressures most amenable to rapid intervention should be prioritized, while longer-term efforts continue to moderate more intractable pressures, such as climate change and ocean acidification. Targeting drivers and pressures over which there is more immediate control will help ecosystems to maintain the resilience needed to prevent some dangerous "tipping points" from being reached, and allow for better coping with those impacts of climate change that cannot be prevented in the short term. Stakeholders in each of the economic sectors will need to be engaged. Government ministries can take a leading role in their sectors while city and other local authorities can play a decisive role, especially in terms of local land use planning" (SCBD 2011).

Target 5 – Habitat loss, fragmentation and degradation

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.

Key concepts

This target refers to the rate of loss, fragmentation and degradation of major habitats. While habitat types can be divided into numerous categories, the principal ones of relevance for which trend data are available include forest, grassland, shrubland, rivers, lakes and inland wetlands, coastal habitats (mangrove & seagrasses), coral reefs and polar habitats.

Trends in habitat loss and fragmentation of terrestrial habitats are typically measured using remotely-sensed data, which have the potential to deliver indicators of forest change and fragmentation with very high spatial and temporal resolution. Field validation of remotely-sensed products is essential. Although data quality (spatial and spectral resolution) has improved over time there has been a lack of consistency. It is difficult to find products comparable with older datasets due to changes in spatial, spectral and radiometric scale, as well as in attribute naming conventions and definitions, making it difficult for trends to be accurately determined.

Going forward, between 2011–2019 high resolution maps that accurately provide information on changes in habitat extent and fragmentation rates are technically feasible to obtain for many terrestrial habitats, although careful consideration of the temporal scale will be essential for some habitats such as inland wetlands. Remote sensing has proved more effective in determining trends in extent of forest than in monitoring other habitats. In particular, accurate identification and separation of wetland habitats and of treeless habitats such as grasslands, savanna and agriculture is challenging. Hypertemporal and hyperspectral analysis and Synthetic Aperture Radar (SAR) hold potential, but require better development at the global level.

Measuring degradation *within* habitats is challenging: it can often go unnoticed until it leads to fragmentation. While hyperspatial and hyperspectral remote sensing data and LIDAR (Light Detection And Ranging) can provide relevant data for assessing habitat degradation, these are available only at local or in some cases national level. The change in abundance of characteristic species provides a measure of ecosystem degradation through human impacts such as logging. It is difficult to track changes in the abundance of non-dominant or sub-canopy species through remote sensing.

Trends in species abundance may be derived from models, although the underlying datasets from which they are derived require updating based on repeated observations. This needs to be complemented by globally available data on population trends and extinction risk trends for habitat specialist species, as indicators of degradation of forest and other habitats.

In general, habitat loss for all but the shallowest marine habitat types cannot be measured using remote sensing. Specific programmes are monitoring extent (and in some cases, condition) of particular habitats such as coral reefs, seagrasses, and mangroves. Changing temperatures are also rapidly fragmenting ocean connectivity, and impacting the migration of marine species – this can be revealed by linking satellite data with data on marine animal movements, and conducting depth oceanography via satellites.

Table 5: An initial list of variables/datasets/indicators for monitoring progress towards Target 5.

Observation dataset	Sources and Organisational Holder/s	Start year [end year if interrupted]	Frequency of update	Geographical Coverage	Spatial Resolution
Forests extent & fragmentation[8] [9]					
Global Forest Resource Assessment (extent only)	FAO	1946	Every 5 years	Global	National
Monitoramento Da Floresta Amazônica Brasileira Por Satélite (PRODES)[10]	Instituto Nacional de Pesquisas Espaciais (INPE)	1988	Annual	National	30 m
Moderate Resolution Imaging Spectroradiometer (MODIS) Continuous Fields and hotspots of forest loss project	San Diego State University (SDSU)/NASA	2000	1-5 years	Global	500 m
Advanced Land Observing Satellite - Phased Array type L-band Synthetic Aperture Radar (ALOS-PALSAR)	Japanese Space Exploration Agency (JAXA)	Around 2007	Every two years	Global	10 m
TREES	European Commission – Joint Research Centre (EC JRC)	1991	5-10 years	Eurasian boreal and tropical forests	100 m
GlobCover	European Space Agency	2005	Updated in 2009	Global	300 m
Landsat	US Geological Survey (USGS)/NASA/Global Land Cover Facility (GLCF)	1970s	At least annually	Global, needs processing but automated algorithms now becoming available. USGS is planning to provide land cover datasets from Landsat in 2012 - 2013	30 m
Other terrestrial habitats					
Grassland extent and fragmentation	Global Land Cover 2000 (GLC2000) & GlobCover (2005, 2009); Global Land Cover Network (GLCN)	2000	GlobCover allows some comparison of change	Global	300 m
Grassland, desert, shrubland extent and fragmentation	Fractional cover	2001 & more recent	Annual till 2005. New product expected annually from 2011	Global	1km (new product 30m)
Alpine habitats	Global Observation Research Initiative in Alpine Environments (GLORIA)	In some locations since 2001, others more recent	Sporadic	Global (incomplete)	Mountain scale
Marine					
Mangrove extent	Global Mangrove database and Information System (GLOMIS)	1997	Annual	Global	Few hundred m

[8] Many global forest mapping programs measure tree cover, conflating plantations and forests. Thus the relationship between habitat and forest is not always obvious, introducing errors when translating to biodiversity.

[9] Many additional regional and national programs exist

[10] Provides annual deforestation rates for the Amazon (Brazil) based on LANDSAT images

Seagrass extent	Seagrass watch; SeagrassNet	1998; 2001	Annual	26 countries; 32 countries	Seagrass bed
Reef extent	Reefs at Risk; World Resources Institute (WRI)	1998	Repeated in 2011	Global	1998 resolution 4 km, 2011 resolution 500 m
Coral reef extent and condition	Global Coral Reef Monitoring Network (GCRMN, ReefBase)[11]	1997	Annual for some data, every 4 years for other data	Global	Regions and reef level
Oyster reef extent and condition	The Nature Conservancy (TNC)	2011	Currently only one time	Global	Oyster reef level
Seamounds, cold seeps, hydrothermal vents	Census of Marine Life	2000-2010	Irregularly	Global	Vent (etc.) level
Coral reef socio-economic parameters	Global Socioeconomic Monitoring Initiative for Coastal Management (SOCMON)[12]	2003	Ad hoc	Near global	Reef level
Inland wetlands					
Wetland extent (for different wetland types)	Global Wetlands Observation System (GWOS)/Ramsar	Expected in next few years	~5 years	Global	< 1 km
River fragmentation by dams	Umeå University; TNC	2005	Baseline data only at present, can be updated with funding	Global	For major rivers
Deltas	World Deltas Network; Delta Research and Global Observation Network (DRAGON)	Integrated datasets from various regional and global assessments	Ad hoc	Global, partly based on regional datasets	For major river deltas
Polar					
Arctic biodiversity assessment	Conservation of Arctic Flora and Fauna (CAFF)	First assessment expected release in 2013	Will provide baseline data and gap analysis	Entire arctic	Unknown
Circumpolar Arctic Vegetation Map	CAFF	Completed recently	Ad hoc	Entire arctic	Unknown
Circumpolar Boral Vegetation Map	CAFF	Ongoing	Ad hoc	Entire arctic	Unknown
Extent of ice cover	Global Terrestrial Network for Glaciers (GTN-G) World Glacier Monitoring Service (WGMS); National Snow and Ice Data Centre (NSIDC), Colorado; Snow Water and Permafrost Assessment (SWIPA)	WGMS has some observations from late 19th century; NSIDC dates from 1979; SWIPA dataset will be released in June 2011	WGMS and NSIDC datasets updated annually; SWIPA will be one time initially	Global; arctic and polar regions	Glacier level
Degradation of habitat types					
Hyperspatial, hyperspectral, LIDAR and for forests	Various	Varies, generally last	3–5 years	Local to national	0.1 to10 m

[11] The GCRMN is an operational network of the International Coral Reef Initiative (ICRI) and collects coral reef monitoring data from all sources and analyzes and interprets it in Global Status Reports published every 4 years. Data are analyzed at the global, regional and national scales. ReefBase is the central database of the GCRMN, and is developed and maintained by The WorldFish Center. ReefBase is available online, and provides data and information on the location, status, threats, and management of coral reefs in over 100 countries and territories. Other regional programs include Atlantic and Gulf Rapid Reef Assessment (AGRRA; Caribbean), Wildlife Conservation Society (WCS) programms and Coastal Oceans Research and Development in the Indian Ocean (CORDIO; Western Indian Ocean), and others for the Indo-Malayan region and Pacific.

[12] SOCMON data are available from ReefBase and recorded primarily through regional coordination centers, with some aggregation to the global office at The National Oceanic and Atmospheric Administration (NOAA).

		decade			
Plot-based assessments for forests	Long Term Ecological Research (LTER) Network; Tropical Ecology Assessment and Monitoring (TEAM) Network; International Forestry Resources and Institutions (IFRI); World Agroforestry Centre (ICRAF); and others	1980 or later	Annual from 2012	Varies	Forest and habitat patches
Population trends of habitat specialist species (vertebrates)[6]	Living Planet Index (LPI) dataset (Zoological Society of London (ZSL) & WWF); Wild Bird Index (WBI) dataset (BirdLife International/ European Bird Census Council (EBCC)/ North American Bird Conservation Initiative – United States (NABCI-US)); Wetlands International; Arctic Species Trend Index (ASTI) (Circumpolar Biodiversity Monitoring Program (CBMP), CAFF, ZSL, WWF)	1960–1980	Annual, one time for CBMP	Global (patchy); polar for CBMP	Country or Ecosystem
Extinction risk of habitat specialist species	IUCN Red List	1980 (amphibians); 1988 (birds); 1996 (mammals, corals)	4–10 yearly	Global	Meaningful disaggregation by taxonomic group, region or biome possible.

Gaps and data limitations

Key gaps in data on habitat extent, fragmentation and degradation include: the condition of temperate coastal marine habitats, offshore marine breeding and spawning grounds, kelp forests, intertidal and sub-tidal ecosystems, vulnerable shelf habitats, seamounts, hot-and cold seeps, ocean surface, benthic and deep sea habitats; remote sensing data for inland wetland and non-forest terrestrial habitats; better information on small-scale habitat degradation in all habitats; and extent, fragmentation and condition of polar habitats.

The different definitions of 'Forest' currently used may undermine the effectiveness of the monitoring of habitat loss, fragmentation and degradation; the same problem has hardly been explored for other habitat types. A Red List of Ecosystems will be a potentially useful tool for monitoring changes to status of habitat.

As new remote sensing datasets become available, it is imperative that they can be calibrated to existing data to allow comparison of trends over time. The expertise and technical know-how on remote sensing and GIS is limited in many developing countries, and capacity building will be essential. A lot more might be needed to support the training process.

Further analysis is required to derive fragmentation and degradation trends from remote sensing data for all habitat types. Expanded population trend and species extinction risk monitoring is needed to improve these measures of habitat degradation. Hyperspectral data are not widely available but would help greatly with discrimination of habitats and species on the ground. More hyperspectral instruments are required to provide repeated and global coverage.

Adequacy assessment

Trend data are currently available globally for many components of this target, with improvements expected in the coming decade in habitat extent estimates derived from remote sensing data, that is, finer spatial and spectral resolution, more frequent and better resolved into habitat types. This will be complemented by improving measures of habitat condition, in particular based on population and species trends for species characteristic of each habitat.

Estimated costs

The costs of delivering adequate remote sensing data are substantial, but these are increasingly being made freely available in multiple synthetic global analyses. The most recent 5-yearly Forest Resource Assessment of FAO cost €17.25 million. Converting these data to habitat maps and analyses of changes in habitat extent, fragmentation and degradation will require additional analysis at major global biodiversity hotspots, which would cost an additional several million euro. In terms of habitat monitoring with very high resolution data, sampling systems could be used to monitor selected representative sites and areas of special interest (e.g. biodiversity hot spots) instead of full coverage, which could reduce cost significantly.

Annual operating costs for *in situ* monitoring of threatened plant species highlighted by the Sampled Red List Index (SRLI), which would also give us a Living Planet Index (LPI) for plants, would be about €1.1 million. Annual operating costs for a Wild Bird Index to track global bird population trends would be around €210,000, with the need for additional investment in national bird monitoring programmes in the order of €690,000. Expansion of geographic representativeness of the former, and particular for taxonomic coverage of the latter, would require substantial additional investment.

Target 6 – Sustainable exploitation of marine resources

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.

Key concepts

Monitoring progress toward this target requires information on indicators for the health of marine ecosystems, which includes ecosystem function, and the status of exploited target and by-catch species. Global observation systems for the oceans are being implemented that address ecosystem function based on simple oceanic parameters that have an impact on biodiversity, such as temperature, salinity and, recently, also pH. Ecosystem productivity can be estimated from plant and bacterial biomass as determined by remote sensing. More detailed information on plankton and benthos is obtained by regional monitoring efforts, such as the continuous plankton recorder surveys from SAFHOS and numerous local monitoring programmes that are part of legal requirements for judging good environmental status (in the EU).

The available data sets on status vary in their coverage and the quality of the underlying data, which means that a combination of status observations will be required. For example, population trends of exploited and by-catch vertebrate species, although very useful, will only realistically be based on data from a sub-set of species, so broader brush approaches (proportion of fish stocks within safe biological limits) will be needed to give the global perspective.

Catch per unit effort (CPUE), at large scales e.g. national and above, is very useful for giving a measure of abundance as one aspect of sustainability, however, measurement of effort is fraught with difficulty and may not be reported to a consistent standard. Total catch is even coarser and would be difficult to interpret without a measure of effort but can be 'reliably' collected at multiple scales. In the absence of effective catch constraining measures, continuing levelling off or reduction of catch would be interpreted as serious evidence of unsustainable fishing.

Marine Protected Areas (MPAs) are recognised as one important response for managing the ecosystem impacts of fishing, therefore the extent and management effectiveness of these should be monitored. Fisheries management plans are a necessary (but not sufficient) step towards sustainable management, thus these responses be monitored.

Table 6: An initial list of variables/datasets/indicators for monitoring progress towards Target 6.

Observation dataset	Sources and Organisational Holder/s	Start year [end year if interrupted]	Frequency of update	Geographical Coverage	Spatial Resolution
Reported landings	FAO	1950	Annual	Global	Global, regional, national
Practice of destructive fishing techniques (as proxy for pressure on habitat)	Bottom trawl, dynamite fishing in practice - Regional Fisheries Management Organisations (RFMOs)	Various	Usually annual	Global (uneven coverage)	Global, regional, national
Fishing effort (number and type of vessels)	Vessel monitoring systems (National and regional Fishery monitoring centre)	Varies according to country / region	Continuous	Global (uneven coverage)	Regional, national
Catch Per Unit Effort	Regional Fisheries Management Organisations (RFMOs)	Varies according to region and/or species group	Usually annual	Global (uneven coverage)	Global, regional, national

Kelp forest (Laminaria, Macrocystis species)	FAO; also Norway, New Zealand, USA, Australia, Japan The Californian Channel Islands Kelp Monitoring Program Tasmanian MPA Monitoring Program	1950 (FAO) 1982 1992	Annual Annual Annual	Regional	Unknown
Plankton monitoring	Continuous plankton recorder data set (Sir Alister Hardy Foundation for Ocean Science (SAHFOS))	1931	Annual	North Atlantic and North Sea	Small standard areas within region
Population trends of exploited vertebrates and by-catch species	LPI database (ZSL/WWF) Arctic Species Trend Index (ASTI) (CBMP, CAFF, ZSL, WWF)	1970	Annual	Global (uneven coverage)	Global; system; biome; habitat; regional; thematic subset
Extinction risk trends of exploited species and by-catch species	IUCN Red List and Red List Index dataset (IUCN, BirdLife International)	1988 (seabirds) 1996 (mammals, corals)	4–10 years	Global	Meaningful disaggregation by taxonomic group, region or biome possible
Proportion of fish stock in safe biological limits	FAO	1974	Varies between regions	Global	Stock or species at the FAO statistical scale
Maximum sustainable yield	Regional Fisheries Management Organisations (RFMOs)	Various according to species or stock	Usually annual	Various according to species or stock	Stock or species level
Status of Vulnerable Marine Ecosystems (VMEs)	Regional Fisheries Management Organisations (RFMOs)	2006 at the earliest but VMEs still being identified and appropriate monitoring proposed	Unknown	Global	Global, regional
Coral reef and near-shore habitat monitoring	Ocean Health Index (CI)	Scheduled for 2012	Annual	Global (limited to coral reefs and near shore habitats)	Unknown
% of depleted species with recovery plans	RFMOs; ICATT; Convention on Migratory Species – relevant agreements such as Agreement on the Conservation of Albatrosses and Petrels (ACAP); CAFF	Various	Annual	Global but species focussed	Global, regional, national
Extent of MPAs (also in Target 11)	World Database on Protected Areas (WDPA; UNEP-WCMC)	1872	Annual	Global	Global, regional, national, biome
MPA effectiveness (also in Target 11)	World Database on Protected Areas (UNEP-WCMC); Arctic protected area index (CAFF)			Very patchy	Global, regional, national, biome
MPA coverage of important biodiversity areas and VMEs (also in Target 11)	BirdLife International; Conservation International; Alliance for Zero Extinction	1900	Annual	Regional	Marine region

Gaps and data limitations

Despite the fact that the oceans cover 70 % of the planet, large parts of it are either insufficiently monitored or not at all. Good inventories of biodiversity exist only for certain coastal areas in developed countries, and mostly at very local scale. Biodiversity hot spots are not well known for the oceans, except for some coastal ecosystems such as coral reefs. The ten year effort of the Census of Marine Life and its different projects ending in 2010, however, has already considerably improved the situation.

The temporal sensitivity of Red List Indices is limited because of the broad nature of the Red List categories, so for some species this will limit the trends information that will be available by 2020. Available population trends in exploited (and by-catch) vertebrates are spatially and taxonomically biased and with less representation of tropical and small scale fisheries species. Data from non-commercial practices such as recreational fishing and subsistence use are missing here, and are important to include especially when vulnerable or threatened species are targeted. Regional gaps include areas currently either not exploited or lightly exploited that are likely to become more heavily used in future such as the deep sea and the Southern Ocean.

There are concerns about CPUE as a measure of sustainability. Standard and reliable measures of fishing effort are vital as total catch is of limited value without effort measures. The application of mean trophic level as a marine biodiversity indicator has been cautioned (Branch et al. 2010) and is considered unsuitable for measuring fishing impacts or the rate at which marine ecosystems are being altered by fishing, so another measure may be required to monitor status at the community and ecosystem level.

MPA management effectiveness is poorly known (Mora et al. 2006) and monitoring of these and VMEs is in its infancy.

Adequacy assessment

The global observation systems that exist are relevant to this target, but need to be developed further, as there are concerns regarding coverage, data quality and the breadth of the biodiversity that is recorded.

The knowledge base for the marine environment is in many aspects (e.g. temporal and spatial resolution, inventories) considerably less developed than for terrestrial environments. This has implications for *inter alia* reliable baseline establishment. The marine environment also has both a two dimensional (bottom/ ocean-floor) and three-dimensional (water column) component. Both of these, but especially the latter, are very dynamic on several temporal and spatial scales. This has implications for the ability to establish robust target measurements.

The Intergovernmental Oceanographic Commission (IOC), and several of its activities are highly relevant. The IOC hosts the Global Oceans Observing System (GOOS) Secretariat. Also part of IOC is the Ocean Biogeographic Information System (OBIS), under IOC's International Data and Information Exchange programme. Both IOC and OBIS are mentioned as important partners for the CBD in the COP-10 report.

Another programme is the Global Ocean Biodiversity Initiative (GOBI), which is a growing consortium of ocean-related initiatives and organizations, and aims to assist the CBD and its secretariat in bringing science into decision-making processes with regards to the marine environment.

Apart from these, there are also US and European initiatives. In the US seven federal agencies (The National Oceanic and Atmospheric Administration (NOAA), NASA, The Marine Mammal Commission (MMC), The Office of Naval Research (ONR), The National Science Foundation (NSF), The Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) and the Smithsonian Institution (SI)) discussed in May 2010 the overarching components of a Marine Biodiversity Observation Network (BON), which culminated in the pioneering report 'Attaining an Operational Marine Biodiversity Observation Network' (http://www.nopp.org/wp-content/uploads/2010/03/BON_SynthesisReport.pdf). Other large-scale projects and Networks of

Excellence have been sponsored by the EU including Marine Genomics Europe, Eur-Oceans and especially Marine Biodiversity and Ecosystem Functioning (MarBEF). All these initiatives have resulted in important datasets and a wealth of information, actively maintained by the European marine science community.

As these and other initiatives are developing, it would be better if effort is focused on improving the quality of data and the geographic and taxonomic coverage of available data sets rather than calling for new ones. Increasing the coverage of the LPI for exploited and by-catch species is important. For tracking extinction risk of commercially exploited aquatic species and by-catch species a repeat assessment of Red List status at 4 to 10 year intervals is required. Global reporting of fishing effort needs to be improved but this should be feasible as the relevant data is already collected by many nations or RFMOs. Improving measurement of management effectiveness of MPAs is a major challenge but teams from UNEP-WCMC and others are working on this. The importance of MPA networks has been recognized by the PoWPA (Programme of Work on Protected Areas) however, its uptake in NBSAPs and implementation at the regional level is limited. Central reporting of recovery plans for important pelagic stocks could be improved.

Estimated costs

The costs of implementing and maintaining a global ocean observation system has been calculated at millions of Euros. Several projects are underway to estimate the cost of networks of coastal observatories and a small number of deep-sea observatories are under construction (e.g. The Monterey Accelerated Research System (MARS) in Monterey Bay, The NorthEast Pacific Time-Series Undersea Networked Experiments (NEPTUNE) in Canada, The European Seas Observatory NETwork (ESONET) in Europe). As an example, the simple measurements of temperature and salinity made by the Argo floats (The broad-scale global array of temperature/salinity profiling floats) required an investment of about €11 million.

The LPI currently costs €172,500 a year (Jones et al. 2011) and should be relatively low cost to simply incorporate more existing datasets (€69,000). €2.07 million was recently spent updating the WDPA and it costs about €690,000 a year to maintain. Support for updating online access to quantitative fishery-independent data sets based on existing broad-scale ecological monitoring programs (California Kelp Forest Monitoring, Australian MPA Monitoring, Reef Life Survey) could be done relatively cheaply (<€345,000), with data then directly feeding into global indices such as the LPI. Expanding to ensure full coverage of MPAs and incorporate management effectiveness would be costly.

Target 7 – Biodiversity-friendly agriculture, forestry and aquaculture

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

Key concepts

Biodiversity is not only critical to the sustainability of production systems (encompassing agriculture, aquaculture and forestry), but production systems themselves and the way they are managed have direct impacts on biodiversity and the delivery of ecosystem services (other than production).

Monitoring progress towards this target requires three types of integrated measurements: agricultural management practices (AMPs) (and changes in AMPs); agricultural biodiversity associated with different production systems (PSs) (e.g. varietal diversity; genetic diversity associated with agricultural systems is discussed in Target 13); and biodiversity within production systems and the surrounding landscape impacted by those PSs.

Global food production has relied increasingly on large-scale intensive production systems that raise concerns regarding ecological sustainability. Although there is a trend, in places, towards more sustainable, lower input agriculture, the demand for produce continues to increase. A further 70% increase in food is required by 2050 to feed the projected global population of 9 billion people.

Monitoring of biodiversity in production landscapes needs to be prioritised, both to complement monitoring in protected and natural areas, as well as within production landscapes to ensure that areas of particular importance are watched more closely. An issue that needs to be considered, in view of the prospects for ecological intensification and adaptation of agriculture[13] (Brussaard et al. 2010; Jackson et al. 2010), is the scale at which sustainability must be assessed to inform the land-sparing versus land-sharing debate.

Table 7: An initial list of variables/datasets/indicators for monitoring progress towards Target 7.

Observation dataset (incl. those that do not yet exist)	Sources and Organisational Holder/s	Start year [end year if interrupted]	Frequency of update	Geographical Coverage	Spatial Resolution
Proportion of commercially harvested forests that are certified as sustainably managed	FSC and other certification schemes; International Tropical Timber Organization (ITTO)	1993	Annual	Global	Forestry concession
Proportion of agricultural production with eco- or bio-farming certification (including aquaculture)	National and international certification bodies	Does not yet exist	Annual	National and global	National and Sub-national
Changes in agricultural and aquaculture management practices (AMPs) & activities (e.g., enhanced diversity in production systems, low tillage, low input agriculture, pollination management, adherence to technical standards e.g. for sea cages etc.)[14]	Consultative Group on International Agricultural Research (CGIAR); FAO[15]; National Health Institutes; Globally Important Agricultural Heritage Systems (GIAHS); Land Use/Cover Area frame Survey (LUCAS; EUROSTAT)	Does not yet exist in globally integrated and systematic form	5-yearly	Various	Sub-global
Proportion of agricultural lands and aquaculture farms managed sustainably for biodiversity	Certification bodies; Agri-environment schemes; palm oil and soya roundtables; soil	No integrated datasets yet	Annual	Global	National

[13] Ecological intensification is enhancement of the capacity of agricultural lands to deliver agricultural goods and ecosystem services. The delivery of ecosystem services in industrial agriculture is as much an issue as is the production of agricultural goods in low-input agriculture in informing the land-sparing versus land-sharing debate.

[14] Systematic data collection of management practices for selected production systems has been carried out by some initiatives e.g. GIAHS, LUCAS

[15] There is regular global assessment of relevant data by FAO for forestry (and trees outside forests), but there is no equivalent assessment of AMP, their changes, and relevant impacts on biodiversity. This would require new, systematic data collection (by FAO and other partners) at a global scale as well as adaptation/refinement of existing relevant methodologies.

	quality datasets - Africa Soil Information Service (AfSIS); Digital Soils Map of the World; groundwater and water-table data; organic farming; sustainable livestock production; Partnership on Agricultural Research (PAR) – production system level	exist			
Area planted under GMOs with recognised ecological impacts	International Service for the Acquisition of Agri-biotech Applications (ISAAA); Baseline for gene flow in Andersson & De Vicente (2010)	Unknown	Annual	Global	National
Volumes of pesticide, herbicide and fertilizer usage and areas under use of these	World Bank Living Standards Measurement Survey; Agribusiness sector (Global Landscape Initiative) Indicadores de Desenvolvimento Sustentável (IDS; Instituto Brasileiro de Geografia e Estatística (IBGE) database http://www.sidra.ibge.gov.br/bda/tabela/listabl.asp?z=p&o=11&i=P&c=766)	Various	Various	Various National (Brazil)	Sub-national Sub-national
Incidence of pesticide and herbicide resistance/tolerance	FAO; Agro-chemical industry	Unknown	Ongoing	Global but patchy	Local
Use of biological agents for soil fertilization, plant nutrition and biological control	Innoculant and biological control industry	Unknown	Unknown	Unknown	Unknown
Biodiversity community measures testing signal of agricultural impacts	GEO BON (freshwater, marine); national agencies; governments; via GBIF	Not yet implemented	Annual	Global	Sub-national
Incidence of disease outbreaks in wild fish attributed to farming activities	FAO	Unknown	Unknown	Unknown	Unknown
Population trends of farmland specialist species	WBI (BirdLife International/EBCC/US NABCI Committee); LPI dataset (ZSL/WWF); FAO Global Pollinator Monitoring Network	1980	Annual	Europe and N. America and selected African countries for birds	National
Population trends of forest specialists in managed forests	WBI dataset (BirdLife International/EBCC/US NABCI Committee); LPI dataset (ZSL/WWF); TEAM; US Forest Service	1960–1980	Annual	Various	National
Extinction risk trends of farmland specialists & forest specialists in production landscapes	IUCN Red List and RLI dataset (IUCN, BirdLife International etc.)	1980 (amphibians); 1988 (birds); 1996 (mammals)	4–10 yearly	Global	Meaningful disaggregation by taxonomic group, region or biome possible
Levels of agro-biodiversity within and across production systems (α-, β- and γ- diversity)	Synthesis of research products; see Jarvis et al. 2008 (review and methods for indicator)			Some data available for some countries	Sub-national

Gaps and barriers

There is a general dearth of reliable information on the extent to which production systems are being managed sustainably at sub-national, national and global levels. The research community needs to focus more on monitoring biodiversity through a global network of diverse agricultural landscapes (Sachs et al. 2010)

Adequacy assessment

Integrated data for a set of representative places on changes in agricultural management practices, including agricultural diversity and responses of biodiversity within and around agricultural systems, is not available.

For the forestry sector, proportion of land used for production that is managed sustainably, in terms of forest certification criteria, is available. Comparative information for the other sectors/production systems is not readily available, but could potentially be calculated.

Data on agricultural management practices and their sustainability exist, but primarily for large industrial agriculture and for selected production systems (e.g. GIAHS, LUCAS), and not equally for all parts of the world. These data need to be synthesized.

Population trends and extinction risk trends of forest and farmland specialist bird species are currently the only readily available data.

Estimated costs

No global cost estimate for reaching adequacy has been attempted.

Target 8 – Pollution reduction

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

Key concepts

This target needs to combine pollution inputs to the system and information about the levels above which these inputs become detrimental to ecosystem function and biodiversity. The inputs into the system can be of very different natures (natural vs. anthropogenic, point vs. area). The extent to which pollutants are detrimental to ecosystem function and biodiversity is not always known, but clear effects of the following compounds have been reported: nutrients (nitrogen, phosphorus), sulphur, pesticides/herbicides, aerosols and ozone. Ultra-violet radiation (UV), nocturnal light and sound in excessive amounts can also be considered pollutants. For an indication of excess pollutant exposure, it is important to know the difference between natural vs. anthropogenic exposure, for which emission/dispersion and deposition model calculations are needed. Measurements are not (always) able to discriminate between these different origins of pollutants.

Table 8: An initial list of variables/datasets/indicators for monitoring progress towards Target 8.

Observation dataset	Sources and Organisational Holder/s	Start year [end year if interrupted]	Frequency of update	Geographical Coverage	Spatial Resolution
Nitrogen wet deposition (measured)[16]	Co-operative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP)	1980	Annual	EMEP domain (Europe + North America)	Points
	Canadian air and precipitation monitoring network (CapMon)		Annual	Canada	Points
	Acid Deposition Monitoring Network in East Asia (EANET)	1995	Annual	East Asia	Points
	National Atmospheric Deposition Program (NADP, US)	1990	Annual	North America	Points
	The Clean Air Status and Trends Network (CASTNET)	1987	Annual	North America	Points
Nitrogen wet+dry deposition (modelled)[17]	International Nitrogen Initiative (INI, The Oak Ridge National Laboratory (ORNL));	(1860)–2030	Infrequent	Global	1x1 degree
	EMEP	1980	Annual	EMEP domain (Europe + North America)	50x50 km^{2e}
Critical Loads for Nitrogen	Convention on Long-range Transboundary Air Pollution (CLTAP) / Coordination Centre for Effects	1990	Annual	EMEP / CLTAP domain (Europe + North America)	50x50 km^2
Nutrient Balance[18]	FAO / EEA	1970 / 1995	Annual	Global / Europe	National

[16] Measured data on nitrogen and sulphur is incomplete in terms of coverage (Europe -EMEP, North-America - NADP, Canada - CapMon, East Asia - EANET) and only deals with wet deposition (which means dry deposition – sometimes making up 50% of the total amount – is not taken into account.

[17] Available modelled data on nitrogen and sulphur is very variable in terms of resolution and/or domain. Data covering the entire globe is mostly rather coarse, and therefore unable to represent the various local variations in deposition pattern. On the other hand, data on a higher resolution is often only representing smaller modelling domains. The INI and EMEP are given here as examples for these two 'options'. More examples of 'local' modelling work on a higher resolution exist, but work is needed to combine these into a dataset covering a larger domain (with the danger of having incomparable datasets).

[18] The nutrient balance provides indirect information about the potential loss of nutrients to the environment. Disadvantage of this balance approach is that it doesn't show were the nutrients are going (e.g. atmosphere, groundwater).

	OECD	1990	Annual	OECD domain	National
Phosphorus wet deposition (modelled / measured)					
Sulphur dioxide (measured)[7]	EMEP	1980	Annual	EMEP domain (Europe + North America)	Points
	CapMon		Annual	Canada	Points
	EANET	1995	Annual	East Asia	Points
	NADP	1990	Annual	North America	Points
	CASTNET	1987	Annual	North America	Points
Sulphur dioxide (modelled)[8]	INI (ORNL)	(1860 -)1990 – 2030	Infrequent	Global	1x1 degree
	EMEP	1980	Annual	EMEP domain (Europe + North America)	50x50 km^2
Pesticides transport / deposition	The Helsinki Commission (HELCOM)		Infrequent	Baltic Sea	Points
Herbicides transport / deposition	HELCOM			Baltic Sea	50x50km^2
Heavy metals (incl. Mercury) transport / deposition	EMEP[19]	2008		EMEP domain (Europe + North America)	50x50 km^2 [20]
	Arctic Monitoring and Assessment Programme (AMAP) Mercury Assessments		Arctic		
Heavy metals concentration in rivers					
Nitrogen/nitrate concentration in rivers	http://www.eea.europa.eu/data-and-maps/indicators/nutrients-in-freshwater/nutrients-in-freshwater-assessment-published-4 Global Environment Monitoring System (GEMS) dataset	1970	Annual	Global / Inland waters	Point data
Phosphorus concentration in rivers	http://www.eea.europa.eu/data-and-maps/indicators/nutrients-in-freshwater/nutrients-in-freshwater-assessment-published-4 GEMS dataset	1970	Annual	Global / Inland waters	Point data
Ozone concentration (measured)	Global Atmosphere Watch (GAW) / The World Ozone and Ultra-violet Radiation Data Centre (WOUDC);	Around 1965			Points
	NASA / Ozone Monitoring Instrument (OMI)	2004	Daily	Global	
	EMEP	1980	Annual	EMEP domain (Europe + North America)	Points
	CASTNET	1987	Daily	North America	Points
Aerosols (Index)	NASA / Total Ozone Mapping Spectrometer (TOMS)	2004	Daily	Global	~20 km

[19] The EMEP calculations for heavy metals are limited to lead, cadmium and mercury.

[20] The resolution of the EMEP model calculations is currently being discussed and higher resolutions (25x25 km^2 or even 10x10 km^2) may be proposed.

Emission of pollutants to the air (NH_3, NO_X)	National Statistics Bureau / National Governments	continuing	Annual	National	National
Emissions of pollutants to water (NH_4, NO_3, PO_4)	National Statistics Bureau / National Governments	continuing	Annual	National	National
Ultra-Violet (UV) radiation	GAW / Network for the Detection of Atmospheric Composition Change (NDACC) / WOUDC NASA / TOMS	Around 1992 2004	Daily	Global	
Light	NOAA / National Geophysical Data Centre (NGDC)	Around 2000	Daily	Global	~ 5km
Sound (Propulsion, Sonar, offshore windmills)	No existing global database	Does not exist			
Nitrogen loading to surface waters	The Global Water System Project (GWSP) dataset GEMS dataset	 1970	Annual Annual	Global / Rivers Global / Inland waters	Point data Point data
River water quality (nutrient concentration or Chemical Oxygen Demand (COD)/ Biochemical Oxygen Demand (BOD))	GEMS dataset	1970	Annual	Global / Inland waters	Point data
Phosphorus loading to surface water	GWSP dataset GEMS dataset	 1970	Annual Annual	Global / Rivers Global / Inland waters	Point data Point data
Radioactive element deposition	International Atomic Energy Agency (IAEA)				
Pesticide/Herbicide load to surface water	GWSP dataset GEMS dataset	 1970	Annual Annual	Global / Rivers Global / Inland waters	Point data Point data
Riverine nutrient load to coastal zones	HELCOM GEMS dataset Global NEWS (Global Nutrient Export from WaterSheds) dataset	 1970 2000	Annual Annual Infrequent	Baltic Sea Inland waters (Global) Coastal waters (Global)	Point data Point data
Sediment loading	GWSP dataset			Global / Rivers	
Ocean acidification	The Arctic Council is starting an ocean acidification assessment (also see Target 10); European Project on OCean Acidification (EPOCA)	2008		Europe	

Gaps and data limitations

Many of the datasets mentioned here have limited spatial coverage, either because the geographical domain is limited to certain areas or because of the form of the data itself (point data) or because of the large area they cover (open ocean). This limitation can be (partly) overcome by combining the different data sources: model and measurement results can be combined to provide a more complete picture of the different pollutants on the required scales and with sufficient resolution. Furthermore, it is not always clear what the temporal coverage is, since the update frequency of the different datasets is not always reported.

More information is needed about relevant thresholds for the different terrestrial/aquatic systems (e.g. critical loads for nitrogen), in order to be able to evaluate when levels/loads become detrimental to ecosystems. Also, information about possible recovery from excess situations is needed, since that is not available on a global scale as yet.

Adequacy assessment

A small number of the datasets are ready for use (e.g. nitrogen deposition, GEMS datasets), but others need further work for use on a global scale. This work is related to different aspects of the overall pathway: lack of sufficient emission data, in particular open ocean in situ data, (global) models not fully equipped for modelling the respective components, missing measurement data for model validation purposes. Combining different regional datasets can be done for e.g. heavy metals, pesticides/herbicides, etc., but it needs to be investigated to what extent this can result in good quality global data. For some of the components (ozone, UV, light, aerosols) the use of satellite data looks promising as a way forward. However, the adequacy of these datasets is yet to be determined.

Estimated costs

The existing databases mostly arose from research activities, and will require ongoing support if they are to be operationalised. Expansion of the observation networks into rapidly-industrialising developing countries will cost up to several million Euros per country per year, but has benefits far beyond the ambit of biodiversity.

Target 9 – Control of invasive alien species

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.

Key concepts

Effective management of the invasive alien species (IAS; UNEP 2002) problem, i.e. that will result in a reduction in the impact of IAS on biodiversity (as well as a reduction of social and economic impacts), requires, *inter alia*, prevention, early detection, rapid response, containment, control and monitoring. Effective monitoring (see Genovesi *In press*) requires observations on the identification and prioritisation of IAS based on species-specific information on their impacts, as well as knowledge of their current and potential distributions. Because human movement, trade and transport are the key drivers of biological invasions (exacerbated by other change drivers, such as climate change), effective responses include both the existence of policy and the effective implementation thereof, in the form of global, regional and national policy, legislation, strategies, action plans, management plans and measures of how effectively these are being implemented.

This target therefore includes requirements for pressure (identity, distribution and impact of IAS), response (control and pathway management) and state observations (e.g. species extinction risk as a consequence of IAS). IAS-specific expertise, investment in IAS research and country development status affect the degree to which the above can be achieved, and are therefore also pertinent measures of response to dealing with the problem. Changes (increase, decrease, rate of change) in the numbers, distributions and impacts of priority IAS (those with the most severe and extensive impacts), reflect how adequately this target is being met. Pathway management, along with control of priority IAS, are necessary to limit and reduce the size and impact of biological invasions.

Table 9: An initial list of variables/datasets/indicators for monitoring progress towards Target 9.

Observation dataset[21]	**Sources and Organisational Holder/s**	**Start year [end year if interrupted]**	**Frequency of update**	**Geographical Coverage**	**Spatial Resolution**
Pressure[22]					
1. Extent of alien species	Global Invasive Species Information Network (GISIN) http://www.gisinetwork.org/	GISIN was formed to provide a platform for sharing invasive species information at a global level, via the Internet and other digital means. Part of its function is as a metadatabase that reviews and lists existing online IAS databases (of which there are currently 259 spanning the range of taxon-, geographic-, environment- and purpose-specific datasets on alien species).			
	SAHFOS for marine plankton	1931	Regular	N. Atlantic	Continuous
2. Trends in alien species (as used for reporting on the 2010 target)	Delivering Alien and Invasive Species Information for Europe (DAISIE)	1970-2008	Annual	27 EU states + 10 non-EU states	Aggregated across countries
3. Identity, distribution and impacts of IAS	Centre for Invasion Biology (CIB; University of Stellenbosch)	2009	Requires updating to produce trend	Stratified random selection of 57 countries	National
State					
4. Trends in species extinction risk driven by IAS	IUCN Red List and RLI dataset (IUCN, BirdLife International etc.)	1980 (amphibians) ; 1988 (birds); 1996 (mammals)	4-10 yearly	Global	Meaningful disaggregation by taxonomic group, region

[21] See McGeoch et al. (2010)

[22] Other than GISIN, which provides a portal to electronically available alien datasets globally, only those observation datasets currently directly suitable for reporting on the target are listed here.

					or biome possible
Response					
5. IAS-relevant international policy adoption	CIB	1950-2009	Annual	Global (191 countries)	National
6. IAS-relevant national policy adoption	CIB	1960-2009	Annual	Global (191 countries)	National
7. Pathway management[23]	Does not yet exist				National
8. Control of priority species[24]	Does not yet exist				National/global
9. IAS expertise/ capacity and research investment	Does not yet exist				National/global
10. Ballast Water Treatment	Legally required as of 2012 for certain categories of vessels		When in port	Global	Global

Gaps and data limitations

There are currently no collated, standardized sources of information on the control of IAS or on the management of pathways, beyond what is available for a fairly small subset of individual countries. The two 2010 IAS policy indicators provide a measure and basis for further developing these. However, detailed country level information will be needed and this information is not readily accessible or available for many nations (this includes for example information on introduction or establishment dates, evidence of invasiveness and economic costs of management). It is therefore important to start developing these observation datasets as soon as possible and to devise a suitable approach for doing so.

Facilitation of data exchange and access between existing and planned databases will be essential. Knowledge of the distribution of, for example, marine and terrestrial invertebrate IAS is particularly poor, and information on ballast water monitoring and management is also needed. There is poor coverage of invasive species in the pelagic zone, both coastal and open ocean, and temperate regions are particularly badly covered. Extralimital IASs have largely not yet been incorporated into observations, nor have invasive pathogens. Genetically modified organisms or biofuel crops with weedy characteristics, or where gene flow may result in enhanced weediness, have also not been considered for inclusion to date.

Information on the impact of IAS on species extinction risk is currently available only for mammals, birds and amphibians. Several of the above datasets are currently not necessarily being actively updated, or necessarily being extracted for reporting on this target.

Adequacy assessment

Pressure. Some standardised global, regional and national baseline data are available for reporting on the identity, distribution and impact of IAS. These observations need to be repeated to produce trend information and could be expanded to include more countries. Trend observation data exist for alien species in Europe, but these are not for 'priority' or 'invasive' species per se, and are currently not comparable with the global baseline IAS information. The many various databases of alien and invasive species that exist were evaluated as part of the 2010 IAS Indicator process and data from these (supported and supplemented by primary literature) were standardised and collated for the purposes of populating the 2010 IAS Indicator (a 'documented evidence' approach). For comparability purposes, a similar process will be required to report on the 2020 target to start to provide globally representative trend data on the identity and distribution of IAS, as well as to expand the global coverage. An alternative, or perhaps complementary, approach would be to

[23] The nature and content of a 'Pathway management' observation dataset requires formulation and will involve the spectrum of measures from policy to implementation and management effectiveness, as well as the distinction between deliberate (e.g. for aquaculture) and accidental species introductions. There are some data available at national scales on import and inspection information that could be considered for use here.

[24] Prior to generation of this observation dataset, a risk assessment process/method will need to be developed and adopted for designating 'priority' species in a transparent, standardised and repeatable way. The process will be similar to that needed to designate 'invasive' species as a subset of 'alien' species that was necessary for the 2010 IAS Indicator. Risk assessments conducted by importing countries under WTO Agreements are one possibility.

conduct an expert assessment (similar to that used by DAISIE (2009) for Europe) to produce comparable, standardised, prioritized information on IAS for countries. An expert assessment is likely to generate more information than the 'documented evidence' approach, but is more costly and prone to high variability in outcomes across experts, particularly in data and expert-sparse situations (thus potentially lower repeatability for monitoring purposes, unless a formalised process such as that used for the Red List is adopted). The primary biological variables needed to derive invasion risk are the same as those needed to derive species extinction risk, i.e. species abundance (population trends) and distribution, in this case of priority invasive species (see Fig. 1).

State. Observations on trends in species extinction risk as a consequence of IAS are available and will be so for 2020 via the IUCN Red List and related Red List Index.

Response. As outlined under Gaps and data limitations, both the development and population of appropriate observation datasets are required here for adequate reporting on Target 9. While the IAS policy indicators from 2010 provide high level information on the intention of the global community and countries to manage the IAS problem, much more direct measures of management implementation and effectiveness are required.

In summary, it is feasible with moderate effort to generate the additional observation datasets necessary for reporting on the full range of topics in this target between now and 2020.

Estimated costs

The cost of generating the additional observation datasets necessary (including ODs 3 and 5-8) is estimated to be in the order of €110,000 per annum. The estimated cost of Target 12 would include monitoring and reporting on 'Species extinction risk driven by IAS' (OD4), plus a cost for the addition of new taxa.

Target 10 – Coral reefs and other vulnerable ecosystems

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.

Key concepts

This target addresses the effects of anthropogenic pressures such as pollution, overfishing and sedimentation, when combined with added impacts of climate change and ocean acidification on biodiversity. While it is likely that climate change will impact all ecosystems in some way, it is important to prioritize what ecosystems will be affected soon, which have the highest biodiversity and which will be damaged the most. Coral reefs have been identified as the "canary in the coal mine" for global climate change because they suffer high mortality due to coral bleaching in response to increased sea water temperatures (Carpenter et al. 2008). For example, more than 10% of the world's reefs were lost in 1998 alone due to a major global bleaching event (Wilkinson and Hodgson 1999). Further losses have been suffered in 2005, and again in 2010 bleaching events. In addition to coral bleaching, ocean acidification due to increased dissolved carbon dioxide in seawater is a relatively new issue that has been predicted to reduce the ability of many marine organisms, ranging from foraminifera to corals to fin fish, to calcify bones, shells etc. (Hoegh-Guldberg et al. 2007)

The temperate equivalent of coral reefs are shellfish reefs, which historically generated habitat structure and controlled filtration and other ecosystem processes in temperate estuaries and embayments worldwide. Shellfish reefs are now functionally extinct in most regions; however, options are available for remediation and restoration (Beck et al. 2011).

While coral reefs are specifically named in this target, other ecosystems such as arctic ecosystems, mountain forests and wetlands are also highly vulnerable and deserving of monitoring. In the absence of direct measures it may be difficult to determine ecosystem "failure" *per se* for some ecosystems; hence the indicators are taken at the biome, species group or lower levels.

There are very few global ecosystem monitoring programs, relatively more regional and national level programs and large numbers of local level programs. Several new programs such as TEAM for terrestrial organisms, and Reef Life Survey (RLS) in the marine realm, have the stated goal of becoming global but are in the early stages of development with good prospects for growth.

Given the existence of national level monitoring programs for such indicators as fish catch, marine pH, river pollution or invasive species, more effort should be focused on trying to gather the huge amount of existing data. The most effective use of funds will be to strengthen existing successful global programs and to connect existing national and regional programs.

All available data on reefs (including Reef Check and Reef Life Survey data) are collected and compiled by the Global Coral Reef Monitoring Network which is used to produce a Status Report every 4 years

Observations on the impacts of climate change and acidification across other ecosystems are made by a wide range of organizations. The emerging nature of ocean acidification means that no global indicators have been established previously, however, most countries monitor seawater pH. A combination of site-level monitoring (see Hodgson et al. 2006) and remote sensing (see Nim and Skirving 2010) can be used to infer ecosystem integrity and functioning under climate change and ocean acidification.

Among other threatened ecosystems, more than half of the Earth's rivers are under threat from a multitude of factors that affect biodiversity, and attempts to enhance human water security will continue to be detrimental to freshwater biodiversity.

Ecosystem diversity is high in mountain regions and the vulnerability assessment at ecosystem level is vitally important. ICIMOD is an intergovernmental regional centre working in the Hindu Kush

Himalayan (HKH) region for 27 years on capacity building, policy innovations, and indicators at a regional scale. Arctic ecosystems may be less prone to biodiversity losses (except for emblematic mammals such as the polar bear) than many alpine regions where space is limited and species often are endemic. Polar ecosystems, although lower in diversity, are predicted to experience large changes under all future climate scenarios. Like coral reefs, these ecosystems could disappear completely hence monitoring is important to identify species. There has already been a major loss of Arctic sea ice, and coastal glaciers and ice shelves in the Antarctic Peninsula that has dramatically changed patterns of nearshore productivity and biological communities and could affect global ocean currents. A warming of bottom water in polar regions is also likely to have unknown, but potentially large effects on deep sea ecosystems. Target 2 of the Global Strategy for Plant Conservation (GSPC) is for a conservation assessment to be completed for every plant species.

Table 10: An initial list of variables/datasets/indicators for monitoring progress towards Target 10.

Observation dataset	Sources and Organisational Holder/s	Start year [end year if interrupted]	Frequency of update	Geographical Coverage	Spatial Resolution
Coral and oyster reefs					
Ocean sea surface temperature pH	NOAA (incl. Global Coastal Observing System (GCOS)), Cruise network, European Project on Ocean Acidification (EPOCA); World Oceans Database, Coral Reef Watch (CRW)	Various	Continuous	Global	Various
Hard & soft coral bleaching Coral mortality in past year (incl. % live cover) Algal cover (measure of nutrient levels) Abundance and size -- 30 Key fish and invertebrate indicators Frequency and type -- Coral disease Direct human impacts: pollution, nitrification, sedimentation, fishing, poaching, destructive fishing, and socioeconomic indicators.	GCRMN (collects all available data on reefs and includes data from, for instance, databases like Reef Environmental Education Foundation (REEF), WRAS (Reef Check) and NED (Reef Check))[25], Reef Life Survey, Eastern Tropical Pacific Seascape Ecological Monitoring Program (CI)	1997 continuous	Annual	Global (90 countries/territories with reefs)	Global down to individual reefs
Analysis of extinction risk (corals and reef fish)	IUCN Red List	1996 for corals	~10 year	Global	Species
Oyster reefs condition	TNC	2011	Currently only one time	Global	Oyster reef level
Other ecosystems					
Climate impacts on population trends	GLORIA NEON (National Ecological Observatory Network) TEAM Amazon Forest Inventory Network (RAINFOR) BirdLife International/ Durham University/ RSPB/ EBCC The Global Mountain Biodiversity Assessment (GMBA) SAHFOS (continuous plankton recorder)	Various	Various Annual	Various 47 sites on 5 continents Europe	Point data
Climate impacts on community composition Assessing Large Scale Risks for Biodiversity with tested	Community Temperature Index (CTI) TEAM (Terrestrial birds, butterflies, frogs, etc.) GLORIA (Alpine)	2009 2009 (TEAM) 2002	Ongoing annual	Global (CTI) TEAM (15 tropical ecosystems)	Point or site data Various protocols

[25] Reef Check data are maintained in the Web Reef Advisory System (WRAS) database that is open to the public and also are distributed freely to any user. A temperate reef monitoring program focuses on rocky reef ecosystems in California, Mexico and the Mediterranean. The data are held in the online Nearshore Ecosystem Database (NED). Alien species are also tracked.

Methods (ALARM) project and Integrated Project to Evaluate the Impacts of Global Change on European Freshwater Ecosystems (Euro-limpacs) project (freshwater and terrestrial) European Phenology Network UK Marine Environmental Change Network (MECN), Census of Marine Life (CoML), NaGISA project, Reefs	CBMP/CAFF http://seri.at/projects/completed-projects/alarm/	(GLORIA)		GLORIA (Alpine ecosystems)	
Climate change impacts on extinction risk of species	IUCN Red List and Susceptibility assessments	Various (Red List)	Ongoing	Global	~10 minutes (but varies between taxa)
Biome range changes	TRY Initiative (DIVERSITAS) for plants (biome boundary shifts); multiple sources for other taxa; remote sensing	Various	Various	Various	Various
Phenology	Project Budburst (National Education Association (NEA)); World Phenology Network; remote sensing products (MODIS & Advanced Very High Resolution Radiometer (AVHRR) time series); Nature's Notebook Program (USA National Phenology Network (USANPN))	2007	Annual	US	Biome
Acidification impacts on calcite shelled organisms Sea surface salinity and other variables collected underway, by research and opportunity ships.	NOAA Pacific Marine Environmental Laboratory (PMEL) GOSUD (Global Ocean Surface Underway Data) Pilot Project	2007	Continuous	NE Pacific Global	100 m Ship tracks

Gaps and data limitations

- Geographic and temporal coverage of coral reef data is variable at the country level due to limited funding and available volunteer teams. The global dataset has the highest coverage in the Caribbean and Asia. Some large coral reef countries such as India and China are poorly covered due to restrictions at the national government level on data sharing. There are also gaps in Africa, non-French South Pacific island states and eastern Pacific countries. More volunteer teams are needed in large coral reef countries such as Indonesia.
- Few marine ecological data are quantitative or species-based, as is most useful for identifying trends in biodiversity and assessing extinction risk.
- No global pH monitoring network exists. However, there are regular pH monitoring programmes since the last decade in the Pacific (Hawaii) and the Atlantic (Bermuda, Canary Islands). There is a need to link national water quality monitoring program datasets relevant to ocean acidification.
- Climate data at a scale relevant to biodiversity monitoring.
- Global observations of ocean acidification and its impacts on organisms with calcium carbonate exoskeletons or plates are also required.

- Networks of site based projects (e.g. TEAM and GLORIA) in other ecosystems e.g. freshwater, marine, low-lying coastal areas, seagrass, mangroves are needed.
- IUCN Red List assessments of plants and invertebrates is needed.
- Data to calibrate models e.g. migration potential; genetic adaptation to climate change
- Data to validate biodiversity model outputs.
- Fire monitoring is another fundamental indicator of vulnerability to climate change of forests, grasslands and other ecosystems; however, this is currently carried out at smaller scales than regional.

Adequacy assessment

The limited number of reefs surveyed per year (<700) and the clumped nature of the surveys means that current coverage is insufficient to provide the needed data to assess reef status in many countries and at the global level. The available data are adequate to make broad-brush assessments at the global and regional scales, while recognizing that variable coverage creates inherent biases. The WRAS database for coral reefs needs to be made more accessible to users. GCRMN data are not standardized and are compiled at four-yearly intervals, which are too long to track short term events like bleaching, but highly useful over the longer term as Status Reports. It is important to obtain representative data from key coral reef countries such as the Philippines, Bahamas and Indonesia which have both high diversity and huge areas of reef spread over large areas.

A small number of the available datasets described above are ready for use (e.g. Reef Check, REEF, Reef Life Survey, and World Phenology Network), while other site-based network approaches (e.g. TEAM and GLORIA) are starting to establish useful datasets for certain ecosystems. Rapid expansion of these networks to add additional vulnerable ecosystems (marine, freshwater and coastal low-lying) would provide an ideal source of the long term climate-coupled observation data needed.

Compiled information such as the IUCN Red List and Climate Change Susceptibility assessments provide good long-term information on population trends and changes in extinction risk, but additional assessments are needed to better cover groups such as plants and invertebrates. Two indicators used in the SEBI 2010 programme could be used in the CBD context. The Climatic Impact Index is applicable to bird populations (currently in Europe only), while the Community Temperature Index has been applied to European butterflies, but its use could potentially be extended to other taxonomic groups and a global scale. Most countries already monitor seawater pH, however, there is a need to link these data sets to obtain global coverage.

Estimated costs

A cost estimate for TEAM roll out is €4 million per annum. The current cost of the Reef Check program is €700,000 per annum. Large additional investments would be needed to start monitoring arctic and temperate alpine ecosystems on a global scale.

Strategic Goal C

To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity

"Whilst longer term actions to reduce the underlying causes of biodiversity are taking effect, immediate actions, such as those related to protected areas, species recovery programmes, land use planning approaches, and other targeted conservation interventions in the broader land- and seascape, can help conserve biodiversity and critical ecosystems. These might focus on culturally-valued species and key ecosystem services, particularly those of importance to the poor, as well as on threatened species. For example, carefully sited protected areas could prevent the extinction of endangered species by protecting their habitats, allowing for future recovery" (SCBD 2011).

Target 11 – Protected areas

By 2020, at least 17 per cent of terrestrial and inland water, 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.

Key concepts

This target reflects a measure of response to biodiversity loss. "Inland water" is here taken to include all lakes, rivers and wetlands.

The COP-10 "further information" document (SCBD 2011) explains that representativeness should apply to both the species and ecosystem level. The target is intended to direct protected area (PA) expansion and improvement towards areas of particular importance and representativeness of biodiversity, and not PA expansion as an end unto itself. Emphasis is on PA coverage being related to: a) representativeness, b) equitable and effective management, and c) connectivity and integration into wider land/seascape. In practice, this target may need to consider trade-offs and synergies relating to biodiversity and ecosystem services as demands for land/water protection. For example, in a Papua New Guinea study (Faith et al. 2001) a protected-area system, covering17% of the country and constrained to capture key ecosystem services, was only able to represent a bit more than half the biodiversity that would have been captured by a 17% area dedicated to biodiversity conservation. Planning based on trade-offs and synergies among biodiversity and ecosystem services goals can maximise both, but will require observation systems for countries with comparable data, with comparable geographic coverage for these different aspects.

The emphasis below is on identifying observational datasets to support reporting at the global level. The target draws directly from the Program of Work on Protected Areas (PoWPA), and other mechanisms such as the Global Strategy for Plant Conservation Target 5 i.e. "Protection of 50 per cent of the most important areas for plant diversity assured".

Table 11: An initial list of variables/datasets/indicators for monitoring progress towards Target 11.

Observation dataset	Sources and Organisational Holder/s	Start year [end year if interrupted]	Frequency of update	Geog Coverage	Spatial Resolution
Protected area coverage					
Coverage of PAs in terrestrial, marine and freshwater environments	World Database on Protected Areas (WDPA, through "Protected Planet") maintained by UNEP-WCMC and IUCN	1872	Annual	Global (including marine and international sites)	Site
Areas of importance for biodiversity and ecosystem services					
PA coverage of areas of particular importance for biodiversity	Key biodiversity areas, including Important Bird Areas (IBAs, BirdLife International), Important Plant Areas (IPAs, Plantlife International), Alliance for Zero Extinction sites (AZEs), and Ecologically and Biologically Significant Areas (EBSAs) (IUCN and others).	Various: IBAs (1980); IPAs (1990s); AZEs (2005); EBSAs (2009)	Annual	Global (IBAs, AZEs, Ramsar) and many countries (IPAs, Key Biodiversity Areas (KBAs))	Site
PA coverage of areas of particular importance for ecosystem services[26]	Natural Capital Project Key sites for biodiversity (as above), but including also Ramsar and natural World	Various (e.g., Ramsar, 1971; World Heritage 1972)	Annual	Global (Ramsar, World Heritage) and national	Site

[26] This could be tracked by means of tracking PA coverage of key sites for biodiversity that also have important benefits for ecosystem services (e.g., Ramsar sites for water; forest IBAs for carbon), as well as independently.

	Heritage sites (in WDPA) and others.			(NCP and others)	
Management effectiveness: implementation of management					
Management implementation	Protected Area Management Effectiveness (PAME) database (UNEP-WCMC and IUCN World Commission on Protected Areas (WCPA)); Management Effectiveness Tracking Tool (METT, WWF/World Bank); IBA monitoring framework (BirdLife International)	Various (e.g., 1999 for IBAs)	Annual	Global (but patchy)	Site
Management effectiveness: outcome of management					
Site-based trends, including trends in state (e.g., change in land/habitat cover and quality) and pressure (e.g., freshwater extraction, fire frequency, etc.) from field and remote sensing data.	Not yet active institutionally, although the Digital Observatory of Protected Areas (DOPA), developed by EC JRC and others, will help assess the state and pressure of PAs. BirdLife International has developed, trialled and begun implementing a programme of global IBA monitoring.	Various (e.g., 1999 for IBAs; back to 1990 for remote sensing approaches)	Varies (some annual)	Varies (DOPA has completed coverage for Africa, and is expanding into Caribbean and Pacific). IBA monitoring implemented variably at national scales.	Site
Biodiversity trends, including trends in species populations in PAs and extinction risk trends of species in PAs	Living Planet Index dataset (ZSL/WWF); Red List Index datasets (IUCN/BirdLife International)	For individual datasets, see Target 12	Varies (annual to 4-10 yearly)	Global	See Target 12
PAs managed equitably					
Income	National Parks agencies	Various	Annual	National	Site
Governance	World Database on Protected Areas (WDPA)	1872	Annual	Global (including marine and international sites)	Site
Ecological representativeness and integration into wider landscapes/seascapes					
PA coverage of vegetation or habitat types, biomes, ecoregions and ecosystems	WWF terrestrial, marine and freshwater ecoregions (WWF); Mountain Biodiversity Portal (GMBA); Global Islands database (UNEP-WCMC); Hydrological features, e.g., rivers and lakes (Hydrological data and maps based on SHuttle Elevation Derivatives at multiple Scales - HydroSHEDS)	Various	Various	Global	Sub-global
PA coverage of species diversity across systems (marine, terrestrial and freshwater)	Mapped and modelled species distribution ranges (IUCN Red List, UNEP-WCMC); Species locality data (BirdLife International, GBIF)	Various	Annual	Global	1-5 km
PA coverage of turnover in compositional diversity	Species dissimilarity modelling based on locality (BirdLife, GBIF) and distribution data (IUCN, UNEP-WCMC)	Feasible, not yet routine	~ 5 year	Global	~5 km
Connectivity					
Within site habitat fragmentation and between site connectivity	Site managers; Global land cover datasets (e.g., University of Maryland's 1km Global Land Cover, the 1-km Global Land Cover Characteristics product, Ionia GlobCover, and others)	Various (UMD GLC from 1998; GLCC from 2000; GlobCover from 2005)	Various	Global (sub-global datasets also available)	Down to high resolution satellite images (c. 20 m). Scaling up to 1-km, but varies (GlobCover is 300m)

Gaps and data limitations

Protected area coverage. The main constraints in the key global dataset, the WDPA (served through "Protected Planet"), include: boundaries are often poorly delineated; the date of designation is missing for many PAs; and many PAs are mapped only as points. Although WDPA coverage and quality is constantly improving, including through closer relationships with regional and national data provides (e.g. EEA, Protected Areas Database of the US (PAD-US)), PA coverage is possibly tracked more closely for some countries/regions by other initiatives/institutions (e.g., CBMP for Arctic), which should therefore be invited to contribute data to the WDPA.

Areas of particular importance for biodiversity and ecosystem services. There has been limited progress in some countries in identifying sites of important biodiversity for taxa other than birds, through IBAs (and for highly threatened and highly restricted species, through AZEs), especially in aquatic (marine and freshwater) environments. Identification of important plant areas is essential for Target 5 of the GSPC. Also problematic is the lack of reliable methodology for defining and mapping ecosystem services at a site-scale; however, there has been some progress with identifying sites of biodiversity importance that also harbour ecosystem service values (carbon, water, cultural value) through, for example, the Ramsar and World Heritage conventions. Although the role of climate change and its impacts on biodiversity and ecosystem service provision are still being understood, initial studies (e.g. Hole et al. 2009) suggest that despite considerable turnover at sites, IBA networks will remain robust under future climate change scenarios.

Management effectiveness. Reliable measurements for protected area management efficacy are difficult, and the regular collection of information to support these is challenging. Some basic information on implementation is housed in the PAME database (maintained by UNEP-WCMC and IUCN WCPA), but coverage is incomplete and biased. Measures of PAME have tended towards two types, those focused on sites (e.g. habitat measures) and those focussed on trends of species at sites (population and extinction risk trends). Besides geographic biases, a key shortcoming of many of these studies is failure to compare trends both within and extralimital to PAs (complicated by the availability of suitable data from outside PAs). Management effectiveness needs to be related to the species or habitats of conservation concern at the site. There are also many confounding variables that need to be accounted for (e.g., location bias). For Gaps and data limitations on species trend datasets, see Target 12.

Protected areas should be managed equitably. The equitable management of PAs is difficult to address and encompasses both governance and economic issues. There is some information on governance maintained by the WDPA, but no global source of information on income.

Ecological representativeness. Multiple methods for assessments of ecological representativeness exist. Although there is no global classification of habitats per se, global maps dividing the terrestrial, marine and freshwater systems into ecoregions have been compiled. At a species level, distribution range maps are now increasingly available for taxa other than terrestrial vertebrates, including for several marine (corals, seagrasses, cartilaginous fishes) and freshwater (freshwater crabs, crayfish, amphibians, selected fishes) taxa, with coverage expanding rapidly. Modelling based on environmental and biological data can help refine range polygons (e.g., Rondinini et al. 2005). There is, however, a lack of data for assessing species-level representativeness. Observation systems on primary biotic data (e.g. GBIF) can also provide information to assess representativeness against this target; while such data are typically patchy (and not "adequate" on their own), modelling approaches can add value to these data. Likewise, macroecological modelling of turnover in compositional diversity for lesser-known, yet highly-diverse, biological groups could be undertaken by linking fine-scaled environmental surfaces with best-available locality records from GBIF etc. Genetic and phylogenetic data could also potentially be integrated into the above analyses (thereby linking to Target 13).

Integration in the broader landscape. Data are scarce concerning ecological processes that are a) operating at land/seascape scales and b) necessary to sustain biodiversity within PAs. Potential synergies with Target 5 exist.

Connectivity. Measurement of habitat connectivity relies mostly on habitat fragmentation metrics. Main issues include that connectivity is very much scale-dependent (species), and absolute quantification is not straightforward.

Adequacy assessment

Protected area coverage. The WDPA represents the definitive global dataset on protected area coverage and is critical for reporting against this target. Geographic extent is global, and notwithstanding data gaps and deficiencies, adequate for reporting to the global and sub-global (national, ecoregional, continental etc) level. The WDPA now includes the World Database on Marine Protected Areas (WDPA-Marine), thereby providing complete coverage for PAs in both terrestrial and marine realms. Furthermore, increasingly the WDPA is being expanded to include private PAs and Indigenous and Community Conserved Areas (ICCAs). Date of establishment permits temporal tracking of PA expansion.

One issue of concern is that application of the definition of PA has been left largely to national and regional authorities, with large inconsistencies in how the PA definition has been applied. Many PAs listed in the WDPA, including a large proportion of MPAs with fishing allowed, do not appear to qualify as PAs under the revised IUCN definition (Dudley 2008).

Areas of particular importance for biodiversity and ecosystem services. In terms of biodiversity, all countries have data on globally important sites for birds (through IBAs) and highly threatened and highly restricted taxa (through AZEs); ~60 countries have additional data on other taxa (mammals, amphibians, plants as IPAs, some marine and freshwater groups). The WDPA maintains information on sites identified under the Ramsar and World Heritage Conventions.

Protection of Ramsar sites relates to integration into wider land/seascapes (see below) with regards to hydrological cycle regulation (flood protection in two ways, water purification, nutrient cycling), wetlands, waterbirds and fisheries.

Management effectiveness. Limited data are available on management implementation. Management effectiveness databases are improving, but coverage may not yet be globally sufficient. Use of species population trends to monitor effectiveness is still hampered by inadequate taxonomic and geographic coverage, and need for trend data both within and outside PAs.

Protected areas managed equitably. Available observation data may not be adequate to report against this component of the target.

Ecological representativeness. Relatively good global coverage is available for all systems at the ecoregion/biome level. Species distribution polygon and point locality data coverage and quality are reasonable for many taxa, including in aquatic realms, and rapidly expanding and improving in coverage.

Integration in the broader landscape. Available observation data may not be adequate to report against this component of the target.

Connectivity. Several global land cover products exist (derived from satellite imagery) and offer outstanding potential for assessing forest fragmentation. However, their utility in monitoring fragmentation characteristics of other habitats requires further testing. Almost all information on connectivity of marine systems has been deduced from theoretical models. These urgently require field validation.

Estimated costs

The maintenance of the WDPA currently costs in the region of €400,000 per annum (for global collation, updating and maintenance only). This does not represent the full cost of observing these data, since much of that is borne by partner organisations or national governments. Achieving globally-consistent accuracy and improved ancillary data such as on PA management will require additional funds.

Target 12 – Prevented extinction of threatened species

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.

Key concepts

This target reflects a measure of the state of biodiversity. Globally comprehensive and repeated measures of extinction risk (reported over time as the Red List Index; Butchart et al. 2004, 2007) for some taxonomic groups (mammals, birds, amphibians, corals) exist, dating back, in some instances, three decades (Hoffmann et al. 2010). These data demonstrate that in the absence of current conservation policies, declines in the Red List Index would have been 20% larger over the last three decades. These existing data mean that periodic re-assessment (once per 4 years) of these taxa is particularly valuable. Plans are for expansion (funding needed) across other groups i.e. reptiles, fishes, invertebrates, plants, and fungi (Stuart et al. 2010). Extinction risk is a particularly fundamental measure, given the irreversibility of extinction, and spans both common and rare species, but its measures typically have low temporal sensitivity and are of a relatively coarse (i.e., national level) spatial resolution (Brooks and Kennedy 2004). Observation data on extinction risk per se can be supplemented by population trend data for highly threatened species in some taxa (e.g., birds).

Table 12: An initial list of variables/datasets/indicators for monitoring progress towards Target 12.

Observation dataset	Sources and Organisational Holder/s	Start year [end year if interrupted]	Frequency of update	Geographical Coverage	Spatial Resolution
Extinction risk and changes in extinction risk	IUCN Red List and Red List Index dataset (IUCN, BirdLife International, Botanic Gardens Conservation International (BGCI), CI, Kew, NatureServe, Sapienza Univ Rome, Texas A&M Univ, ZSL, etc), comprising the "Barometer of Life". Extinction risk of marine species is assessed through the Global Marine Species Assessment (GMSA)	1980s-90s (birds, mammals, amphibians, corals); late 2000s (other taxa; Sampled Red List)	Annual; comprehensive assessments each four to 10 years; to date, birds 5 times, amphibians, mammals and corals twice	Global; all countries	Meaningful disaggregation by taxonomic group, region or biome possible
Changes in populations of threatened species (and other sensitive species, e.g., endemics)	Critically Endangered Bird Indicator (CEBI; BirdLife International)	Just getting started	Would be annual	~200 species worldwide	Global
	Status of AZE species and AZEs	2005	Twice to date	587 sites globally	Sites; see Target 11
	Indices of changes in abundance for threatened species in other taxonomic groups	LPI could provide useful time series data for some species, as could regional population indices (e.g. ASTI) but likely to be biased to recovering species. Global population monitoring may be possible for some plants (Kew through sampled Red Listing approach; GLORIA network; CAFF) and large mammals (IUCN Species Survival Commission (IUCN SSC); International Whaling Commission, International Council for the Exploration of the Sea; Pacific International Council for the Exploration of the Sea (PICES)); and regionally for numerous taxa including amphibians, butterflies, etc for Europe (e.g., see EEA) and North America (e.g., see NatureServe)			

Gaps and data limitations

The IUCN (including the SSC and partner institutions) has organised the process for measuring extinction risk since the 1960s, with quantitative assessments dating back to the 1980s, and comprehensive across all common and rare species within better-known taxonomic groups

(mammals, birds, amphibians, corals), reported as the RLI (e.g., for the 2010 Biodiversity target; Butchart et al. 2010; SCBD 2010b). Observations are not yet comprehensive for reptiles, fishes, invertebrates, plants, or fungi. Plans for a "Barometer of Life" (Stuart et al. 2010) are in place – although not funded – to fill these gaps, as well as to implement a sampled approach for speciose taxonomic groups (Baillie et al. 2008), which represent the vast majority of the Earth's species (e.g., among freshwater invertebrates, the few global assessments that have been conducted involve taxa that comprise relatively few species and/or have limited global distributions).

Extinction risk from climate change is also not currently well-reflected, although processes are underway to strengthen this (Foden et al. 2009). Additionally, these measures could be supplemented with high resolution population monitoring for Critically Endangered species, especially for birds, large mammals, and plants. The AZE (Ricketts et al. 2005) and the LPI (Loh et al. 2004) could provide useful data, as well as other global (e.g., Kew, GLORIA, IUCN SSC) and regional (e.g., CAFF, EEA, NatureServe) networks.

Adequacy assessment

Geographic extent is global, with numerous national processes as well as the ~8,000-person expert network of IUCN SSC contributing data, although for plants and many other taxa, IUCN Specialist Group networks have not yet achieved global coverage either taxonomically or geographically; development of taxonomic expertise to expand this coverage is essential. Biome coverage includes terrestrial and freshwater (mammals, birds, amphibians) as well as marine (mammals, birds, corals), although much greater representation of freshwater and marine taxa is particularly desirable.

Spatial resolution scales to the ranges of the taxa considered, but in aggregate is approximately 1-degree, and so adequate for reporting at national and eco-regional, as well as global, levels. Temporal resolution is rather coarse, with re-assessments at ~4 year intervals or longer.

Taxonomic coverage with multiple assessment dates is comprehensive across all species of mammals, birds, amphibians, and corals (>20,000 species) and plans are in place – but not funded – to expand coverage to reptiles, fishes, and some invertebrates, plants, and fungi. Coarse resolution of extinction risk data over time is naturally complemented by finer resolution data on individual population trends of threatened and other sensitive species (e.g. endemics), but for which there are taxonomic and geographic biases (an exception being data related to threatened birds).

Estimated costs

The budget for setting up a "Barometer of Life" is estimated at about €45 million.

Target 13 – Genetic diversity of socio-economically and culturally valuable species

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.

Key concepts

Genetic diversity is one of the three levels of biodiversity. It is the biological basis of world food security. In the context of this target, genetic diversity refers to the genetic material contained in traditional varieties, modern cultivars and breeds grown and maintained by farmers and livestock keepers, as well as their wild relatives and other wild plant and animal species that can be used as food, and as feed for domestic animals, (or as medicines, fibre, clothing, shelter, wood, timber, energy etc.) or are of cultural value to humans.

There are about 7.4 million cultivated plant accessions conserved in over 1750 genebanks around the world (FAO 2010a) and 8054 animal breeds (FAO 2010b). It is estimated that more than 70% of the genetic diversity of some 200-300 crops is already conserved in *ex situ* collections, but no information exist for the extent of diversity *in situ*/on farm. In addition there are over 2,500 botanic gardens maintaining samples of some 80,000 plant species (FAO 2010a). FAO (2010b) reports that 21% of the global total of animal breeds is at risk, with Europe and the Caucasus and North America having the highest proportion on account of the highly specialized industries in which production is dominated by a small number of breeds, similar to the crop situation. In addition, 8% of the world's breeds are already extinct and 35 percent are of unknown risk status (lack of data is a particular problem in the developing regions of the world).

Aquaculture and domesticated aquatic organisms are also important resources for food security. Capture fisheries harvest thousands of wild, undomesticated species from the world's oceans, seas, coastal areas and wetlands (FAO 2010c). In 2009, more than 300 cultured aquatic species provided more than 55 million metric tonnes (mt) of total production. Capture fisheries is the largest sector that still relies on hunting and trapping wild species, in 2008 producing 80 million mt and 10 million mt from marine and inland waters, respectively. However, the genetic diversity of most aquatic organisms is still largely undocumented and often poorly managed. FAO is currently preparing a first State of the World's Aquatic Genetic Resources Report that should help to address these issues.

Measures for monitoring trends in genetic diversity should be able to indicate whether or not genetic erosion (loss of diversity over time) and genetic vulnerability (distribution of genetic diversity in space) are occurring or not. These measures may include richness (numbers), risk status (abundance), evenness (frequency) and turnover variables of diversity units over space and time. Indigenous knowledge (IK) of local communities should also be considered as an indicator of diversity of many socio-economically and culturally important plant and animal species (see Target 18).

Table 13: An initial list of variables/datasets/indicators for monitoring progress towards Target 13.

Observation dataset	Sources and Organisational Holder/s	Start year [end year if interrupted]	Frequency of update	Geographical Coverage	Spatial Resolution
FAO Ex situ collection database in the World Information and Early Warning System (WIEWS); the World Information Sharing Mechanism on the implementation of the Global Plan of Action (WISH-GPA) for Plant Genetic Resources for	National records, FAO	1995 to date	Updated regularly; during SOW and (Scope of Work) GPA (Global Plan of Action)	Global (154 countries)	National

Food and Agriculture (PGRFA; crops, including wild relatives)			processes		
GENESYS (A global accession-level information gateway to genetic resources)	Ex situ data from CGIAR centres; SINGER (System-wide Information Network for Genetic Resources) EURISCO (A web-based catalogue that provides information about *ex situ* plant collections maintained in Europe); USDA GRIN (US Department of Agriculture Germplasm Resources Information Network)	In development, (SINGER back to 1975, EURISCO 2005)	Continuous	Global coverage (with some gaps)	Accession level
Collecting Mission database	Bioversity International	Since 1974 - 2003	Historical information	Global, digitized	Site level
BGCI PlantSearch Database	BGCI	1987	Regularly	Global; 570,000 records	Wild collected site level
Genetic diversity of domesticated animals (and fish)	FAO – DAD-IS (Domestic Animal Diversity Information System, terrestrial domesticated animals only)	Backbone launched 1996	Ongoing. Countries can update their data whenever they want.	Global (198 countries and territories) with a few gaps.	Countries
Genetic diversity of aquatic species	FAO country reporting	1954	Annually	Global	FAO fishing areas and continents for species
FAO State of the World Reports on Aquatic Genetic Resources (AqGR)	Regional reports	to begin in 2012	TBA	Global	Species and stocks/variety
Reintroduction/ ex situ conservation programs (animals)	International Species Information System (ISIS) – zoo information data	1973 onwards	Ongoing	Global	825 zoos in 76 countries
FAO State of the World reports on Plant Genetic Resources for Food and Agriculture (PGRFA)	National country reports, National Information Sharing Mechanisms (FAO)	1996, 2010	Every 10 yrs or so	Global	National
FAO State of the World reports on Animal Genetic Resources for Food and Agriculture (AnGRFA)	Country reports, FAO	2007	Regularly	Global	National

Gaps and data limitations

One of the major constraints to effective conservation of genetic diversity is insufficient knowledge about the location, extent and distribution of diversity, and how much useful diversity is being lost. This information is critical for planning immediate actions as well as long-term conservation planning in an era of global change in production systems and natural habitats. It is widely believed that genetic resources are being lost in farmers' fields, livestock keepers' herds and flocks, in more natural ecosystems (e.g. wild relatives, forest genetic diversity) and even in genebanks (FAO 2010a, b). However the extent of this loss is poorly documented. It is also argued that in some cases new diversity in terms of new varieties and breeds (such as in aquaculture) are being created and not lost. It will be important not to lose diversity of wild relatives as breeds are being developed.

No global information system or knowledge base is available for crop genetic diversity at the *in situ*/on farm level. Major gaps exist in the level of genetic diversity for socio-economically important wild species including crop wild relatives, medicinal plants, and trees at the *ex situ* and *in situ* levels. The genetic diversity of wild fish stocks, inland and marine, is poorly known, but represents evolutionarily significant units below the species level that should be conserved. In the case of AnGRFA, the DAD-IS provides global coverage and a standardized set of data fields in which countries record the size and structure of their national breed populations belonging to 34 avian and mammalian species, species groups or fertile interspecies crosses. However, population data are incomplete (population size is unknown for 35 percent of breeds) and are not updated regularly enough to enable trends to be tracked accurately.

Adequacy assessment

It is important to note that the information available in the above observation data sets are not direct measures of genetic diversity but are rather proxy measures. With the emergence of molecular sequence data, DNA barcoding and the application of low cost molecular tools, the potential exists for developing more direct genetic diversity measures. FAO's *ex-situ* collection database of WIEWS contains summary records of Plant Genetic Resource (PGR) holdings (more than 5 million accessions belonging to more than 18,000 species) reported by more than 1,500 national, regional or international genebanks (see: http://apps3.fao.org/wiews/wiewspage.jsp?i_l=EN&show=Introduction).

GENESYS, the global accession-level information gateway on genetic resources that is currently in development, will provide an online, one-stop entry point for information managed by genebanks worldwide. GENESYS is supported financially by the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) (see http://www.itpgrfa.net/International/content/127-nations-signatories-global-treaty-save-and-share-crop-diversity), and the Global Crop Diversity Trust. It already provides access to more than 2.4 million accession-level records compiled from CGIAR's SINGER, EURISCO, and USDA GRIN. Under the Biodiversity Indicators Partnership (BIP) (http://www.bipindicators.net/cropcollections) programme, FAO, Bioversity and L'Institut de Recherche pour le Développement (IRD- France) has used these datasets to develop an *ex situ* collection indicator based on an "enrichment" index that measures the dynamics of the taxonomic and geographical diversity contained within *ex-situ* collections across time. These indices may be expanded in collaboration with GEO BON. GEO BON is exploring geographic diversity proxies, including models based on range extent of species.

There is also the genetic indicator worked out under the EU's SEBI project: 'share of original local breeds'. A key indicator to show loss of the many local original breeds and crop varieties by replacement with a few highly productive global ones (same homogenisation process as wild biodiversity) is the ratio between the volume (abundance) of original local to global races. For example, in The Netherlands this is about 2%, 5% and 0.1% respectively for cattle, sheep and poultry, and other countries follow the same trend (see http://www.pbl.nl/en/publications/2008/Halting-biodiversity-loss-in-the-Netherlands).

The IBPGR/IPGRI Collecting Mission database contains only historic collecting information which could be very useful in monitoring genetic erosion over time through re-sampling, but there is no mechanism in place to capture new collections.

The Crop Wild Relative Catalogue for Europe and the Mediterranean contains in excess of 25,000 species and more than 280,000 records of taxon occurrences in 130 geographical units across the Euro-Mediterranean region.

The Generation Challenge Programme (GCP) only covers a limited number of crops while DAD-IS provides a global breed inventory and, if updated more regularly, could provide the data needed to obtain an accurate picture of trends in breed diversity. However, it does not include data on genetic diversity within or between breeds.

BGCI also holds information for more than 2500 botanic gardens which includes a great diversity of wild species many of which are medicinal plants and crop wild relatives which contributes to the gene pool of target crops.

Estimated costs

The existing databases are maintained by the FAO or the CGIAR, as part of the missions of supporting global public goods.

Strategic Goal D

Enhance the benefits to all from biodiversity and ecosystem services

"Biodiversity underpins the services provided by ecosystems to humankind. This includes essential services such as the provision of food, clean water, the removal of wastes and the mitigation of the impacts of extreme events. While all people benefit from ecosystem services, some are more directly dependent on them for their livelihoods and well-being. Biodiversity and ecosystems also play an increasingly important role in combating climate change and its impacts. Ecosystems are being modified often to increase the proportion of provisioning services delivered in a given time (e.g., for food, wood, etc.) or to make them more suitable for other human requirements (e.g., water regulation for transport, irrigation), thereby typically decreasing their potential to deliver other services (regulating, cultural). Wise management of ecosystems aims to ensure the continuous delivery of a range of services or co-benefits. The potential for the delivery of ecosystem services in degraded systems is small and hence the benefits for human societies limited. This Strategic Goal is to enhance the delivery of ecosystem services through the promotion of management for multiple ecosystem services and the restoration of degraded systems. Efforts should focus on maintaining and, wherever possible, restoring terrestrial, freshwater and marine ecosystems to ensure the provision of valuable ecosystem services, contributing to the achievement of the Millennium Development Goals and to climate change mitigation and adaptation" (SCBD 2011).

Target 14 – Ecosystem services

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.

Key concepts

Ecosystem services are the benefits people obtain from ecosystems. Ecosystems encompass a wide range of systems, from near-pristine forests or wetlands, to highly modified agricultural and urban systems; they all provide services to people. The services include, among others not mentioned here, provisioning services (also known as 'goods', and including such things as food, timber and water), regulating services (such as water quality, climate and pest regulation), and cultural services (such as recreation, inspiration, heritage and education).

Prioritizing ecosystem services to be monitored is a difficult choice. Different services contribute to human well-being in a variety of different ways: provision of food or water is essential for having access to the basic materials for a good life; the regulation of disease vectors, water quality or climate regulation are tightly related to health and security; and cultural services deal with non-material but still essential aspects of human well-being. Different actors value the various ecosystem services in different ways: subsistence farmers rely directly on the local provision of food, timber or biofuels, while urban populations benefit from food produced elsewhere, and regulation of water quality in places far removed from the place they live.

A critical task is to understand the complex tradeoffs among and between services. Trade-offs occur among ecosystem services, such as those between planting crops for biofuel versus crops for food; across space, such as increasing agricultural yields through fertilizer use at the cost of decreasing water quality downstream; across time, such as increasing agricultural yields through increased irrigation at the cost of soil salinization several decades later; and also occur across groups of people, when increased use by a one group implies a decrease in availability to other groups.

The list of services to be monitored will evolve through time as a result of changes in societal needs, development of new indicators, and changes in data accuracy and availability. The first efforts should focus on compiling the readily available information.

Sources of information will include that derived from remotely sensed data, national and sub-national statistics, local quantification of services in a network of sites, as well as models developed at multiple spatial scales.

The services included in the table aim at including a wide range of types of services. Different societies within and among countries will prioritise them differently, depending on their circumstances. Some, such as the availability of clean water and adequate food, will probably be of universal concern.

In order to emphasize the needs of women, indigenous and local communities, the poor and vulnerable, all measures of ecosystem services would need to cover both the average supply and demand, as well as the distributional (equity) dimension in relation to the component of the target regarding the particular foci groups of people. The table below encompasses services that are particularly relevant to marginalised groups in society.

In some cases it is possible and useful to estimate of the value of the services. This helps in evaluating tradeoffs and setting priorities. The table below therefore includes columns for *supply*, *service* and *value*. A preliminary assessment of the value of ecosystem services would provide a baseline against which to measure any changes.

Table 14: An initial list of variables/datasets/indicators for monitoring progress towards Target 14.

Observation dataset	**Source and Organisational Holder/s**	**Start Year [End year if interrupted]**	**Frequency of update**	**Geographical Coverage**	**Spatial Resolution**	**Supply (natural capital)**	**Service**	**Value**
Total crop production[27]	The FAO Statistical Database (FAOStat) Instituto Brasileiro de Geografia e Estatística (IBGE) database	1980	Annual	Global National (Brazil)	National Sub-national		Total crop production	Total market value of all crops
Total wood production[28]	Forest Resource Assessment/FAOStat Instituto Brasileiro de Geografia e Estatística (IBGE) database	1980	Annual	Global National (Brazil)	National Sub-national	All standing wood biomass in unprotected areas	Total wood production / total fuelwood production	Total market value of all wood products
Livestock production[29]	FAOStat	1961	Annual	Global	National		Total livestock production	Total market value of all livestock products
Fisheries production[30]	FAOStat/FishStat	1950	Annual	Global	National	All (commercially) important species	Annual total landings of commercially important species	Total market value of all commercially important species
Biofuel production[31]	FAOStat BEN	1961 2006	Annual Annual	Global National	National National		Total oil seed crop production	Total market value of all oil seed crops
Water supply for domestic use	FAO's global information system on water and agriculture (AQUASTAT); WorldBank	1958	Annual	Global	National	Volume annual surface water/ ground water yield	Volume annual freshwater withdrawals domestic	Provision of water of adequate quality
Water supply for irrigation	AQUASTAT, WorldBank	1958	Annual	Global	National	Volume annual surface water/ ground water yield	Volume annual freshwater withdrawals for agriculture	Total market value of irrigated crops
Nutrient retention for clean drinking water	Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) and The Lund-Potsdam-Jena Dynamic Global Vegetation Model (LPJ model)		Seasonal /Annual	Global	National	Total N or P retained annually	Total N or P retained upstream of extraction points annually	Total annual avoided water treatment costs
Erosion control[32] (for reservoir maintenance)	InVEST and LPJ		Seasonal /Annual	Global	National	Total soil retained annually	Total soil retained upstream of reservoirs	Total annual avoided dredge costs

[27] Includes total crop production for forage

[28] Includes fuel wood production

[29] Live animals + livestock processed

[30] Freshwater fisheries + marine fisheries + aquaculture

[31] Production of oil seed crops, see Johnston and Holloway 2007, www.sage.wisc.edu/energy

[32] Measure currently being developed by InVEST and LPJ, needs expansion/adaptation

Coastal protection								
Climate regulation[33] (also see Target 15)	Word Data Centre for Greenhouse Gases (WDCGG)	1981	hourly/daily/monthly	Global	National		Carbon sequestration, avoided emissions	Carbon-market value, social value, carbon trade value
Nature-based tourism[34]	IUCN/WCPA task force	1990s	Annual	Global	National	Area under natural habitat		Income from nature-based tourism
Area near-intact habitat[35]								Option value / existence value
Population trends for service-delivering species groups (e.g. pollinators, scavengers, seed dispersers)[36]	FAO; African Pollinator Initiative (API); LPI dataset (WWF/ZSL); WBI dataset (BirdLife International/EBCC/NABCI-US Committee)	1970s-1980s	1-5 years	Regional to global	National to continental		Total area of crops pollinated	Avoided costs for pest control
Extinction risk trends for service-delivering species groups (e.g. pollinators, scavengers, seed dispersers)	IUCN Red List and RLI dataset (IUCN, BirdLife International etc)	1980 (amphibians); 1988 (birds); 1996 (mammals)	4–10 years	Global	Meaningful disaggregation by taxonomic group, region or biome possible		Total area of crops pollinated	Avoided costs for pest control

Gaps and data limitations

There are several existing datasets but many gaps. The ecosystem service research and monitoring community is of the opinion that the gaps can be filled within 5 years through a combination of aggregation of nationally-held datasets, targeted capacity development and network development, the expansion of site-based assessments, and modelling activities.

Incipient monitoring schemes are now being developed to assess ecosystem service delivery trends at the site scale using a consistent approach, initially based on a subset of more easily measured services (hydrological, tourism, harvested goods, and carbon).

Adequacy assessment

Key elements of the observing system exist (particularly those relating to marketed provisioning services), but the models and supplemental datasets needed for global coverage still need development.

Estimated costs

The incremental cost to reach adequacy is likely to be €1–10 million per annum.

[33] Includes NO_2 and Methane via carbon-equivalents. Discussed in more detail in Target 15.

[34] Under development, needs to be developed from scratch

[35] Not ready for implementation, measures need to be developed from scratch

[36] Measures need to be developed

Target 15 – Climate change and resilience

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.

Key Concepts

The contribution of ecosystems to climate mitigation is given the shorthand 'carbon', but in reality is via being net sources or sinks of several greenhouse gases in addition to CO_2, such as CH_4 and N_2O, as well as through changes in surface reflectivity (albedo). The size of the contribution by ecosystems to climate regulation can be calculated 'top-down', at the global to continental scale, from the difference between the increasing concentrations in the atmosphere minus the known anthropogenic emissions. Currently only about half of the emissions remain in the atmosphere, so the rest must be taken up by land and ocean ecosystems. This global ecosystem sink term varies greatly from year to year. The trend and its variation can be used as a proxy of the resilience of the climate regulation service at the global scale. Resilience is the capacity of ecosystems to tolerate change without losing their essential functions. It is a specific property rather than a general property of ecosystems - in this case it is the resilience of the climate regulation function to the combined effects of climate and land use change. The resilience of biodiversity and non-climate regulating ecosystem services to climate change is a different issue, perhaps best indexed through adaptation capacity (see below).

Carbon stocks. Carbon stocks are themselves climate-neutral, but a change in the carbon stock represents either an emission or uptake of CO_2 to or from the atmosphere, known as a 'flux'. For some carbon-rich ecosystems – such as forests, grasslands and wetlands – repeated measurement of carbon stocks is the preferred method of quantifying fluxes at a local to national scale. Note that rewarding an increase in carbon stock alone, without considering possible impacts on other greenhouse gases, albedo, ecosystem services and biodiversity, can lead to perverse outcomes. In the case of the ocean absorption of carbon dioxide, there are potentially serious negative consequences to both biodiversity and ecosystem services of the resultant acidification (see Target 10).

Desertification. Decline in vegetated green cover as detected by satellites, summed over the seasonal cycle, is the most widely used indicator of desertification. Many indices have been used (Normalized Difference Vegetation Index (NDVI), Enhanced Vegetation Index (EVI), Soil Adjusted Vegetation Index (SAVI) etc.). The index most directly related to loss of plant productive capacity is the Fraction Absorbed Photosynthetically Active Radiation (FAPAR). It is the core variable used in models of primary production in terrestrial ecosystems.

Restoration of degraded ecosystems. "at least 15% of degraded ecosystems" presumably does not mean that 15% of the *types* of ecosystem will have been restored, but that at least 15% of the *area* of degraded ecosystems, across all types, will have been restored. Globally, 10–15 million km^2 are considered seriously degraded and a further 10 million km^2 is undergoing degradation.

Climate change adaptation. The theoretical basis for assessing the vulnerability of species and ecosystems to climate change is still under development, and no global-scale agreed observation sets yet exist. IUCN and DIVERSITAS are working on this issue, and progress on indicators within the next five years is likely. Ecosystem connectivity (see Target 11) is considered a resilience measure.

Table 15: An initial list of variables/datasets/indicators for monitoring progress towards Target 15.

Observation dataset	Sources and Organisational Holder/s	Start year and duration	Frequency of update	Geographical coverage	Spatial resolution
Greenhouse gas fluxes					
Atmospheric concentration of GHGs, plus N20 and isotopes	Global Atmospheric Watch	1970, ongoing	Monthly	Global	Continental, improving
Anthropogenic emissions of GHGs	ORNL Distributed Active Archive Center (DAAC)	1990 ongoing	Annual	Global	National
Fluxes from specific ecosystems	FLUXNET (about 500 flux towers in a range of ecosystems)	About 2000, ongoing	Hourly, annualised	Global but patchy	Points of ~1km radius
Emissions/uptake of CO_2, CH_4 and N_2O by ecosystems	GEO BON Ecosystem Services working group	Under development	Annual	Global modelled product	~50 km
Monitoring desertification and dryland restoration and climate effects					
FAPAR or related vegetation greenness proxies	ESA, NASA and several other space agencies	1996 onward	10-daily	Global	300m
Albedo	NASA (MODIS or Multi-angle Imaging Spectroradiometer (MISR)); ESA (MEdium Resolution Imaging Spectrometer (MERIS))	2000 onward	10-daily	Global	500m
Climate driver variables – rain, temperature, humidity, wind, biomass, soil carbon, fire extent	Global Climate Observing System (GCOS) Essential Climate Variables	Some exist since 1850 but most are in preparation	Various, depending on variable, but mostly at least annual	Global	Variable, but typically gridded to about 50 km
Carbon stocks					
Forest extent and biomass by type. Supplementary information on age and species composition	Does not yet comprehensively exist, but under development among by GEO Forest Carbon Tracker, UNDP and others. FAO Forest Resources Assessments (FRA) is also a source and potential host for a consolidated set	Databases for some types and regions exist since 1970	5-yearly	Global forested areas	~30m
Wetland extent and carbon density by type	Does not yet exist. Ramsar mapping activity will help produce it. Wetlands International may be a logical host for the product	Databases for some types exist since ~1970	5-yearly	Global	~30m
pCO_2 of the ocean and related indicators such as calcium carbonate compensation depth	NOAA (Takahashi dataset)	~1950	Continuous recording from cruises	Global but uneven	~100 km
Restoration of degraded ecosystems					
Database of Restoration actions: net GHG forcing outcomes and biodiversity impacts	Does not yet exist, but could be based on registers of Carbon offset and REDD+ programmes, e.g. Indonesia's Forest Resource Information System (FRIS), Afforestation, Reforestation, Deforestation (ARD), Clean Development Mechanism (CDM) & Voluntary Carbon Standard (VCS)	Does not yet exist	Database would be continuously updated as projects report	Global but only covering areas within REDD+ or restoration projects	Project scale
Vulnerability to climate change					
Indicator of vulnerability based on organism traits	IUCN, in collaboration with others	Under development	Single time, updated decadally	Global	Broad ecosystem type

Gaps and data limitations

The knowledge-base of amounts of ecosystem carbon density, fluxes and rates of sequestration is poor and patchy across ecosystems: better for e.g. forests and peatlands, poorer for e.g. inland non-peat wetlands and coastal wetlands. The plant functional type attributes (e.g. photosynthetic light use efficiency and stomatal sensitivity to drought) required for the calculation of Gross Primary Productivity (GPP) from FAPAR are not yet available for many tropical and dryland plant functional

types. 10-daily climate data at the same spatial resolution as the vegetation cover data is not available over much of the developing world.

Although several degradation assessments exist (Global Land Degradation Assessment (GLADA) is an example), there is no agreed baseline of the extent and location of degraded ecosystems worldwide, and thus change products are currently unfeasible**.** A key barrier is the absence of agreement on what constitutes a "degraded ecosystem". The Millennium Ecosystem Assessment (2005) proposal that degradation be defined as a persistent reduction in the capacity of the ecosystem to supply services, may offer a way forward.

There are no known currently active processes or databases documenting ecosystem restoration activities worldwide. It may be possible to establish a mechanism for compiling such a dataset in relation to reporting requirements under ARD, CDM and the emerging REDD+ activities of the The United Nations Framework Convention on Climate Change (UNFCCC); the private-sector VCS process and project databases under the United Nations Convention to Combat Desertification (UNCCD) and the Global Environment Facility (GEF). It would be helpful to suggest to such processes a simple and unified set of metrics that would document their biodiversity outcomes. Extent of intact habitat (including its degree of connection to other patches of intact habitat) is a key variable. A project-scale combination of assessment of status and trends of rare and threatened species, coupled with a mean abundance of biodiversity as a whole, might be a generalised way of tracking biodiversity impacts in both restoration and avoided deforestation projects. Systematic monitoring schemes at restoration sites have been developed by BirdLife International.

Adequacy assessment

The atmospheric and oceanic measurements are already taken, and the network is growing to meet GCOS and Global Terrestrial Observing System (GTOS) adequacy standards and thanks to recent technological advances, to the point that continental-scale resolution of source-sink patterns is now feasible. Flux measurements are seriously undersampled in most tropical, subtropical and dryland systems, especially in Africa and SE Asia. The ORNL emissions database is constructed partly from country submissions to the UNFCCC, but is independently verified, for instance from fossil fuel trade statistics, and is adequate for this purpose. FAPAR and albedo are available from several satellites at acceptable accuracy, but the satellites end their planned operational life in the next few years. Continuity missions are required. Global databases of ecosystem protection and restoration activities aimed at climate mitigation and biodiversity protection/restoration only exist in fragmented prototype form. The incentives potentially exist to standardise and unify them, if they are built into the evaluation rules for those projects.

Estimated costs

The calculation of the global net CO_2 sink/source is currently performed by the Global Carbon Project at a cost of €250,000 per annum. Extension to the other GHGs would require possibly another €250,000 per annum, and global analysis of FAPAR would require possibly €500,000 per annum. Flux sites cost about €50,000 per annum each to operate. More representative sampling would require in the order of 100 new sites, but strategically located. The cost of *in situ* measurements of carbon stocks is project scale dependent and is often a by-product of forest or range inventory, but can range up to several million Euros for a large country if undertaken stand-alone. Interoperability of the ARD, CDM, VCS and future REDD+ databases would come at a small incremental cost to the costs of the projects themselves.

Target 16 – Access and benefit sharing (ABS)

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.

Key concepts

COP Decision X/1 calls upon Parties to sign the Nagoya Protocol on Access and Benefit-sharing, to designate national ABS focal points, and to adapt their national legislation. These activities can be used as indicators to assess trends in the implementation of this target. Under Decision X/1 Parties are requested to inform the CBD Secretariat on these activities while the CBD Secretariat is requested to make this information available through the ABS Clearing-House Mechanism (CHM). The ABS Clearing-House Mechanism will have to be established after the adoption of the Nagoya Protocol on ABS.

Table 16: An initial list of variables/datasets/indicators for monitoring progress towards Target 16.

Observation dataset	Sources and Organisational Holder/s	Start year [end year if interrupted]	Frequency of update	Geographical Coverage	Spatial Resolution
Number of signatories and ratifications to the Nagoya protocol	ABS Clearing-House Mechanisms	At onset of Nagoya ABS protocol, ongoing	Continuous	Global	National
Number of countries with national ABS focal points	ABS Clearing-House Mechanisms	2000	Continuous as new focal points appear	Global	National
Number of countries with national and sub-national ABS legislation in place	ABS Clearing-House Mechanisms	At onset of Nagoya ABS protocol, ongoing	Continuous	Global	National
Number of permits, or their equivalent, issued at the time of access as evidence of the decision to grant prior informed consent and of the establishment of mutually agreed terms	ABS Clearing-House Mechanisms	At onset of Nagoya ABS protocol, ongoing	Continuous	Global	National

Gaps and data limitations

The key barrier is the coming into force of the Nagoya Protocol on ABS, following which the ABS Clearing-House Mechanism will be established to collect and analyse incoming data.

Adequacy assessment

Likely to be adequate by 2015.

Strategic Goal E

Enhance implementation through participatory planning, knowledge management and capacity building

"Most actions under the Convention are initiated and carried out at the national or sub-national levels, and will be delivered through the implementation of national biodiversity strategies and action plans. National strategies need to integrate new national targets consistent with this Strategic Plan and implemented through action plans involving all sectors of government, society and the economy. This will also require improvements in knowledge and how it is disseminated, as well as substantial increases in capacity in all countries, especially developing countries and countries with economies in transition and, particularly, in the least developed countries and small island developing states. Progress towards this strategic goal will contribute to all of the other strategic goals and targets contained in this Strategic Plan" (SCBD 2011).

Target 17 – National strategies and action plans

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.

Key concepts

National Biodiversity Strategy and Action Plans are supposed to be key instruments in national implementation of the CBD. Of the CBD parties, 88% have prepared NBSAPs, and they have generated important results in many countries, including helping to create a better understanding of biodiversity, its value and how to address threats.

Generally however, the main drivers of biodiversity loss have so far not been seriously influenced by NBSAPs. In most cases, there is poor correlation between NBSAPs and cross-sectoral policies such as poverty alleviation and Millennium Development Goal (MDG) strategies, as well as between NBSAPs and sectoral policies. Few countries have time-bound and measurable targets, prioritised amongst actions, mechanisms for monitoring and review, strategies for communication and for financing and sub-national strategies and action plans.

Guidance on NBSAP preparation has been adopted by CBD COP-9 and been reaffirmed by COP-10. Important elements to be taken into account in the NBSAP preparations include:

- Broad participation
- Mainstreaming with sectoral and cross-sectoral plans and polices
- Finance strategy
- Endorsement at high political level to ensure broad ownership
- Taking into account implementation of the other biodiversity-related Multilateral Environmental Agreements (MEAs)

It would be beneficial if the development and design of NBSAPs were aligned to promote comparison between countries. The preparation process is crucial for the operationalisation of the NBSAPs, and the momentum gained in the preparatory process should be maintained in the implementation phase.

Table 17: An initial list of variables/datasets/indicators for monitoring progress towards Target 17.

Observation dataset	Sources and Organisational Holder/s	Start year [end year if interrupted]	Frequency of update	Geographical Coverage	Spatial Resolution
Number of CBD parties that have developed or revised NBSAPs in line with the Strategic Plan and other CBD guidance.	National governments	1995	Irregular, 4-10 years	National	
The number and type of stakeholders who participate in the revision and updating process of NBSAPs	National governments	Database does not yet exist	Every few years	National	
Number of CBD parties fulfilling national reporting	National governments	2002	Every 4 years	National	
The proportion of other strategies and plans like NBSAPs at the sub national or supra national levels as well as cross-sectoral and sectoral plans and policies aligned with NBSAPs.	Regional organisations' biodiversity related strategies; local authorities' development plans; national MDG and other development plans; national plans and policies for forestry, fisheries and agriculture	Various	Various	Regional and national	
Comprehensiveness of NBSAPs by addressing threatened species, erosion of domesticated races and varieties, and site scale conservation priorities.	IUCN Red List and KBAs; FAO; Bioversity International.	Various	Irregular, 4-10 years	Global	National
NBSAPs account for the	The other biodiversity related	Various	Irregular, 4-	National	National

objectives of other biodiversity related conventions' objectives	conventions (the Ramsar Convention, the Convention on Migratory Species (CMS), the Convention on International Trade in Endangered Species (CITES), the World Heritage Convention and ITPGRFA)		10 years		

Gaps and data limitations

The main observational gap with respect to the remit of this target, read narrowly, is in the consistent evaluation and data capture from NBSAPs in order to extract global-level indicators, rather than in the NBSAPs themselves. The shortcomings of NBSAPs in influencing mainstream development are to a large extent due to weaknesses in the process of their development. The process was often technical and did not manage to sufficiently influence policy beyond the remit of the national agency directly responsible for biodiversity. While the need for mainstreaming across sectors is generally recognised, there is little direction on how this is actually going to take place.

Many NBSAPs are overly ambitious and prescriptive while at the same time lacking a strategy for financing its implementation. Even NBSAPs without the above deficiencies in process and design are often still not well implemented due to e.g. limited financial, human and technical capacity, weak administrative and institutional structure, lack of political will and public awareness, and poor enforcement of legislation

Adequacy assessment

The next generation of NBSAPs is expected to be under development soon to meet the target to have adopted and commenced implementation of a revised NBSAP by 2015. A series of regional workshops on NBSAP development will take place in 2011 and 2012.

Estimated costs

Guidance and financial support through GEF are available. Currently up to €345,000 (500,000 USD) is available for eligible countries to prepare their NBSAPs. The incremental costs of extracting the information to populate the indicator are likely to be relatively small.

Target 18 – Traditional knowledge and customary use

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.

Key concepts

In line with Articles 8(j) and 10(c) of the Convention, Traditional Knowledge (TK) innovations and practices that are compatible with conservation and sustainable use of biodiversity should be respected, protected, maintained and promoted. Promotion of their wider use in ecosystem management should be with the approval and participation of relevant indigenous and local communities. The rights of indigenous and local communities over their TK, innovations, practices and related biological resources, along with their rights to practice and pass on TK, innovations and practices should be respected.

The guidance developed as part of the Convention's cross-cutting issue on TK, innovations and practices (Article 8(j) and related provisions) provides advice on how this target can be implemented. Capacity building and programmes for the recognition and mainstreaming of Article 8(j) and related provisions should be strengthened and implemented.

Parties to the Nagoya Protocol on ABS take into consideration, *inter alia*, the interrelationship between genetic resources and TK, the importance of TK for the conservation of biological diversity and the sustainable use of its components, and the need for related national legislation in relation to relevant international obligations. Accordingly, Targets 16 and 18 are strongly related.

Table 18: An initial list of variables/datasets/indicators for monitoring progress towards Target 18.

Observation dataset	**Sources and Organisational Holder/s**	**Start year [end year if interrupted]**	**Frequency of update**	**Geographical Coverage**	**Spatial Resolution**
ABS protocol Target 16. Number of national states having signed up ABS legislation	ABS Clearing-House mechanism (see Target 16); Intellectual Property Rights (IPR) Compliance (World Intellectual Property Organization (WIPO); national Intellectual Property (IP) offices)	On ratification of protocol	Not yet determined?	Global	National
Status & trends of linguistic diversity	UNESCO CAFF/CBMP for Arctic languages National census data	Various	Irregular	Regional Global	Regional National, regional National
Status & trends on land use change and land tenure in territories of indigenous and local communities	Cadastre, lands use change is a key dataset, which needs developing; Dataset on land tenure to be developed (data are available for parts of India) CBMP considering monitoring land tenure in Arctic	Not yet started Not yet started		Regional	National, regional
Status & trends in the practices of traditional occupations	International Labour Organisation (ILO)	Unknown	Unknown	Global	National
Legislation on protection of indigenous knowledge	UN (Working Group on Article 8(j) and Related Provisions); National legislatures	Various	Various	Global	National
Status & trends of participation of indigenous communities in biodiversity monitoring	No known dataset	Not yet begun	~ 5 years	Global	National or sub-national

Gaps and data limitations

- Lack of a standard global database on land use change, in territories of indigenous and local communities.
- Transnational (trans-boundary) traditional use, language expression and cultural-nation identities complicate data collection.
- Dataset on land tenure to be developed, for territories of indigenous and local communities, unlikely to be supported broadly due to political sensitivities.
- Definition of traditional knowledge/practices is variable and boundaries are uncertain.
- Widespread lack of legal protection of TK.
- The value of TK is effectively eroded by climate change and the associated disruption of ecosystems.
- Relevance of traditional conservation and sustainable use knowledge in relation to rapid population growth is unclear.
- There is a risk that the ABS protocol will not yet be ratified or in effect (requires ratification by at least 50 countries to go into effect) and, once ratified, parties to the ABS protocol may fail to establish national focal points and national competent authorities.
- The issue of documenting TK (including that relevant to conservation and sustainable use), and providing wider access to this, is sensitive. TK holders may resist full and effective participation.
- TK-holding communities require extensive consultation during development of domestic TK and ABS legislation; both types are historically slow and challenging to introduce.

Adequacy assessment

Adequacy for this target will depend on the adequacy of Target 16 (ABS implementation). Adequacy will further depend largely on the adequacy of the assessment (both quantitative and qualitative) of Indigenous Knowledge Systems (IKS) legislation introduced at national level.

Presumptions have been made that various proxy indicators (linguistic diversity trends, traditional land use/tenure trends, and traditional work occupation trends) will inform on respect for traditional knowledge, innovations and practises, and accordingly on progress to this target.

Estimated costs

The costs of collecting the above information to adequate levels are unknown, since there are no precedents. If the data depend on the ABS clearinghouse mechanism the incremental costs are likely to be small, but the data is likely to be sparse and of variable quality.

Target 19 – Biodiversity knowledge improvement and transfer

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.

Key concepts

There is need for improved knowledge of biodiversity and this target is interpreted as focusing on raising awareness of status and trends in biodiversity and habitats, identifying where gaps exist and where attention is needed. This also involves improving the means of gathering and analysis of data and their transformation into knowledge and transferring this information to the relevant parties for action.

A key overarching challenge is to shorten the response time from when information is created to when it is available to decision makers. Monitoring activities must be dynamic and forward looking, focused not on static but rather on dynamic and flexible monitoring allowing for robust change detection. The aim must be to allow for a quicker response time for policy makers and to ensure sustainable funding to deliver this.

1. *Data frameworks*
    - A multidisciplinary approach is required.
    - Data sharing policies (at all levels) and agreements should be established and adopted to allow for free and open access to data and models.
    - The standards for information exchange should be freely available and adopted.
    - The development of a unique identifier for each known taxon would facilitate data access and integration.
    - All data, products and standards, should be available through the Global Earth Observation System of Systems (GEOSS) and other relevant bodies via portals and distributed services.
    - Local, national, regional and global facilities should be available to facilitate the publication and development of data sets, interoperable web services, models and spatial data infrastructure.
    - Effective mechanisms to allow for data quality assurance should be established and adopted.
    - Significant and sustainable funding is required to accomplish all the above and allow for the mobilisation of additional data.
2. *Knowledge frameworks*
    - There is a need for improved knowledge of biodiversity itself.
    - There is a need for improved knowledge on the value and functioning of biodiversity.
    - Regional assessments are required and should be encouraged.
    - National monitoring programmes should be improved and maintained and where necessary established.
    - Effective tools and publications are required to allow for knowledge transfer and development.
    - Improved mechanisms for science policy interface at all levels need to be established.
    - There is a need for reference materials to be made available including guidance and best practice documents.
    - Information available in natural history museums should be digitised and made accessible.

- Existing national Red List data even where they are not strictly compatible with IUCN lists should be accessible, as this would help facilitate standardised assessments.
- There is a need to digitise collection information from taxonomic institutions to increase the primary biodiversity data available via GBIF and other portals.

3. Capacity and technology transfer frameworks

- Increased capacity to use data and the technologies to support the development of policies need to be put in place at all levels.
- A focus on communication and outreach is needed in order to allow for effective understanding of the values and functioning, status and trends of biodiversity and the consequences of its loss.
- Technologies transfer: Access to and transfer of technologies is facilitated in accordance with Article 16 of the CBD.
- Improved mechanisms for science policy interface at all levels need to be established.

Table 19: An initial list of variables/datasets/indicators for monitoring progress towards Target 19.

Observation dataset	**Sources and Organisational Holder/s**	**Start year [end year if interrupted]**	**Frequency of update**	**Geographical Coverage**	**Spatial Resolution**
National Biodiversity Information Facilities (BIFs)	Governments	Various	Various	National	Various, often <10 km
National and thematic CHM	National agencies; NGOs; Academics	Various	Various	National	Various
Regional networks	E.g. Spatial Data Infrastructures (SDIs) (e.g. Arctic SDI); INSPIRE (an infrastructure for spatial information in Europe); EBONE, DOPA; CBMP; ICIMOD	Various	Various	Multinational	Various
Global networks[37]	E.g. GEOSS; GBIF; IUCN (e.g. WDPA)	Various	From daily to long term	Global	Various
Thematic networks[38]	E.g. GMBA; BirdLife International; OBIS; CBMP; CoML; Community Monitoring inventory	Various	Various	Multinational to global	Various
Assessment networks	MA; CAFF (Arctic Council)	Various	Various	Multinational to global	Various
Number of newly described species	Biodiversity NGOs, especially Species 2000; GBIF National agencies; Academics; natural history museums and herbaria	2000	Irregular, could be annual	Global	Various
Transfers of biodiversity relevant technologies Number of technology transfer centres	ABS Clearing House; National agencies; NGOs; Academics; Private sector	No existing global database	Annual	Global	National
Education: Number of students from developing countries receiving education in developed countries; Number of people from developing countries trained on biodiversity related knowledge support by developed countries; Budget for biodiversity related research	National agencies; NGOs; Academics; Private sector	No global systematic database exists	Annual	Global	National

[37] see GEOBON Detailed Implementation Plan (GEO BON 2010a)

[38] see GEO BON - Principles of the GEO BON Information Architecture (GEO BON 2010b)

Gaps and data limitations

- A lack of fundamental information (baseline and gap analyses) on the status and trends of biodiversity.
- Incomplete, inadequate and biased taxonomic, spatial and temporal coverage.
- Clearing house mechanisms have not yet achieved full coverage and should build upon GBIF and networks which are producing information.
- Policy and technology frameworks exist but there are large gaps in data availability.
- There are weak linkages to policy makers and poor understanding of the importance of biodiversity.
- It is important to insure that information is easily accessible and accompanied with the necessary metadata to allow it to be used appropriately.
- The cost effectiveness of gathering data and putting in place mechanisms to transform these to useful knowledge needs to be considered.

Adequacy assessment

There is awareness of the need to address this target but the capacity to do so is severely lacking. Instruments to facilitate the development of this capacity, including improvement of data quality and availability, are underway e.g.:

- Establishment of GEO BON
- Various existing networks of biodiversity knowledge, e.g. GBIF, Encyclopaedia of Life
- Policy developments are in progress (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES))

More work is needed in further developing the knowledge base upon which the data integration and synthesis depend.

Estimated costs

Unknown. Transferring existing data is less costly. New data and digitising data is more expensive.

Target 20 – Resources in support of the convention

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.

Key concepts

Limited financial capacity is a major obstacle to the implementation of the Convention and the Strategic Plan. The fulfilment of this target will also have implications on the feasibility of achieving the other 19 targets contained in the Strategic Plan for Biodiversity 2011-2020. Comprehensive estimates of total current financing of biodiversity, and by extension, the returns to investment in biodiversity conservation and the highest priority gaps or opportunities for investment remain a challenge. Estimates of spending and financial needs are available for some important contributors to biodiversity conservation (e.g. protected area networks, removal of perverse policy incentives), but not others (e.g. biodiversity business, green infrastructure). Investment in biodiversity is in a period of diversification from traditional sources, most notably Official Development Assistance (ODA) and domestic governmental investment, to private profit-seeking, private non-profit, and other sources of biodiversity finance (Butchart et al. 2010; Gutman and Davidson in Rands et al. 2010; Salcido et al. in Rands et al. 2010). In broad terms, total global estimates of current investments in biodiversity conservation are likely to be in the $10s of billions annually, whereas needs are likely to be in the mid $100s of billions annually (James et al. 2001; Bruner et al. 2004; Berry 2007; IUCN 2010; Rands et al. 2010). Succinctly, "scaling up successful approaches requires much greater investment in biodiversity conservation, by at least an order of magnitude"[39].

In decision X/3 a number of indicators were agreed on which should be developed and used to establish baselines and monitor the implementation of the strategy for resource mobilization and enable setting concrete targets under Target 20 at a later stage, and are found below. There is some overlap among these indicators, so some refinement, based on need and data availability is advisable. With the exception of ODA for the implementation of the Convention, tracked by the OECD-DAC, there are currently no established mechanisms to collect comparable figures on these indicators. Definitions on what should be counted as biodiversity funding/expenditure are under development. They will draw on the International Monetary Fund (IMF) and OECD systems.

Through decision X/26 the terms of reference and process for assessing funding needs of eligible countries to determine the amount of funds necessary for the sixth replenishment period of the Global Environment Facility Trust Fund, were established.

Table 20: An initial list of variables/datasets/indicators for monitoring progress towards Target 20.

Observation dataset	Sources and Organisational Holder/s	Start year [end year if interrupted]	Frequency of update	Geographical Coverage	Spatial Resolution
Aggregated financial flows, in the amount and where relevant percentage, of biodiversity-related funding, per annum, for achieving the Convention's three objectives, in a manner that avoids double counting, both in total and in, *inter alia*,	No current global database exists, and very few national ones	Does not yet exist	Annual	Global	National

[39] The recent Copenhagen Accord refers to scaled up, new and additional funding to enable and support enhanced action on mitigation, including substantial finance to REDD+, adaptation, capacity-building, technology development and transfer. The commitment is to provide resources (via public and private, bilateral and multilateral, and alternative sources of finance) ranging from $10 billion a year in the short term ("Fast Track") to $100 billion a year by 2020 to address the needs of developing countries.

the following categories: *(a)*Official Development Assistance (ODA); *(b)*Domestic budgets at all levels; *(c)*Private sector; *(d)*Non-governmental organizations, foundations, and academia; *(e)*International financial institutions; *(f)*United Nations organizations, funds and programmes; *(g)*Non-ODA public funding; *(h)*South-South cooperation initiatives; *(i)*Technical cooperation					
Number of countries that have: *(a)*Assessed values of biodiversity, in accordance with the Convention; *(b)*Identified and reported funding needs, gaps and priorities; *(c)*Developed national financial plans for biodiversity; *(d)*Been provided with the necessary funding and capacity-building to undertake the above activities	Global database does not yet exist. One could potentially be established by the CBD secretariat	Does not yet exist	Annual	Global	National
Amount of domestic financial support, per annum, in respect of those domestic activities which are intended to achieve the objectives of this Convention	National. One example is the UK biodiversity expenditure reported in http://jncc.defra.gov.uk/pdf/BIYP_2010.pdf	2000/01	Annual	National	National
Amount of funding provided through the Global Environment Facility and allocated to biodiversity focal area	GEF	~2000	Annual	Global	National
Level of CBD and Parties support to other financial institutions that promote replication and scaling-up of relevant successful financial mechanisms and instruments	Global database does not exist	Does not yet exist	Annual	Global	National
Number of international financing institutions, United Nations organizations, funds and programmes, and the development agencies that report to the OECD-DAC, with biodiversity and associated ecosystem services as a cross-cutting policy	OECD-DAC		Annual	Regional	National
Number of Parties that integrate considerations on biological diversity and its associated ecosystem services in development plans, strategies and budgets	Global database does not yet exist. One could potentially be established by the CBD secretariat on the basis of Party reports	Does not exist	Annual	Global	National
Number of South-South cooperation initiatives conducted by developing country Parties and those that may be supported by other Parties and relevant partners, as a complement to necessary North-South cooperation	Global database does not exist	Does not yet exist	Annual	Global	National
Amount and number of South-	Global database does not	Does not yet	Annual	Global	National

South and North-South technical cooperation and capacity-building initiatives that support biodiversity	exist	exist			
Number of global initiatives that heighten awareness on the need for resource mobilization for biodiversity	Global database does not exist	Does not yet exist	Annual	Global	National
Amount of financial resources from all sources from developed countries to developing countries to contribute to achieving the Convention's objectives	Global database does not exist	Does not yet exist	Annual	Global	National
Amount of financial resources from all sources from developed countries to developing countries towards the implementation of the Strategic Plan for Biodiversity 2011-2020	Global database does not exist	Does not yet exist	Annual	Global	National
Resources mobilized from the removal, reform or phase-out of incentives, including subsidies, harmful to biodiversity, which could be used for the promotion of positive incentives, including but not limited to innovative financial mechanisms, that are consistent and in harmony with the Convention and other international obligations, taking into account national social and economic conditions	Global database does not exist, see Target 3	Does not yet exist	Annual	Global	National
Number of initiatives, and respective amounts, supplementary to the financial mechanism established under Article 21, that engage Parties and relevant organizations in new and innovative financial mechanisms, which consider intrinsic values and all other values of biodiversity, in accordance with the objectives of the Convention and the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of the Benefits Arising out of Their Utilization	Global database does not exist	Does not yet exist	Annual	Global	National
Number of access and benefit-sharing initiatives and mechanisms, consistent with the Convention and, when in effect, with the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of the Benefits Arising out of Their Utilization, including awareness-raising, that enhance resource mobilization	ABS clearing house mechanism	When ABS comes into force	Annual	Global	National

Gaps and data limitations

- Lack of integration of biodiversity values in accounting systems (TEEB 2010)
- Lack of agreement on definitions.
- Inadequacy of biodiversity earmarking of funding.
- Lack of information on the assessment of the benefits of the funding.

- Effective allocation of resources unclear.

Methodological guidance for the above indicators is under development. Coherent and comparable data exist for a few (sub-) indicators, e.g. ODA, GEF funding. For others data could be obtained once methods and definitions are agreed upon

Adequacy assessment

At present no globally-consistent databases and observation networks exist for this target. For some of the high-level indicators (such as total expenditure by national governments on biodiversity protection, suitably defined) the data must be recorded in national budgets and could therefore be collated if a suitable mechanism existed. The expenditure in the private sector is much more diffuse, and would be hard to quantify in total, but a data-collecting exercise across to several dozen major international biodiversity NGOs would probably uncover the majority of it.

Estimated costs

There is no direct precedent for making an estimate. At the minimal level described above (collation of national and major NGO expenditures annually), through a mechanism such as reports to the CBD, the cost could be quite modest – perhaps a few hundred Euros per year.

Towards an integrated observation system

This document is organised by the goals and targets defined by the CBD for the period from 2011 to 2020. This may give the impression of an extremely fragmented observational system. In reality, there are many core shared databases (see the section on 'Essential Biodiversity Variables' below) and important links and co-dependencies between targets. These are mostly pointed out in the target-by-target discussions. These connections between targets, indicators and underlying datasets are seen as a positive feature of the system overall, since they potentially lead to efficiencies, coherence and the ability to combine the same basic observations in novel and value-adding ways. This can only be achieved if attention is paid to the system-as-a-whole right from the start, ensuring compatibility of variables and spatial and temporal resolutions.

A large number of organisations are involved in biodiversity observations, and many more in biodiversity indicators drawing on those observations. Many of the primary observations are made by locally or nationally-based agencies or non-governmental organisations, some with global mandates. Several organisations have tackled various aspects of the issue of global data sharing – IUCN for species, GBIF for collection records and UNEP-WCMC for protected area databases are three leading examples.

Solving the broader problem of information sharing and gap-filling with respect to global environmental management triggered the formation of the Group on Earth Observations (GEO; www.earthobservations.org/index.html), which currently has over 80 member countries and 61 participating organisations. The solution conceived by GEO is a 'system of systems', called GEOSS (Global Earth Observation System of Systems; www.earthobservations.org/geoss.shtml), which complements and integrates existing activities rather than replacing them. GEO BON is the primary biodiversity component of the GEO system and is a voluntary partnership between many of the stakeholder organisations and countries in the biodiversity field (including data providers, data aggregators and data users). Version 1.0 of the GEO BON implementation plan (GEO BON 2010a) was drafted in the first quarter of 2010 by over a hundred experts, organised into eight working groups and reflects much of their collective thinking. The working groups (see: www.earthobservations.org/geobon_wgs), who conduct the coordination actions of GEO BON, are a resource for advancing the GEO BON objective for an operational, fit-for-use biodiversity observation system.

The work being proposed by GEO BON during the GEO work plan period 2012-2015 can help support the monitoring of status and trends in biodiversity for the CBD. Examples include:

- Extending observations for the annual wild bird indicators (WBI), from those regions where they are already established, aiming to cover the entire globe by 2020.
- Creating a Global Freshwater Biodiversity Observation and Analysis Consortium to address key questions in monitoring and management of freshwater ecosystems.
- A first full global analysis of a new measure of stability of ecosystem carbon services.

Important biodiversity observations not well represented in the Aichi targets

This Adequacy Assessment was developed by working backwards from the user needs, as defined by the Aichi targets set by the CBD for the period 2011-2020. This section briefly addresses a broader adequacy question with respect to biodiversity observations: what observations, in addition to those identified by the above process, are needed to constitute an adequate observation system for biodiversity change, including but not restricted to the requirements of the 2020 targets. One point of departure for such an analysis is the GEO BON Implementation Plan, which works forwards from the key observational datasets that are known to exist or are targeted for development in the near future. A second 'reality check' is to assess the degree to which the indicators used to assess the CBD 2010 target – many of which will continue to be collected – find a place in the 2020 target scheme.

There is a significant degree of convergence between the GEO BON Implementation Plan and the core datasets which it identifies, and the observational needs of the 2020 targets, particularly in Goals B and C. Social and policy-related observations are less well represented in the GEO BON Plan than the needs of the Aichi targets would suggest. On the other hand, the following areas, highlighted as important or emerging by the GEO BON community, are under-represented in the 2020 targets. This highlights the issues and gaps inherent in the potential observation sets suggested under the targets.

Genetic diversity. This includes phylogenetic diversity (a measure of the evolutionary processes responsible for generating biodiversity in the first place), and the rapidly-emerging area of environmental metagenomics. The latter approach is particularly useful in addressing the problem of the large number of organisms that are either undescribed by science or do not comfortably fit into the species concept since they do not reproduce sexually. Genetic information in the 2020 targets is only specifically mentioned in relation to the diversity in domesticated species used in agriculture, and their wild relatives (Target 13). The falling cost of gathering genetic information and the rapid growth of genetic databases makes it inevitable that there will in the future be a higher reliance on this type of data in biodiversity observation systems.

Diversity at ecosystem scale (functional and community diversity) is not adequately represented by the very broad ecosystem classes that are typically used in Target 5. For instance, the 'area of forest cover' treats all forests as equal, whereas in reality there are many varieties of forest, not equally important or threatened as a source of services and a locus of biodiversity.

An unintended consequence of the target-by-target approach is the risk of being unable to address the crucial issue of between-target trade-offs. It may not be possible to maximise them all, so it is important to know the dependencies between them and how to prioritise decision-making. Trade-offs may also occur across scales: success at one scale may lead to failures in other places or at other scales. The indicator in this case would be a metric of the degree to which 'balanced biodiversity planning' is practiced.

The target set mostly treats climate change through the potential contribution of ecosystems to climate change mitigation. Climate change is also an increasingly-important driver of biodiversity change.

Essential biodiversity variables

An alternative way to look at observation capacities is to identify 'essential biodiversity variables' in a way analogous to the 'essential climate variables' identified by GCOS for use in the UN Framework Convention on Climate Change. Those variables can be classified using the classic framework of Pressures-State-Response-Benefits and discriminate between primary change observations and derived measures and indicators of biodiversity change (Figure 1 below). For example, an analysis of ecosystem services and associated benefits may require the integration of *in situ* observations of species population trends, remote sensing data on changes in land use and functional ecosystem change, data on other drivers of ecosystem change such as climate change, and socio-economic data. In contrast, population trends of selected species can be derived almost directly from *in situ* species population observations.

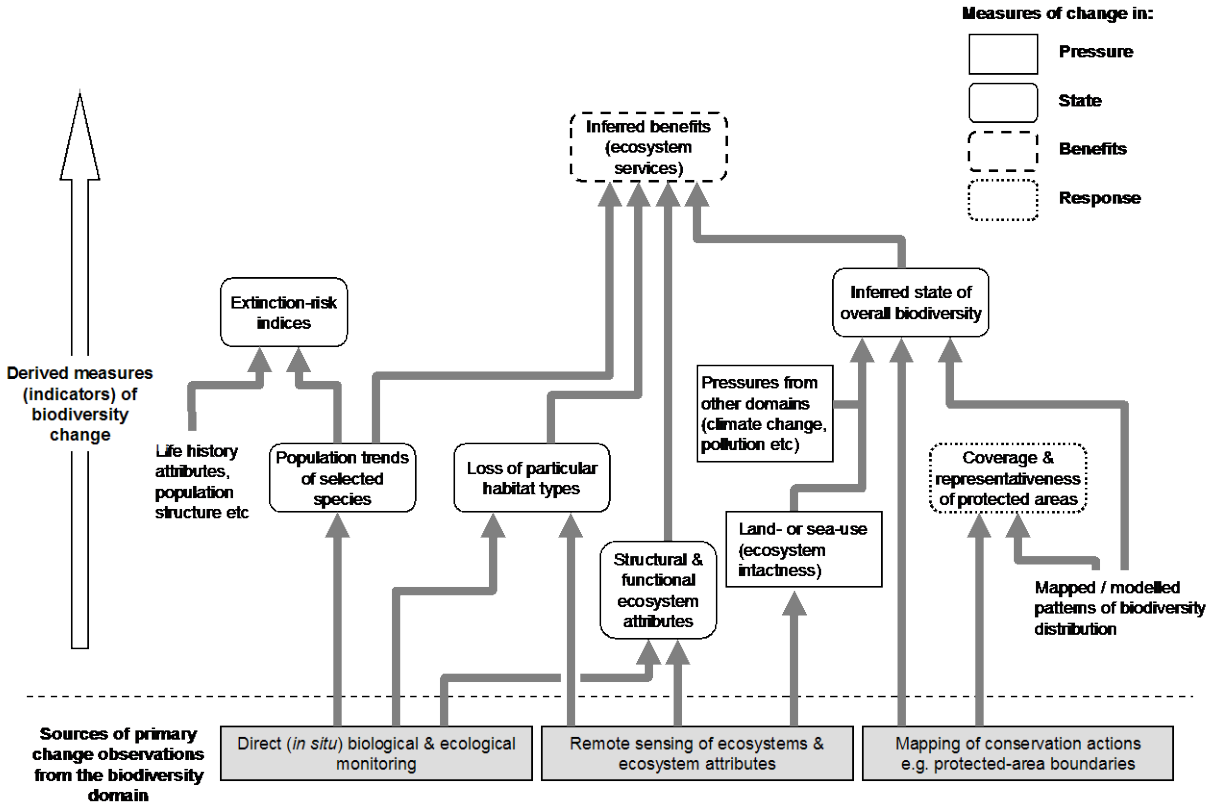

Figure 1: An indicative framework for deriving pressures, state, responses and benefits (impacts) measures of biodiversity change from primary change observations (*in situ*, remote sensing, and actions). Note that this figure only lists some of the derived measures and some of the primary observations.

It is important to note that some state measures can be interpreted as pressure measures and vice-versa. For instance, change in land cover with loss of particular habitat types is a measure of the state of biodiversity but as it can be the direct result of land-use change, it is also a measure of pressure on ecosystems and its populations. There is also a relationship between the type of primary change observation – *in situ* monitoring, remote sensing and mapping of conservation actions – and the Pressures-State-Response-Benefits framework (Figure 1), although categories overlap.

Table 21: An initial list of essential variables for monitoring change in biodiversity.

Essential variables	**Sub variable**	**Examples of datasets and/or relevant institution**[40]	**Gaps**	**Could be done by 2020 or already in development**	**Targets** () denotes less relevance
State: Genetic diversity for selected species over time	Domestic animals and exploited species	DAD-IS (FAO)	Data gaps and infrequent data updates, particularly in developing region; fisheries and aquaculture not covered.		(4), 6, 7, 13, 14, (15)
	Cultivated plants	*Ex situ* collections databases (FAO, CGIAR)	Lack of *in situ* data	Mapping diversity of a targeted set of cultivated plants and their wild relatives; Inventory of threatened cultivated plant varieties	(4), 6, 7, 13, 14
	Threatened species	ISIS (animals) BGCI (plants)	Coverage (predominantly large mammals, captive populations) No genetic data		(5), (8), 12
State: Species abundance over time, distribution patterns, and extinction risk	Terrestrial species abundance	Birds (BirdLife International)	Africa, South / central America, Asia, Pacific Tropics	Critically endangered and common birds in gap regions	5, 6, 7 ,10 ,11 ,12 ,14 ,15
		Mammals (ZSL/WWF)		Large mammals (camera trapping – Wildlife Picture Index) and bats (iBats) could be done in gap regions	
		Butterflies	Africa, Americas, Asia	Iconic species monitoring in gap regions	
		Plants	No population trend data except for tree species and species targeted for demographic research - usually either highly threatened or invasive aliens	SRLI of threatened plant species in hotspots	
	Marine species abundance	Fishes (International Council for Exploration of the Sea (ICES), Northwest Atlantic Fisheries Organization (NAFO), OBIS) SAHFOS plankton monitoring National and EU monitoring programmes	Non-commercial species	Reef Life Survey (RLS) – citizen science Extend SAHFOS monitoring transects Coordinate regional monitoring programmes	
	Invasive species	The Global Invasive Species Database (GISD), DAISIE, Centre for Agriculture and Biosciences International (CABI) compendium	Temporal trends	Reassessment of countries with collated data and expansion of countries/taxa by additional data collation	9, (15)

[40] Note that the list of data sets in this table is not exhaustive, and more examples can be found under each of the targets in the previous sections.

	Species distribution patterns	GBIF IUCN, BirdLife International, NatureServe, ZSL Encyclopaedia of Life, OBIS, Citizen science	Limited taxonomic coverage	Using GBIF mediated data for niche modelling (Encyclopaedia of Life, AquaMaps), expansion of WorldBirds, eBird	(2), 5, 9, 11,
	Extinction risk	IUCN Red List, BirdLife International, NatureServe, ZSL	Taxonomic coverage & temporal trends	Reassessments (birds, mammals, amphibians, corals, cycads, conifers); Taxonomic expansion (reptiles; freshwater fish, molluscs, marine fish; selected invertebrate groups, plants sampled for the RLI, legumes, palms, crop relatives, medicinal plants, fungi)	5, 6, 7, 9, 10, 12, 14
State: Functional types and ecosystems	Terrestrial Habitats	Land cover (ESA, Indian Space Research Organisation Geosphere-Biosphere Program (ISRO-GBP), NASA) TRY initiative database Land use change (Global Observation for Forest and Land Cover Dynamics (GOFC-GOLD) – Canadian Forest Services)	Habitats that cannot be tracked by this process Separation between plantations and natural forest Ecosystem intactness		5, 11, 14,
	Inland wetlands	Water quality (Government Agencies, GEMS-Water) & quantity (World Water Assessment Programme (WWAP))	Global wetland distribution Biodiversity data over time for river basins		5, 8, 11, 14
	Marine/coastal	Physical oceanography parameters such as salinity and temperature (World Ocean Database and Atlas, GOSUD) Argo floats GOOS Coral reef extent	500 oceanographic stations but low coverage in developing world Over 3000 floats in operation worldwide	Reef check is improving our monitoring of coral reef health.	5, 10, 11, 14
State: Ecosystem services	Fisheries production (marine and freshwater)	FAO			6, 14
	Water supply for domestic use and irrigation	FAO, WB			14
	Wood products production	FAO			7, 14
	Crop production	FAO	Not spatially explicit		7
	Nutrient retention for clean drinking water	InVEST and other models	Models still in development		14

	CO_2, N_20 and CH_4 regulation for climate control	LPJ and other models			14, 15
	Erosion control	LPJ and other models			14
Responses	Protected areas	WDPA and (WCMC)	Lacks vector data for many PA, and there is not data on management effectiveness for the majority of the sites	Collecting more data on management effectiveness and improve spatial resolution.	1, 14, 15
	Important sites for biodiversity	Key biodiversity areas (e.g. IBAs, AZEs, IPAs, PBAs, EBSAs)	Limited taxonomic coverage	Identifying Important Plant Areas (Worldwide), currently being coordinated by PlantLife International	14, 15
	Prevention and control measures for invasive aliens	CIB (Stellenbosch University)			9
	Political facilitation for biodiversity issues	ABS Clearing-House Mechanisms, National Biodiversity Strategy Plans	Some of these are just starting (ABS).	It is likely that a set of indicators based on the ABS Clearing House mechanisms will be developed by 2020.	2, 3, 16, 17, 18, 19, 20
	Biodiversity awareness and sustainability	Certification of biodiversity friendly products (e.g. FSC), opinion polls and visitation rates to biodiversity areas (National/Regional Statistical Bureaus), Ecological Footprint Index	The information is scattered.	Needs further integration and definition of key indicators to be monitored.	1, 2, 3, 4

Some of the essential variables to assess biodiversity change, particularly those dealing with some of the pressures on biodiversity, are being collected by several organizations with the aim of assessing other dimensions of environmental change (e.g. climate change, energy policy, agricultural policy). Here the focus is on the variables directly related to the observation of biodiversity and ecosystem services (Table 21). Some of the social variables directly related to biodiversity were captured (see "Responses" rows), but without the same systematic approach. This differential emphasis of the variables in the table means that some of the targets are not as well represented as others.

The essential biodiversity variables are organized in three categories: state of biodiversity, ecosystem services, and responses. The state of biodiversity variables are in turn organized into four levels of biological organization – genes, species, functional groups/ecosystems, and ecosystem services – and in some cases by major ecological realm – terrestrial, freshwater and marine – or other important categories. It is important to note that another organization could have been followed for the table, by structuring it around the regional biodiversity observation networks being developed by GEO BON and others. For instance, species abundance, ecosystems, ecosystem services and responses for the entire Arctic, are all being monitored or will be monitored by the Circumpolar Biodiversity Monitoring Programme.

An analysis of Table 1 reveals several major patterns in the gaps in existing observation systems. First, the spatial coverage is still very incomplete. Much more data exists for the developed world than for the developing world, and one could argue that the need for data is even more urgent in the latter as pressures mount in places that are often biodiversity-rich. Second, even in the developed world, the availability of time series data is limited. For example many countries do not yet have any basic system of regular species population monitoring for even the most well known taxonomic groups. The lack of biodiversity time series contributes towards difficulties in disentangling human impact from natural variability.

It would be possible to expand current monitoring programs to regions of the world where gaps exist in time to contribute to reporting on the 2020 targets, as long as that expansion is selectively targeted to the most critical data needs and is complemented by remote sensing and modelling approaches. This expansion of monitoring programs to gap regions and the improvement in spatial and taxonomic coverage in other regions is a key priority in the development of GEO BON.

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Appendix 1: Glossary and acronym list

ABS: Access and Benefit-sharing (A key element of the CBD programme)

ACAP: Agreement on the Conservation of Albatrosses and Petrels (www.acap.aq)

Adjusted Net Savings: (also known as genuine saving), is an indicator of the sustainability of an economy. It measures the true rate of savings in an economy after taking into account investments in human capital, depletion of natural resources and damage caused by pollution.

AfSIS: Africa Soil Information Service

AGRRA: Atlantic and Gulf Rapid Reef Assessment (www.agrra.org)

AHTEG: Ad Hoc Technical Expert Group

ALARM: Assessing Large Scale Risks for Biodiversity with tested Methods (www.alarmproject.net)

Albedo: The diffuse reflectivity or reflecting power of a surface

ALOS-PALSAR: Advanced Land Observing Satellite - Phased Array type L-band Synthetic Aperture Radar

AMPs: Agricultural Management Practices

AnGRFA: Animal Genetic Resources for Food and Agriculture

API: African Pollinator Initiative

AqGR: Aquatic Genetic Resources

AquaMaps: An approach to generating model-based, large-scale predictions of currently known natural occurrence of marine species. (www.aquamaps.org)

AQUASTAT: FAO's global information system on water and agriculture, developed by the Land and Water Division (www.fao.org/nr/water/aquastat/main/index.stm)

ARD: Afforestation, Reforestation, Deforestation - a mechanism under the Kyoto Protocol for developed countries to gain carbon credits from forest management

ASTI: Arctic Species Trend Index (http://arcticportal.org/features/features-of-2010/arctic-species-trend-index)

AVHRR: Advanced Very High Resolution Radiometer

AZE: Alliance for Zero Extinction (www.zeroextinction.org)

AZEs: Alliance for Zero Extinction sites

BBC: British Broadcasting Corporation (www.bbc.co.uk)

BEN: BalançoEnergético Nacional, Brasil (https://ben.epe.gov.br/)

BGCI: Botanic Gardens Conservation International (www.bgci.org)

BIF: Biodiversity Information Facility

Biodiversity observation system: An end-to-end system enabling information flow from primary observation to end use and back again

BioNET: Global Network for Taxonomy (www.bionet-intl.org)

BIP: The Biodiversity Indicators Partnership (www.bipindicators.net)

BOD: Biochemical Oxygen Demand

BOEMRE: The Bureau of Ocean Energy Management, Regulation and Enforcement (www.boemre.gov)

BON: Biodiversity Observation Network

Breed: As related to agricultural crops. A particular type or variety.

CABI: Centre for Agriculture and Biosciences International. A not-for-profit science-based development and information organization, providing information and applying scientific expertise to solve problems in agriculture and the environment (www.cabi.org)

CAFF: Conservation of Arctic Flora and Fauna. CAFF has a range of monitoring programmes that provide a number of arctic wide datasets for monitoring habitat coverage, condition and fragmentation as well as trends in selected species (www.caff.org)

CapMon: Canadian air and precipitation monitoring network (www.ec.gc.ca/rs-mn/default.asp?lang=En&n=752CE271-1)

CASTNET: The Clean Air Status and Trends Network (www.epa.gov/castnet)

CBD: Convention on Biological Diversity (www.cbd.int)

CDM: The Clean Development Mechanism of the UNFCCC (http://cdm.unfccc.int/)

CEBI: Critically Endangered Bird Indicator

CGIAR: The Consultative Group on International Agricultural Research (www.cgiar.org)

CI: Conservation International (www.conservation.org)

CIB: Centre for Invasion Biology (www.sun.ac.za/cib/iasi)

CIFOR: Center for International Forestry Research (www.cifor.cgiar.org)

CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora (www.cites.org)

CLTAP: Convention on Long-range Transboundary Air Pollution

CMBP: Circumpolar Biodiversity Monitoring Programme

CMS: Convention on Migratory Species

COD: Chemical Oxygen Demand

CoML: Census of Marine Life

Consumption of Fixed Capital: A measure that indicates the decrease in the net present value (NPV) of the future income stream to be expected from the use of the asset.

CORDIO: Coastal Oceans Research and Development in the Indian Ocean (www.cordioea.org)

CPUE: Catch Per Unit Effort

CRW: Coral Reef Watch (www.coralreefwatch.noaa.gov/satellite/ge/)

CTI: Community Temperature Index

DAAC: Distributed Active Archive Center of the The Oak Ridge National Laboratory

DAD-IS: Domestic Animal Diversity Information System of the FAO

DAISIE: Delivering Alien and Invasive Species Information for Europe

DiveBoard: A place for scuba divers to keep and share their diving memories, as well as a place to help scuba divers discover new places, species and fellow divers to make their diving experience even more enjoyable (http://diveboard.com/)

DIVERSITAS: The international programme for biodiversity science (www.diversitas-international.org)

DOPA: Digital Observatory of Protected Areas (http://dopa.jrc.ec.europa.eu/)

DRAGON: Delta Research and Global Observation Network

EANET: Acid Deposition Monitoring Network in East Asia

EBCC: European Bird Census Council

EBird: A citizen science project for monitoring birds (http://ebird.org/)

EBONE: European Biodiversity Observation Network

EBSA: Ecologically and Biologically Significant Area

EC: The European Commission

EC-JRC: European Commission – Joint Research Center

Ecosystem Marketplace: A project of Forest Trends, is a leading source of news, data, and analytics on markets and payments for ecosystem services (such as water quality, carbon sequestration, and biodiversity) (www.ecosystemmarketplace.com)

Ecosystem services: The benefits people derive from nature. The Millennium Ecosystem Assessment classification of services is widely used.

EDIT: European Distributed Institute of Taxonomy

EEA: European Environment Agency

EIA: Environmental Impact Assessment

ELC: Environmental Law Centre of the IUCN (www.iucn.org/about/work/programmes/environmental_law/elp_work/elc/)

EMEP: Co-operative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe.

Encyclopaedia of Life: A project to create an online reference source and database for every one of the 1.8 million species that are named and known on the planet (www.eol.org)

ENERDATA: Enerdata is an independent Information and Consulting firm specialising in the global energy industry and carbon market. Enerdata provides advanced databases, reports, forecasts, news, research and analysis on the oil, gas, coal and power markets in the global energy industry and carbon market. (www.enerdata.net/)

EPA: The United States Environmental Protection Agency

EPE: Empresa Brasileirade Pesquisa Energética

EPOCA: European Project on OCean Acidification

ESA: The European Space Agency

ESONET: European Seas Observatory NETwork (www.esonet-noe.org)

EU: European Union

EURISCO: A web-based catalogue that provides information about *ex situ* plant collections maintained in Europe (http://eurisco.ecpgr.org/home_page/home.php)

Eurobarometer: A series of surveys regularly performed on behalf of the European Commission since 1973. It produces reports of public opinion of certain issues relating to the European Union across the member states. The Eurobarometer results are published by the Public Opinion Analysis Sector of the European Commission - Directorate General Communication. (http://ec.europa.eu/public_opinion/index_en.htm)

Euro-limpacs: Integrated Project to Evaluate the Impacts of Global Change on European Freshwater Ecosystems

EUROSTAT: Eurostat is the statistical office of the European Union. Its task is to provide the European Union with statistics at European level that enable comparisons between countries and regions.

EVI: Enhanced Vegetation Index

Ex situ: Offsite. Referring to the study, maintenance or conservation of an organism away from its natural

Extralimital species: Species introduced outside their natural geographic range within a geopolitical area.

FAO: The Food and Agriculture Organization of the United Nations

FAOStat: The FAO Statistical Database

FAPAR: Fraction Absorbed Photosynthetically Active Radiation

FishStat: Database of global fish biodiversity maintained by the FAO

FLUXNET: a global network of micrometeorological tower sites that use eddy covariance methods to measure the exchanges of carbon dioxide, water vapor, and energy between the biosphere and atmosphere

FRA: The Global Forest Resources Assessments of the FAO

FRIS: Indonesia's Forest Resource Information System

FSC: The Forest Stewardship Council

GAW: Global Atmosphere Watch. A WMO programme - a partnership involving 80 countries, which provides reliable scientific data and information on the chemical composition of the atmosphere, its natural and anthropogenic change, and helps to improve the understanding of interactions between the atmosphere, the oceans and the biosphere.
(www.wmo.int/pages/prog/arep/gaw/gaw_home.html)

GBIF: Global Biodiversity Information Facility (www.gbif.org)

GCOS: 1) Global Climate Observing System; 2) Global Coastal Observing System

GCP: The Generation Challenge Programme (www.generationcp.org)

GCRMN: The Global Coral Reef Monitoring Network (www.gcrmn.org).

GDP: Gross Domestic Product

GEF: The Global Environment Facility (www.thegef.org)

GEMS: Global Environment Monitoring System (www.gemswater.org)

GenBank: The NIH (National Institutes of Health in the USA) genetic sequence database, an annotated collection of all publicly available DNA sequences.

GENESYS: A global accession-level information gateway to genetic resources (www.genesys-pgr.org)

Genetic erosion: Loss of genetic diversity over time

Genetic vulnerability: The status of species that have a narrow genetic base and/or restricted distribution of genetic diversity in space

GEO: Group on Earth Observations (www.earthobservations.org/geobon.shtml)

GEO BON: Group on Earth Observations Biodiversity Observation Network (www.earthobservations.org/geobon.shtml)

GEOSS: The Global Earth Observation System of Systems (www.earthobservations.org/geoss.shtml)

GHG: Greenhouse gas

GIAHS: Globally Important Agricultural Heritage Systems

GISD: The Global Invasive Species Database (www.issg.org/database)

GISIN: Global Invasive Species Information Network (www.gisinetwork.org)

GLADA: Global Land Degradation Assessment

GLC2000: Global Land Cover 2000

GLCF: Global Land Cover Facility

GLCN: Global Land Cover Network

Global NEWS: Global Nutrient Export from WaterSheds. An international, interdisciplinary scientific taskforce, focused on understanding the relationship between human activity and coastal nutrient enrichment. (http://marine.rutgers.edu/globalnews/index.htm)

GlobCover: A project of the ESA that aimed at producing a global land cover map to a resolution three times sharper than any previous satellite map (2005) and the sharpest possible global land cover map that can be created within a year (2009).

GLOBIO: Global Biodiversity model for policy support. A modelling framework to calculate the impact of five environmental drivers on land biodiversity for past, present and future (www.globio.info)

GLOMIS: Global Mangrove database and Information System

GLORIA: Global Observation Research Initiative in Alpine Environments (www.gloria.ac.at)

GMBA: The Global Mountain Biodiversity Assessment

GMSA: Global Marine Species Assessment

GOBI: Global Ocean Biodiversity Initiative (www.gobi.org)

GOFC-GOLD: Global Observation for Forest and Land Cover Dynamics. A panel of GTOS with its overall objective being to improve the quality and availability of observations of forests and land cover at regional and global scales and to produce useful, timely and validated information products from these data for a wide variety of users (www.fao.org/gtos/gofc-gold/index.html)

Google trends: A public web facility of Google Inc., based on Google Search, that shows how often a particular search-term is entered relative to the total search-volume across various regions of the world, and in various languages. (http://en.wikipedia.org/wiki/Google_Trends)

GOOS: Global Oceans Observing System

GOSUD: Global Ocean Surface Underway Data

GPA: Global Plan of Action

GPP: Gross Primary Productivity

GRIN: The Germplasm Resources Information Network of the National Genetic Resources Program (www.ars-grin.gov)

GSPC: The Global Strategy for Plant Conservation (www.bgci.org/ourwork/gspc/)

GTAP: The Global Trade Analysis Project: a global network of researchers and policy makers conducting quantitative analysis of international policy issues (www.gtap.agecon.purdue.edu/about/project.asp)

GTN-G: Global Terrestrial Network for Glaciers

GTOS: Global Terrestrial Observing System

GWOS: Global Wetlands Observation System

GWSP: Global Water System Project (www.gwsp.org)

HANPP: Human Appropriation of Net Primary Production

HELCOM: The Helsinki Commission. Works to protect the marine environment of the Baltic Sea from all sources of pollution through intergovernmental co-operation between Denmark, Estonia, the European Community, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden.

HKH: Hindu Kush Himalayan

HydroSHEDS: **Hydro**logical data and maps based on **SH**uttle **E**levation **D**erivatives at multiple **S**cales. A global hydrological database being developed by WWF's Conservation Science Program (www.worldwildlife.org/science/projects/freshwater/item1991.html).

IAEA: International Atomic Energy Agency

IAIA: International Association of Impact Assessment

IAS: Invasive Alien Species

IBA: Important Bird Area

iBats: Bat information network (www.ibats.org.uk)

IBGE: Instituto Brasileiro de Geografia e Estatística (www.sidra.ibge.gov.br)

IBPGR: International Board for Plant Genetic Resources (now International Plant Genetic Resources Institute (IPGRI)

ICCA: Indigenous and Community Conserved Area

ICCAT: The International Commission for the Conservation of Atlantic Tunas

ICES: International Council for Exploration of the Sea (www.ices.dk)

ICIMOD: International Centre for Integrated Mountain Development

ICOM: International Council of Museums

ICRAF: World Agroforestry Centre (also known as the International Centre for Research in Agroforestry)

ICRI: International Coral Reef Initiative

IEA: International Energy Agency (www.iea.org)

IFRI: International Forestry Resources and Institutions

IKS: Indigenous Knowledge System

ILO: International Labour Organisation

IMF: International Monetary Fund (www.imf.org)

IMO: International Maritime Organization (www.imo.org)

Indicator: A metric believed to represent an underlying issue or process in a predictable and sensitive way

INI: International Nitrogen Initiative (http://initrogen.org)

INPE: Instituto Nacional de Pesquisas Espaciais, Brazil

In situ: In the original position/Onsite. Referring to the study, maintenance or conservation of an organism within its natural surroundings

INSPIRE: An infrastructure for spatial information in Europe to support Community environmental policies, and policies or activities which may have an impact on the environment.

Invasive alien species: A species outside of its [indigenous geographic] range whose introduction and/or spread threatens biodiversity (UNEP, 2002).

InVEST: Integrated Valuation of Ecosystem Services and Tradeoffs. A family of tools to map and value the goods and services from nature which are essential for sustaining and fulfilling human life (www.naturalcapitalproject.org/InVEST.html)

IOC: Intergovernmental Oceanographic Commission

IP: Intellectual Property

IPA: Important Plant Area

IPES: International Payment for Ecosystem Services

ipBES: Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (www.ipbes.net)

IPGRI: International Plant Genetic Resources Institute

IPR: Intellectual Property Rights

IRD-France: L'Institut de Recherche pour le Développement France

ISAAA: International Service for the Acquisition of Agri-biotech Applications

ISIS: International Species Information System (www.isis.org)

ISRO-GBP: Indian Space Research Organisation's Geosphere-Biosphere Program (www.isro.org)

ITPGRFA: International Treaty on Plant Genetic Resources for Food and Agriculture

ITTO: International Tropical Timber Organization

IUCN: International Union for Conservation of Nature

IUCN SSC: IUCN Species Survival Commission

JAXA: Japanese Space Exploration Agency

KBA: Key Biodiversity Area

LIDAR: Light Detection And Ranging

Lincaocnet: A project on edible insects of Western and Central Africa targeting the base communities. Involved with gathering of field data and publication of web portal.

LPI: Living Planet Index

LPJ Model: The Lund-Potsdam-Jena Dynamic Global Vegetation Model; combines process-based, large-scale representations of terrestrial vegetation dynamics and land-atmosphere carbon and water exchanges in a modular framework.

LTER: Long Term Ecological Research

LUCAS: Land Use/Cover Area frame Survey

MarBEF: Marine Biodiversity and Ecosystem Functioning (www.marbef.org)

MARS: The Monterey Accelerated Research System (www.mbari.org/mars/)

MDG: Millennium Development Goals

MEA: Multilateral Environmental Agreement

MECN: Marine Environmental Change Network of the UK (www.mba.ac.uk/mecn)

Meltwater: Meltwater is a global Software as a Service (SaaS) company specializing in disruptive productivity solutions. Meltwater News is a media monitoring service, combining the industry's broadest search capabilities, analytical tools and a consultative relationship with its clients. (www.meltwater.com/products/meltwater-news/)

MERIS: Medium Resolution Imaging Spectrometer

METT: Management Effectiveness Tracking Tool

MISR: Multi-angle Imaging Spectroradiometer

MMC: Marine Mammal Commission (www.mmc.gov)

Modern cultivars: As related to agricultural crops. Recently developed. Often dwarf, semidwarf, stiff-stemmed, high-tillering, nitrogen-responsive, photoperiod-insensitive, high-yielding varieties. Differing in characteristics from traditional cultivars/varieties.

MODIS: Moderate Resolution Imaging Spectroradiometer

MPA: Marine Protected Area

MSC: Marine Stewardship Council

mt: Metric Tonnes

NABCI - US: North American Bird Conservation Initiative – United States (www.nabci-us.org)

NADP: National Atmospheric Deposition Program of the US

NAFO: Northwest Atlantic Fisheries Organization (www.nafo.int)

NaGISA project: A CoML Ocean Realm Field Project. A collaborative effort aimed at inventorying and monitoring coastal biodiversity.

NAPAs: National Adaptation Programmes of *Action*

NAPs: National Action Plans (for biodiversity protection)

NASA: The National Aeronautics and Space Administration

Natural Capital: A biodiversity-based asset that permits the future delivery of ecosystem services.

NatureServe: a non-profit conservation organization whose mission is to provide the scientific basis for effective conservation action. NatureServe and its network of natural heritage programs are the leading source for information about rare and endangered species and threatened ecosystems (www.natureserve.org)

NBSAP: National Biodiversity Strategy and Action Plan

NCEA: The Netherlands Commission for Environmental Assessment. An organization that provides institutional support and training to governments on Strategic Environmental Assessments (www.eia.nl)

NDACC: Network for the Detection of Atmospheric Composition Change

NDVI: Normalized Difference Vegetation Index

NEA: National Education Association

NED: Nearshore Ecosystem Database

NEON: National Ecological Observatory Network

NEPTUNE: The NorthEast Pacific Time-Series Undersea Networked Experiments (www.neptunecanada.ca)

NEWS: Nutrient Export from Watersheds – A global workgroup of UNESCO's Intergovernmental Oceanographic Commission (http://marine.rutgers.edu/globalnews/index.htm)

NGDC: The National Geophysical Data Center (www.ngdc.noaa.gov)

NGO: Non-Governmental Organization

NOAA: The National Oceanic and Atmospheric Administration (www.noaa.gov)

N-PRINT Initiative: A project of the INI. INI strives to both "minimize the negative effects of nitrogen on human health and the environment" and "optimize the beneficial role of nitrogen in sustainable food production."(http://n-print.org/home)

NSF: National Science Foundation of the U.S. (www.nsf.gov)

NSIDC: National Snow and Ice Data Center (Colorado)

NTNU: Norwegian University of Science and Technology

OBIS: Ocean Biogeographic Information System

observado.org: A citizen Science initiative where members of the public can upload their sightings of certain species groups (http://observado.org/index.php)

ODA: Official Development Assistance

OD: Observation dataset

OECD: Organisation for Economic Co-operation and Development

OECD-DAC: Development Assistance Committee of the OECD

OMI: Ozone Monitoring Instrument

ONR: Office of Naval Research. A programme of the US military (www.onr.navy.mil)

OPEN:EU project: One Planet Economy Network Europe project (www.oneplaneteconomynetwork.org)

ORNL: The Oak Ridge National Laboratory

PA: Protected Area

PAD-US: Protected Areas Database of the US (www.protectedlands.net/padus)

PAME: Protected Areas Management Effectiveness

PAR: Partnership on Agricultural Research

PBAs: 1) Prime Butterfly Areas; 2) Prime Biodiversity Areas

PES: Payment for Ecosystem Services

PGR: Plant Genetic Resources

PGRFA: Plant Genetic Resources for Food and Agriculture

PICES: Pacific International Council for the Exploration of the Sea

PMEL: Pacific Marine Environmental Laboratory

PoWPA: The CBD Programme of Work on Protected Areas. Adopted by the 7th CBD Conference of Parties in 2004

Protected Planet: An initiative of the UNEP-WCMC through which the data (both spatial and attribute) on WDPA is available for public use worldwide. With the use of Protected Planet the WDPA has begun to incorporate information on private, community, co-managed and proposed protected areas (www.protectedplanet.net)

PSR: pressure, state, response

RAINFOR: The Amazon Forest Inventory Network

REDD+: The United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD); REDD+ goes beyond deforestation and forest degradation, and includes the role of conservation, sustainable management of forests and enhancement of forest carbon stocks.

REEF: Reef Environmental Education Foundation (www.reef.org)

Resilience: The capacity of ecosystems to tolerate change without losing their essential functions.

RFMOs: Regional Fisheries Management Organisations

RLI: Red List Index

RLS: Reef Life Survey

RSPB: The Royal Society for the Protection of Birds

SAR: Synthetic Aperture Radar

SAVI: Soil Adjusted Vegetation Index

SBSTTA: Subsidiary Body on Scientific, Technical and Technological Advice

SCBD: Secretariat of the Convention on Biological Diversity

SCP: Sustainable Consumption and Production

SDI: Spatial Data Infrastructure

SDSU: San Diego State University

SEA: Strategic Environmental Assessment

SEBI 2010: Streamlining European 2010 Biodiversity Indicators (http://biodiversity-chm.eea.europa.eu/information/indicator/F1090245995). Information on interlinkages between biodiversity indicators can be found here.

SEEA: System of Environmental-Economic Accounting

SERI: Sustainable Europe Research Institute (http://seri.at/)

SI: Smithsonian Institution (www.si.edu)

SIA: Strategic Impact Assessment

SINGER: The System-wide Information Network for Genetic Resources is the germplasm information exchange network of the Consultative Group on International Agricultural Research (CGIAR) and its partners.

SOCMON: Global Socioeconomic Monitoring Initiative for Coastal Management. A program to monitor socioeconomic indicators of human dependence and threats with respect to coral reefs.

SOW: Scope of Work

SRLI: Sampled Red List Index

SWIPA: Snow Water and Permafrost Aassessment

TEAM: The Tropical Ecology Assessment and Monitoring Network (www.teamnetwork.org)

TK: Traditional Knowledge

TMR: Total Material Required

TNC: The Nature Conservancy

TOMS: Total Ozone Mapping Spectrometer

Traditional varieties: As related to agricultural crops. Varieties/cultivars grown by farmers for many years. Often tall, weak-stemmed, long-duration, low-yielding.

TREES: Tropical Ecosystem Environment Observation by Satellites; A project of the EC-JRC

TRY Initiative: TRY (whose full title is “Plant functional types: Refining plant functional classifications for Earth system modeling”) is an IGBP-QUEST-DIVERSITAS Fast-Track Initiative, in coordination with the Max Planck Institute for Biogeochemistry at Jena, Germany.

TV5MONDE: The leading French language channel that reaches more than 215 million households and 55 million viewers every week in 198 countries and territories.

UEBT: Union for Ethical BioTrade

UN: United Nations

UNCCD: United Nations Convention to Combat Desertification (www.unccd.int)

UNCEEA: United Nations Committee of Experts on Environmental-Economic Accounting

UNEP-WCMC: United Nations Environment Programme World Conservation Monitoring Centre

UNESCO: The United Nations Educational, Scientific and Cultural Organization

UNFCCC: The United Nations Framework Convention on Climate Change

USANPN: USA National Phenology Network (www.usanpn.org)

USDA: United States Department of Agriculture

USGS: US Geological Survey

UV: Ultra-Violet

VCS: Voluntary Carbon Standard

VME: Vulnerable Marine Ecosystem

WAZA: World Association of Zoos and Aquariums

WB: World Bank

WBI: Wild Bird Index. A composite index of bird population trends by major habitats derived from national bird monitoring programmes.

WBCSD: The World Business Council for Sustainable Development

WCPA: The World Commission on Protected Areas of the IUCN

WCS: Wildlife Conservation Society

WDCGG: Word Data Centre for Greenhouse Gases

WDPA: World Database on Protected Areas

WDPA-Marine: World Database on Marine Protected Areas

WFN: Water Footprint Network (http://www.waterfootprint.org/)

WGMS: World Glacier Monitoring Service

WIEWS: The World Information and Early Warning System (WIEWS) on Plant Genetic Resources for Food and Agriculture (PGRFA), established by FAO

WIPO: World Intellectual Property Organization (www.wipo.int)

WISH-GPA: World Information Sharing Mechanism on the implementation of the Global Plan of Action for plant genetic resources for food and agriculture (PGRFA).

WMO: World Meteorological Organization

World Birds: a network of Internet systems that provides a platform for the collection, storage and retrieval of bird observations worldwide. An initiative of by BirdLife International, the RSPB and

Audubon, to establish a vast source of bird and environmental information generated by general birdwatchers and professionals alike (www.worldbirds.org)

WOUDC: The World Ozone and Ultra-violet Radiation Data Centre (www.woudc.org)

WRAS: Web Reef Advisory System; an online tool to allow viewing, analysis, and entry of Reef Check survey data (http://datamanagement.reefcheck.org/)

WRI: World Resources Institute

WTO: World Trade Organization

WWAP: World Water Assessment Programme

WWF: The World Wide Fund for Nature/ World Wildlife Fund

ZSL: Zoological Society of London

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