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ENVIRONMENTAL MONITORING AND ASSESSMENT

Guidelines for developing national strategies to use biodiversity monitoring as an environmental policy tool for countries of Eastern Europe, the Caucasus and Central Asia, as well as Interested South-Eastern European countries

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The present publication is the result of a series of meetings organized by the United Nations Economic Commission for Europe (ECE) Working Group on Environmental Monitoring and Assessment.

Mr. Tobias Garstecki consultant to the ECE secretariat prepared the first draft of the guidelines contained in this publication. National experts from Armenia, Austria, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Finland, Georgia, Kazakhstan, Kyrgyzstan, Montenegro, Republic of Moldova, the Russian Federation, Serbia, Switzerland, Tajikistan, the former Yugoslav Republic of Macedonia, Turkmenistan, Ukraine, United Arab Emirates and Uzbekistan participated in the preparation of these guidelines, together with experts from the European Environment Agency, the United Nations Environment Programme (UNEP), the United Nations Statistics Division, the World Health Organization (WHO) European Centre for Environment and Health (ECEH), the Interstate Statistical Commission of the Commonwealth of Independent States, Regional Environmental Centre-Moldova and Regional Environmental Center for Central Asia, as well as representatives of environmental civil society associations and the scientific community.

The ECE secretariat, served both as content editor and overall project manager.

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Foreword

Since 1991, the "Environment for Europe" process has provided the framework for the countries of the United Nations Economic Commission for Europe (ECE) to work together in achieving their commitment to improve environmental protection and to promote sustainable development throughout the ECE region.

Within that process ECE was invited to continue its efforts to make monitoring an effective instrument in environmental policymaking, and in particular assist the countries of Eastern and South-Eastern Europe, the Caucasus and Central Asia in applying this instrument. In doing so, ECE was invited to work in close cooperation with the European Environment Agency and other relevant partners.

The United Nations Economic Commission for Europe (ECE) Working Group on Environmental Monitoring and Assessment elaborated the Guidelines for Developing National Strategies to use Biodiversity Monitoring as an Environmental Policy Tool. They were adopted by the Committee on Environmental Policy at its nineteenth session in October 2013, which invited countries of Eastern Europe, the Caucasus, Central Asia and interested countries of South-Eastern Europe to implement them.

The guidelines are addressed to government officials and experts working for government bodies that are responsible for environmental policy, environmental monitoring and compliance monitoring. In a broader sense, the document can also be of benefit to those working in the private sector, the scientific community and civil society associations active in the environmental and health fields.

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I Introduction

The present guidelines were prepared in response to the invitation of the Sixth "Environment for Europe" Ministerial Conference (Belgrade, October 2007) to the United Nations Economic Commission for Europe (ECE) "to continue its efforts, in cooperation with EEA[1] and other partners, to make monitoring an effective instrument in environmental policymaking in countries of Eastern Europe, the Caucasus and Central Asia and South-Eastern Europe" (ECE/BELGRADE.CONF/2007/8, para.7).

The format and structure of the present guidelines are the same as those of the guidelines for air and water quality monitoring, prepared by the Working Group on Environmental Monitoring and Assessment and approved by the Committee on Environmental Policy and its Extended Bureau in 2010 and 2011, respectively.[2]

The aim of the present guidelines is to provide guidance to the countries of Eastern Europe, the Caucasus, Central Asia and interested countries of South-Eastern Europe (hereinafter "the target countries") to help make monitoring a practical tool for environmental policy, especially in the development of plans and strategies on biodiversity conservation and sustainable use, the mainstreaming of biodiversity conservation objectives across policy sectors and in assessing progress in achieving policy targets and the effectiveness of conservation measures. Minimization of health, environmental and socio-economic risks resulting from biodiversity loss and ecosystem degradation, as well as the maximization of benefits from biodiversity and ecosystems, are the main objectives.

While the guidelines focus on target countries as a group, they also recommend to that country-specific issues be taken into account, such as bio-geographic conditions, the diversity of national economies and established practices in biodiversity and ecosystems management for defining biodiversity monitoring networks, practices and procedures.

The guidelines are based on the assessment and evaluation of the situation with regard to biodiversity monitoring in the target countries contained in their environmental performance reviews (EPRs), prepared under the ECE EPR Programme, as well as in the report, Europe's Environment: The fourth assessment.3 The document reflects relevant experiences gained in countries of the European Union and in other countries where coherent systems of biodiversity surveillance and management have been developed and implemented.

The guidelines also take into account relevant international activities, requirements, guidance documents and recommendations, especially those developed under the United Nations Convention on Biological Diversity (CBD), the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention), the Pan-European 2020 Strategy for Biodiversity (as the principal pan-European strategy on biodiversity succeeding the Pan-European Biological and Landscape Diversity Strategy) and the ECE Joint Task Force on Environmental Indicators.

[1] European Environmental Agency.

[2] *Air and Water Quality Monitoring as Environmental Policy Tools — Eastern Europe, the Caucasus, Central Asia and South-Eastern Europe* (ECE/CEP/168). Available from http://www.unece.org/index.php?id=30339.

[3] European Environment Agency (EEA), Copenhagen, 2007. Available from http://www.eea.europa.eu/publications/state_of_environment_report_2007_1.

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II Linking biodiversity monitoring to environmental policy development and implementation

Biodiversity monitoring should become an integral part of a national biodiversity management system and a central tool to inform decision makers and the public.

National biodiversity monitoring systems (NBMSs) should pay particular attention to pressures, driving factors and policy responses through specific indicators. The effectiveness of NBMSs depends on how closely biodiversity indicators are linked to explicitly stated national policy targets in the field of biodiversity conservation and sustainable natural resource use.

It is recommended that target countries connect strengthening of their NBMSs to the implementation of their major policy and strategic documents in the field of biodiversity. For most target countries, these are likely to be the National Biodiversity Strategy and Action Plans (NBSAPs) prepared within the framework of CBD.

A realistic step-by-step approach to enhancing biodiversity monitoring is recommended, taking into account environmental, technical and economic conditions in each particular target country. Where such systems exist, their revision and step-by-step update is recommended with respect to the present state of the art.

It is recommended that biodiversity management systems include a clearly defined institutional setting, including one central competent authority responsible for the coordination of all activities within that system. Institutions responsible for permitting and for enforcement should be independent from each other.

A. Linking biodiversity monitoring to the updating, resourcing and implementation of National Biodiversity Strategies and Action Plans

The development and/or implementation of comprehensive national biodiversity monitoring systems should be integrated within the strategic objectives and action plans of NBSAPs, in line with relevant decisions and recommendations of CBD.[4]

Realistic estimates of the resources that are needed to establish, develop and implement comprehensive NBMSs should be included in NBSAPs, taking into account the guidance provided in section III.G of this report.

NBMSs should include mechanisms to measure the implementation of NBSAPs, in line with CBD decision IX/8,[5] including the implementation of specific action plans that form part of them, progress towards strategic targets related to the state of biodiversity, and trends in pressures as well as drivers.[6]

Biodiversity monitoring should be used both to measure the effectiveness of actions prescribed in NBSAPs in reaching strategic targets in terms of the state of biodiversity and ecosystems, as well as pressures and drivers. Identified shortcomings in the effectiveness of planned actions to reach biodiversity targets should be addressed through adaptive modifications of relevant action plans at the implementation and updating stages. In this way, biodiversity monitoring will be used as a

[4] I.e., decision VII/8 of the Seventh Meeting of the Conference of the Parties (COP) to CBD (UNEP/CBD/COP/7/21, annex), available from http://www.cbd.int/decision/cop/?id=7745; and recommendation XV/1 of the fifteenth meeting of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) (UNEP/CBD/SBSTTA/REC/XV/1), available from http://www.cbd.int/recommendation/sbstta/?id=12968.

[5] UNEP/CBD/COP/DEC/IX/8, available from http://www.cbd.int/decisions/cop/?m=cop-09.

[6] See Assessment of National Biodiversity Strategies and Action Plans (NBSAPS) (UNEP/CBD/COP/10/INF/11). Available from http://www.cbd.int/doc/meetings/cop/cop-10/information/cop-10-inf-11-en.pdf.

tool to check not only the implementation of specific actions and the extent to which targets are met, but also the logical framework of NBSAPs.

Country Studies on Biodiversity that have been compiled in preparation of an NBSAP may contribute to defining the baseline for NBMSs. In turn, results from NBMSs should be used to update and add in-depth trend information to national biodiversity assessments.

B. Harmonizing national biodiversity monitoring with policy development aimed at implementation of the Strategic Plan for Biodiversity 2011-2020 and with the Pan-European 2020 Strategy for Biodiversity

The CBD Strategic Plan for Biodiversity 2011–2020[7] (CBD Strategic Plan) is relevant to NBMSs because it guides the definition of national biodiversity targets, progress towards which in turn should be measured by national biodiversity monitoring systems. Therefore, it is recommended that target countries adjust their national biodiversity policy framework to the CBD Strategic Plan and reflect these adjustments in updated targets[8] and national indicators as part of their NBMSs.

While developing or updating their national biodiversity monitoring strategies, target countries should use the CBD Strategic Plan and the corresponding indicator sets developed by the CBD Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA)[9] as a flexible framework. This framework should aim at an optimal overlap with indicator sets referring to the Aichi Biodiversity Targets,[10] but should also take into account the specific conditions of geography, biodiversity and the policy framework and capacity in each target country. Priorities should be based on the documented or inferred vulnerability of elements of country's biodiversity, as well as national policy priorities.

The Pan-European 2020 Strategy for Biodiversity (Strategy 2020), which succeeds the Pan-European Biological and Landscape Diversity Strategy, emphasizes the coordinated implementation, including coordinated target setting and consequently monitoring, of all biodiversity-related multilateral environmental agreements (MEAs) throughout the pan-European region. Target countries should take into consideration the recommendations of Strategy 2020 on the exchange of expertise for the development of indicators to monitor progress in implementing the CBD Strategic Plan in collaboration with the Streamlining European 2010 Biodiversity Indicators (SEBI) initiative[11] and the Biodiversity Indicators Partnership.[12]

[7] UNEP/CBD/COP/DEC/X/2, decision X/2. Available from http://www.cbd.int/decision/cop/?id=12268.

[8] "Regional and Sub-Regional Capacity-building Workshops for implementing the Strategic Plan for Biodiversity 2011-2020 through National Biodiversity Strategies and Action Plans", available from http://www.cbd.int/nbsap/workshops2.shtml.

[9] See UNEP/CBD/SBSTTA/REC/XV/1, annex I.

[10] Ibid.

[11] Biodiversity Information System for Europe, http://biodiversity.europa.eu/topics/sebi-indicators.

[12] See http://www.bipindicators.net/.

C. Integrating biodiversity monitoring with policy development on the implementation of biodiversity-related multilateral environmental agreements other than the Convention on Biological Diversity and with policy development on natural resource use, including forestry

The CBD Strategic Plan is not restricted to CBD, but reflects an integrated approach to all biodiversity-related MEAs, including the Convention on International Trade in Endangered Species of Wild Fauna and Flora, the Convention on the Conservation of Migratory Species of Wild Animals, the Convention on Wetlands of International Importance especially as Waterfowl Habitat and the Convention Concerning the Protection of the World Cultural and Natural Heritage.[13] Consequently, linking NBMSs to the CBD Strategic Plan and corresponding NBSAP targets would help target countries monitoring progress in their implementation of many biodiversity-related MEAs.

While designing and updating targets and indicators of their NBMSs, target countries Party to the Bern Convention should also take into account their commitments under this Convention, particularly regarding the development of the Emerald Network of Areas of Special Conservation rest.[14] The respective targets should be integrated into NBMSs and progress monitored accordingly.

Policy on biodiversity conservation and on natural resource use, including forestry and fisheries, are closely interlinked and monitoring systems in both spheres should be equally closely interlinked by target countries.

D. International, including subregional, cooperation on biodiversity monitoring

Target countries should seek close international cooperation, including at the subregional level, while modernizing and upgrading their NBMSs. International cooperation in biodiversity monitoring offers a number of benefits, including:

(a) Improved standardization, and hence comparability, of monitoring data between target countries, which facilitates integration of monitoring results at subregional and regional scales;

(b) More consistent, and therefore more reliable, monitoring of migratory species, e.g., along flyways of migratory birds;

(c) Potential cost-sharing in the process of indicator development, and development of data management and processing methodologies;

(d) A strengthened basis for the joint understanding of bilateral, subregional or regional biodiversity-related challenges and the joint development of policy responses to them.

[13] See summary of the first high-level retreat among secretariats of biodiversity-related Conventions, available from http://www.cbd.int/cooperation/doc/report-hlr-2010-09-01-en.pdf.

[14] Council of Europe, available from http://www.coe.int/t/dg4/cultureheritage/nature/econetworks/Emeraldnetwork_en.asp.

A highly relevant area for regional and subregional cooperation between target countries is the cooperative monitoring of migratory species (such as migratory birds and fish) and of transboundary ecosystems, such as river catchments and enclosed seas.

The SEBI initiative is an example of a regional partnership that has aimed at developing and consistently applying a core set of indicators throughout the pan-European region.[15] Many of the indicators developed by this initiative are now being used by numerous European countries, as well as at the EU and pan-European level.[16]

E. Including ecosystem services in national biodiversity monitoring systems

Strengthened or newly developed NBMSs should include indicators on the status and trends of ecosystem services and the socio-economic benefits offered by them.

Existing national biodiversity monitoring systems following the Driving Forces-Pressures-State-Impacts-Responses (DPSIR) framework typically emphasize the state of biodiversity with the positive and negative factors impacting it. The Responses-Pressures-State-Benefits (RPSB) framework developed for monitoring progress relating to the CBD Strategic Plan complements this with a clear focus on benefits, particularly related to ecosystem services.

Ecosystem services are a highly relevant additional policy focus because they highlight the wider socio-economic support function[17] of biodiversity and ecosystems and therefore provide information relevant to the mainstreaming of biodiversity conservation objectives across economic sectors. This information should be used to its full potential in the interministerial and intersectoral discourse.

The indicator framework developed for the CBD Strategic Plan comprises indicators related to ecosystem services under Strategic Goal D. Target countries should consider adapting and including these indicators in their NBMSs.

Target countries should consider using a recently developed site-based assessment and monitoring toolkit for ecosystem services,[18] as a simple practical means of data collection on the state and trends of ecosystem services, and particularly on the consequences (in terms of ecosystem service delivery) of alternative management scenarios at the site and national levels.

F. Integrating biodiversity monitoring with climate change mitigation and adaptation policies

The integration of biodiversity monitoring with climate change mitigation and adaptation policies needs to be based on a clear understanding of both the interdependence of biodiversity

[15] See http://www.eea.europa.eu/data-and-maps/indicators/#c5=biodiversity&c7=all&c0=10&b_start=0&c10=SEBI.

[16] See http://www.eea.europa.eu/publications/streamlining-european-biodiversity-indicators-2020.

[17] de Groot et al., "Integrating the ecological and economic dimensions in biodiversity and ecosystem service valuation" in *The Economics of Ecosystems and Biodiversity (TEEB): Ecological and Economic Foundations*, Pushpan Kumar (ed.) (London, Earthscan/Routledge, 2010), p. 21, table 3. Available from http://www.teebweb.org/wp-content/uploads/2013/04/D0-Chapter-1-Integrating-the-ecological-and-economic-dimensions-in-biodiversity-and-ecosystem-service-valuation.pdf.

[18] United Nations Environment Programme World Conservation Monitoring Centre, *Measuring and Monitoring Ecosystem Services at the Site Scale: introducing a practical toolkit*, available from http://www.unep-wcmc.org/a-toolkit-for-measuring-ecosystem-services-at-the-site-scale-is-released_751.html.

and ecosystems and climate change with its impacts. The target countries' integration efforts therefore need to focus on two key interactions:

(a) Climate change affects biodiversity and ecosystem function and hence needs to be integrated into national biodiversity monitoring concepts as a key pressure. Analogously, those climate change mitigation measures that do not harm biodiversity and ecosystems can be classified as a policy response to climate change-induced biodiversity loss in monitoring systems;

(b) Biodiversity can contribute to climate change mitigation (e.g., forest ecosystem-based mitigation) and adaptation (ecosystem-based adaptation). Therefore, biodiversity conservation efforts and impacts should be monitored not only as policy responses to biodiversity loss, but also as policy responses to climate change.

In practical terms, target countries should, on the one hand, include targets addressing climate change impacts on biodiversity in their national policy framework for climate change adaptation and mitigation; NBMSs should be optimized to measure climate change impact and progress towards these targets, based on available indicators.[19] On the other hand, target countries should plan, measure and report on the contribution of their biodiversity conservation activities and sustainable use (as detailed in NBSAPs) to reaching climate change mitigation and adaptation targets.

Parties to the United Nations Framework Convention on Climate Change (UNFCCC) have committed to promote systematic observation and development of data archives related to the climate system,[20] which includes biodiversity, and to submit documentation on the impacts on biodiversity and natural systems of proposed Clean Development Mechanism afforestation or reforestation project activities.[21] It is recommended that target countries use their NBMSs to collect the data needed to fulfil these requirements.

Target countries should also monitor indirect effects of climate change, including those of mitigation strategies such as the cultivation of biofuels. Biofuel production can have significant negative impacts on biodiversity, for instance, as a consequence of the conversion of natural ecosystems or biodiversity-rich agricultural ecosystems to biofuel monocultures — such as corn — or through excessive use of agrichemicals in biofuel cultivation. These impacts and the resulting changes in the state of biodiversity should be measured by using and adapting existing indicators, such as those on ecosystem coverage,[22] areas under agricultural management practices potentially supporting biodiversity[23] or the farmland bird population index.[24]

G. Integrating biodiversity monitoring with modelling and mapping activities

Target countries should consider complementing the development of NBMSs with the application of modelling techniques, to the extent practicable, for such purposes as analysis of the relative impact of anthropogenic pressures on biodiversity (past, present and future), and the elaboration of future scenarios.

[19] Secretariat of CBD, *Connecting Biodiversity and Climate Change Mitigation and Adaptation: Report of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change*, CBD Technical Series No. 41 (Montreal, 2009), p. 25. Available from http://www.cbd.int/doc/publications/cbd-ts-41-en.pdf.

[20] See article 4 of UNFCCC.

[21] FCCC/CP/2003/6/Add.2, decision 19/CP.9.

[22] See http://www.eea.europa.eu/data-and-maps/indicators/ecosystem-coverage/ecosystem-coverage-assessment-published-may-2010

[23] See http://www.eea.europa.eu/data-and-maps/indicators/agriculture-area-under-management-practices/agriculture-area-under-management-practices.

[24] See http://archive.defra.gov.uk/evidence/statistics/foodfarm/enviro/observatory/indicators/d/de5_data.htm.

While modelling techniques can complement practical biodiversity monitoring on the ground, they cannot replace it. Existing modelling approaches emphasize that the precision and accurateness of model predictions on biodiversity is constrained by the accuracy and comprehensiveness of the data input.

For predictive and analytical modelling, it is recommended that target countries use and adapt existing generic biodiversity and land-use models and tools such as the Globio-3,[25] CLUE-s,[26] and EcoOcean[27] models, to support their modelling activities. These models have been tested widely, are applicable at the national level to varying degrees, and are compatible with global models.

The application of Geographic Information System (GIS)-based habitat mapping — also in combination with remote sensing data — can help to interpolate species and habitat data and thereby fill gaps in the monitoring grid. Target countries are therefore encouraged to explore the application of GIS-based habitat mapping techniques to complement their NBMSs.

Remote sensing tools are increasingly applied to map and monitor biodiversity at larger scales — particularly at the regional and global scales. There is also significant potential for their application in the framework of national biodiversity monitoring in both the terrestrial and the aquatic realm. Once established, remote sensing approaches to biodiversity monitoring are typically highly cost-effective. Target countries, particularly those with a large area in need of monitoring, should therefore consider the use of remote sensing technology with suitable indicators, including but not limited to the following:

(a) *Trends in land cover and land use*: Satellite-based remote sensing tools are available for monitoring changes in land cover, for instance, for heath lands and forest,[28] as well as the use and conservation status of grasslands.[29] These tools will be increasingly integrated into NBMSs;

(b) *Trends in the conservation status of high-conservation value habitat types*: Remote sensing data have been used to assess the conservation status (including NATURA 2000 quality parameters) of high-conservation value habitats, such as woodland and heath habitats;[30]

(c) *Wetland distribution and status, i.e., wetness/dryness*: Satellite imagery has been used successfully to monitor the distribution, extent and status (e.g., wetness) of coastal and freshwater wetlands.[31] The routine inclusion of wetness indices like the Normalized Difference Water Index into wetland monitoring is also currently being explored in the United Kingdom.[32]

[25] See http://www.globio.info/home.

[26] See http://www.ivm.vu.nl/en/Organisation/departments/spatial-analysis-decision-support/Clue/index.asp.

[27] Jackie Alder et al., *Ecosystem-Based Global Fishing Policy Scenarios*, Fisheries Centre Research Reports, vol. 15, No. 7 (Vancouver, Canada, The Fisheries Centre, University of British Columbia, 2007). Available from http://www.globio.info/downloads/270/EcoOcean%20Alder%20et%20al%202007.pdf.

[28] See, e.g., DeCOVER 2, Space-based services for German land cover (http://www.de-cover.de/public/DeCOVER_Brochure_engl_V1_1_small.pdf).

[29] Jonas Frankea, Vanessa Keucka and Florian Sieger, "Assessment of grassland use intensity by remote sensing to support conservation schemes", *Journal for Nature Conservation*, vol. 20, No. 3 (June 2012), pp. 125–134. Available from http://www.sciencedirect.com/science/article/pii/S1617138112000234.

[30] M. Förster et al., "Approaches to utilising QuickBird data for the monitoring of NATURA 2000 habitats", *Community Ecology*, vol. 9, No. 2 (December 2008), pp. 155–168. Available from http://www.akademiai.com/content/mx32w18805632n58/.

[31] Liesbeth Bortels et al., "Long-term monitoring of wetlands along the Western-Greek Bird Migration Route using Landsat and ASTER satellite images: Amvrakikos Gulf (Greece)", *Journal for Nature Conservation,* vol. 19, No. 4 (September 2011), pp. 215–223. Available from http://www.sciencedirect.com/science/article/pii/S1617138111000057.

[32] Joint Nature Conservation Committee, "Making Earth Observation work for UK biodiversity conservation". Available from http://jncc.defra.gov.uk/default.aspx?page=5563%20 (accessed 18 July 2013).

The application of remote sensing methodology to biodiversity monitoring is still an emerging field. While there are many examples of this application from scientific studies, its introduction to large-scale policy-orientated monitoring schemes (such as NATURA 2000 monitoring) is ongoing. Target countries should therefore establish close two-way communication between agencies responsible for the technical implementation of biodiversity monitoring and those involved in remote sensing in order to overcome the knowledge gap between the two communities.

Remote sensing approaches to biodiversity monitoring are a promising field for cooperation between target countries, because cooperation offers benefits related to standardization of monitoring approaches between countries and the sharing of development costs.

H. Target setting

Target setting for the biodiversity policy and planning framework, as well as in the context of biodiversity monitoring, needs to be preceded by a detailed analysis of available biodiversity data and information (supported by modelling, such as habitat modelling, to the extent possible and appropriate), in order to define the baseline from which biodiversity management activities and the corresponding monitoring system start.

Targets cannot be defined by baseline information and existing monitoring data alone because they are a matter of societal choice. This is not only true for overall policy targets but, to a considerable extent, also for more specific technical targets, which are subject to trade-offs and prioritization, as well as a multitude of financial, cultural, logistical, ethical and social factors.

Targets should be constructed under the SMART (Specific, Measurable, Achievable, Realistic, Timely) concept and structured as main targets (e.g., targets in relation to the state of biodiversity or trends in threats and pressures) and complementary technical targets (e.g., development of biodiversity monitoring networks, institutional settings, mechanisms for preparation of indicator baselines, etc.).

Main targets in the field of biodiversity should address the following priority areas:

(a) The state of biodiversity, including species, habitats and ecosystems;

(b) Pressures (both anthropogenic and natural) on biodiversity and their driving forces;

(c) Benefits received from biodiversity, e.g., from ecosystem services;

(d) Policy and management responses to changes in the state of biodiversity, pressures, driving forces and benefits.

Main targets in the field of biodiversity management should be mutually coordinated and focused on the minimization of negative environmental and socio-economic effects, as well as the maximization of benefits.

Complementary technical targets should be related to the main targets (especially with regard to timing) to create conditions both for setting the main targets and for the assessment of compliance. This should be reflected in indicator hierarchies of NBMSs, for instance, through differentiation between headline and operational biodiversity indicators.[33]

[33] UNEP/CBD/SBSTTA/REC/XV/1, annex I.

In setting the targets, both country-specific issues (e.g., geographic conditions, state-of-the-environment, environmental commitments at the international level and general policy trends) and economic assessment of achievability should be taken into account.

Realistic timing of targets is strongly recommended, following a prioritization of problems based on detailed analysis. A stepwise and flexible approach to the timing of compliance with targets is recommended as well.

I. Better use of biodiversity monitoring data

1. Permitting

All target countries have introduced permitting procedures for activities which may have an impact on biodiversity and ecosystems, including natural resource use (hunting, fishing, collection of wild plants) and infrastructure development. In this respect, results of biodiversity monitoring, preferably in combination with modelling (or at least expert assessment) are necessary to decide on development projects or other activities which may affect biodiversity or ecosystems. Results of biodiversity monitoring should be used during the process of environmental impact assessment or environmental expertise as a baseline against which the estimate of the incremental impact on biodiversity caused by the implementation of the project is assessed.

The target countries are recommended to extend the use of biodiversity monitoring data in combination with modelling tools, such as habitat modelling tools, in permitting processes. Habitat modelling tools can help to extrapolate monitoring data to areas for which no direct monitoring data are available, but where there may be strong impacts on biodiversity and ecosystems.

2. Use by the business sector

The results of national biodiversity monitoring activities should also be made available to and actively promoted among the business sector (including environmentally sensitive industries such as forestry, fisheries, extractive industries, etc.) in order to support the minimization of impacts of business operations on biodiversity and ecosystems (for instance, within the framework of voluntary commitments of businesses to environmental risk minimization), and to help business direct activities within their Corporate Social Responsibility portfolios towards meaningful environmental purposes. Monitoring results should be used specifically to inform site selection for industrial developments, impact minimization and mitigation measures, and site rehabilitation programmes.

3. Prioritization of conservation investments and actions

Biodiversity monitoring results should be used extensively and systematically to prioritize conservation investments and programmes, including those related to protected areas, species conservation, sustainable use of natural resources and the mainstreaming of biodiversity across sectors. Monitoring results are a suitable information base for this because they identify trends in the status of biodiversity and ecosystems and the aggravation of threats, pressures and their root causes, as well as the suitability and sufficiency of existing conservation programmes.

It is crucial that national mechanisms are created to share and discuss the results of NBMSs with the entire stakeholder community in target countries, including non-governmental organizations (NGOs), academic institutions, natural resource users and interested businesses, in order to enable them to use monitoring results for the prioritization of their conservation actions in the same way as Government institutions. The acceptance of conservation priorities informed by

biodiversity monitoring systems throughout the stakeholder community will be the greater the more participative the monitoring system itself is.

4. Communication, education and public awareness-raising

Biodiversity monitoring results are an invaluable resource for communication, education and public awareness (CEPA)-raising activities in target states, which should be used to its full potential. They can also support campaigns to change unsustainable patterns of consumption, resource use and behaviour by showing the consequences of unsustainable patterns for biodiversity and ecosystem values.

Results from biodiversity monitoring are particularly important for inter-agency communication aimed at mainstreaming of biodiversity and ecosystem conservation objectives among Government agencies at all levels, and systematic efforts should be made by ministries of the environment to maximize the impact of monitoring results in this regard. Mainstreaming of biodiversity conservation across sectors is at the same time a central goal of the CBD Strategic Plan. Scientifically well-founded, consistent, long-term data sets from biodiversity monitoring systems provide strong arguments for inter-agency negotiations aimed at biodiversity mainstreaming and their use in this regard should therefore be maximized by target countries.

In order to meet their full potential as resources for CEPA, biodiversity monitoring data should be published both in print and online in easily accessible formats for various target groups, including the education sector, the media, NGOs active in the nature conservation field and the general public. Online databases on monitoring data should include suitable tools for data selection and transfer to facilitate their use.

5. Analysis and reporting

NBMSs produce long-term data sets that are a useful basis for analysis and scientific research, including into long-term biodiversity trends, emerging threats, such as invasive alien species, and climate change trends and impacts. They should be designed in a way that optimizes the suitability of the resulting data sets for further analysis, taking into account other more immediate data uses. This may entail the participation of academic institutions in the development of biodiversity monitoring systems.

Target countries which do not yet include data on the status and trend of biodiversity and ecosystems in their national state-of-the-environment reports are urged to do so. As national environmental reports are produced for policymakers as well as for the public, the data on biodiversity should be accompanied by detailed interpretation of these data in relation to national environmental policy and MEA commitments.

NBMSs should be used for reporting under CBD, particularly during preparation of national reports to CBD, in line with CBD guidance on indicator-based reporting.[34] The reporting commitments of target countries under CBD and other MEAs provide an additional incentive to update or develop NBMSs.

[34] Available from http://www.cbd.int/nr5/.

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III Modernizing and upgrading national biodiversity monitoring and information systems

Within the framework of the development of policy and management systems for biodiversity, the target countries are recommended to prepare and implement programmes for the creation or modernization and upgrading of NBMSs (including institutional set-ups and partnerships, monitoring networks, data quality management and information systems). The main objective of these programmes is to create modern systems that respond to the information and policymaking needs of the target countries and operate on the basis of best available techniques, methodologies and good practices available in the ECE region and worldwide. NBMSs should be integrated with international networks/systems, to the extent possible.

A. Development of a conceptual framework for national biodiversity monitoring systems, based on international best practice

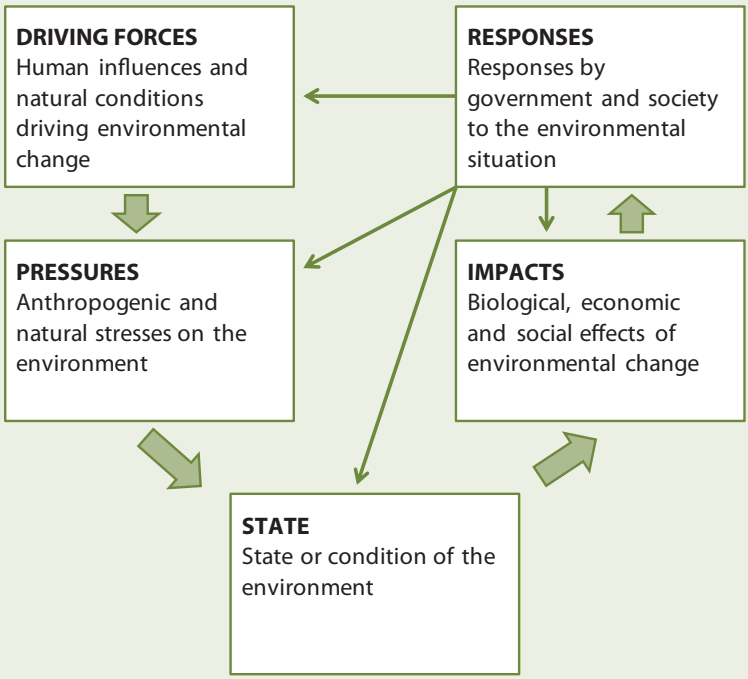
NBSMs should be based on an explicitly stated, consistent conceptual framework, which reflects cause-effect relationships that determine states and trends of biodiversity and ecosystems. Such a framework is necessary to identify evidence needs, to link biodiversity monitoring systems to policy objectives and actions and to structure indicator sets in a meaningful manner.

It is recommended that target countries base the development of their national conceptual frameworks on internationally established and tested frameworks, such as the DPSIR framework of the European Environmental Agency (EEA) and the RPSB framework of the CBD Strategic Plan, which was developed as a conceptual model for communicating biodiversity information. The DPSIR and RPSB frameworks overlap significantly, rather than being mutually exclusive, as RPBS is loosely based on the DPSIR framework.

1. The DPSIR framework of EEA

The DPSIR framework (Box 1) is used for environmental indicator frameworks including and beyond biodiversity indicator systems, and is therefore particularly useful where biodiversity monitoring systems are integrated in and developed as part of wider environmental monitoring systems. It essentially provides a classification of biodiversity indicators in the five categories listed in its name, including a conceptual model about the interactions between these categories.

Box 1 The DPSIR framework for environmental indicators



Source: EEA (http://root-devel.ew.eea.europa.eu/ia2dec/knowledge_base/Frameworks/doc101182).

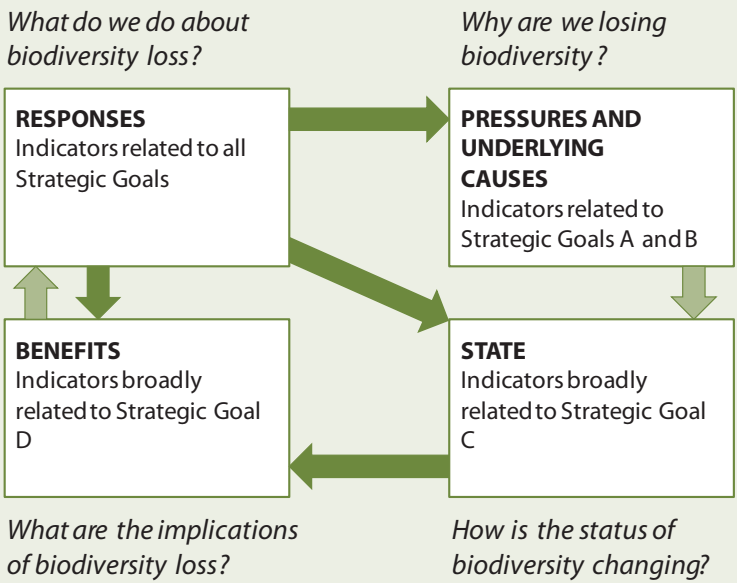
The DPSIR framework, with its clear differentiation between state, pressures and driving forces, can also be used as a tool to assemble evidence along cause-effect chains, to identify areas where policy interventions may have particular impact, and to decide what evidence may be effective in highlighting impacts. This potential should be explored by target countries for use within their NBMSs.

2. The RPSB framework of CBD

The RPSB framework (Box 2) is closely aligned with the goals of the CBD Strategic Plan. It explicitly includes benefits (corresponding to Goal D of the Strategic Plan) and is of particular policy relevance for target countries that have aligned the strategic goals of their NBSAPs with the Strategic Plan. According to SBSTTA recommendation XV/1, this conceptual framework supports communication of biodiversity information around the four overarching policy questions (Box 2), which are loosely based on the DPSIR framework.

In SBSSTA decision XV/1, the RPSB framework complements an indicative list of biodiversity indicators proposed for each of the Aichi Biodiversity Targets, for use at both the global and national levels. Together with the indicative list of indicators, it offers target countries a consistently

Box 2 The RPSB (responses, state, pressures and underlying causes, benefits) framework for biodiversity indicators



Source: UNEP/CBD/SBSTTA/REC/XV/1, annex II.

structured, detailed framework for adaptation and application in the course of the development of national indicator sets and biodiversity monitoring systems and communicating biodiversity information. This is a key advantage of the RPSB framework, which target countries should consider when choosing a conceptual framework for the establishment or further development of their NBMSs.

Through its explicit reference to the CBD Strategic Plan, the RPSB framework provides for close linkages between the monitoring of biodiversity at the national and global levels, and for the harmonization of NBMSs throughout the pan-European region as well as globally.

B. Application of available international guidance in biodiversity monitoring

In the process of developing and implementing their programmes for the creation or modernization and upgrading of their NBMSs, target countries will benefit from available international guidance.

1. Biodiversity Indicator Partnership

The CBD-mandated Biodiversity Indicators Partnership (BIP) is the global initiative to promote and coordinate development and delivery of biodiversity indicators in support of MEAs, the

Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES), national and regional governments and other stakeholders.[35] BIP brings together over 40 organizations working internationally on indicator development to provide the most comprehensive information on biodiversity trends.

2. Red List of Threatened Species of the International Union for the Conservation of Nature

Although the species level is only one level in a hierarchy ranging from genes to ecosystems, biomes and the biosphere as a whole, it remains a key level of impact for pressures on biodiversity, a key level for interventions to conserve biodiversity and, consequently, an important focus for biodiversity monitoring programmes.

The Red List of Threatened Species of the International Union for the Conservation of Nature (IUCN) is the leading tool for describing and evaluating the global status and trends of species diversity, as well as pressures affecting it. It has been used to construct biodiversity indicators such as the Red List Index,[36] which has been adopted as an indicator of the Millennium Development Goals and the Aichi Biodiversity Targets.

In order to increase the effectiveness of the IUCN Red List as a support tool for national and global biodiversity monitoring efforts, target countries should take actions to improve information flow between national biodiversity monitoring systems and the IUCN Red List, in both directions:

(a) Target countries should support national experts in making data on the status and trends of globally threatened species on their territory available to the IUCN Species Information Service, so that global threat categories and assessments reflect the situation in target countries as accurately as possible;

(b) Target countries should use the information available from the IUCN Red List to evaluate national biodiversity monitoring results, particularly aiming at identifying those globally threatened species for which they have a special global responsibility, because of the irreplaceability of populations on their territory, from a global perspective.

Most target countries already maintain national red lists or red data books of nationally threatened species of flora and fauna. It is recommended that those target countries that have not yet done so harmonize the categories, criteria and methodologies used for the compilation of their national red lists with those of the global IUCN Red List of Threatened Species, following the specific guidance of IUCN on national red lists.[37] This will contribute to both more consistent and transparent national red lists and a greater compatibility with the global IUCN Red List.

Efforts are under way to develop an IUCN Red List of Ecosystems.[38] Target countries are encouraged to follow these developments and to consider integrating them into the development of their NBMSs as and when they become available for general use.

[35] See http://www.bipindicators.net/.

[36] P. J. Bubb et al., *IUCN Red List Index — Guidance for National and Regional Use* (Gland, Switzerland, IUCN 2009). Available from http://cmsdata.iucn.org/downloads/rli_guidelines_final_4march09_1.pdf.

[37] Ulf Gärdenfors et al., 2001, "The application of IUCN Red List Criteria at regional levels". *Conservation Biology*, vol. 15, No. 5, pp. 1206–1212. Available from http://www.redeprofauna.pr.gov.br/arquivos/File/artigos/regionalapplication.pdf.

[38] Jon P. Rodriguez et al., "Establishing IUCN Red List Criteria for Threatened Ecosystems", *Conservation Biology*, vol. 25, No. 1 (February 2011), pp. 21–29. Available from http://onlinelibrary.wiley.com/doi/10.1111/j.1523-1739.2010.01598.x/full.

3. International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects in Forests

The International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) is a pan-European forest monitoring programme that operates under the ECE Convention on Long-range Transboundary Air Pollution.

The programme focuses on monitoring and assessment of forest ecosystems, one of the key elements of biodiversity and at the same time one of the economically most important biodiversity resources in the pan-European region. The programme offers technical guidance (both through manuals[39] and publications and through the expert network that forms part of its institutional structure[40]) on key aspects of forest monitoring in relation to air pollution impacts. Therefore, the countries that have not yet done so should consider joining ICP Forests and commence participation in the forest assessment and monitoring activities of the programme.

In most target countries, forest monitoring and hence the implementation of ICP Forests is the responsibility of the State Forest Agency or similar non-commercial State agencies either under the ministry of the environment or other ministries. In these countries, appropriate procedures should be defined to ensure information flow between the institutions responsible for implementation of forest monitoring and the institution responsible for the coordination of NBMSs, in line with the recommendations in section IV.A below.

4. Institutionalization of protected areas management effectiveness assessment and monitoring

Protected areas are a key instrument to respond to biodiversity loss. The effectiveness of protected areas management is as crucial for the functioning of national protected area systems as the number of coverage area. Therefore, countries should institutionalize regular assessments of the effectiveness of their protected area systems as an integral part of their biodiversity monitoring, based on available and tested international guidance such as the World Wildlife Fund's Rapid Assessment and Prioritization of Protected Areas Management (RAPPAM) tool.[41]

C. Principles and practical stepwise approach to setting up or upgrading national biodiversity monitoring systems

The setting up or upgrading of NBMSs should be based on the following general principles:

(a) *Relevance to policy questions*: The NBMS should focus on providing information that is needed to answer the most important national policy questions (e.g., those referring to trends in important national biodiversity values or to trends in known pressures) or measure progress towards the most important policy objectives (e.g., those formulated in NBSAPs);

(b) *Scientific basis and methodological best practice*: The NBMS should use biodiversity indicators that are based on sound science and methodological best practice. One typical way of achieving this will be the application and adaptation of established indicator protocols such as the SEBI indicator set;

[39] *ICP Forests Manual* (electronic manual), available from http://icp-forests.net/page/icp-forests-manual

[40] Available from http://icp-forests.net/page/bodies-structure.

[41] Avaiable from http://wwf.panda.org/what_we_do/how_we_work/conservation/forests/tools/rappam/.

(c) *Transparency of methodologies and accessibility of data*: In order to maximize the use of NBMS outputs, the methodologies used (indicator protocols) and monitoring results should be documented and published online, so that they are accessible to all national stakeholders and potential data users;

(d) *Cost effectiveness and practicability*: For each identified policy question, the most cost-effective indicator, practical monitoring arrangements and data storage formats should be identified. Countries that are setting up new NBMSs could initially focus on a limited set of key indicators, which can later be expanded as resources allow. Additional guidance to maximize cost-effectiveness is provided in section III.I;

(e) *Cooperation*: The central competent authority for the NBMS should enlist the support of all suitable institutions to develop, upgrade and implement their NBMS, as this will contribute to cost-effectiveness, ownership among stakeholders and a wide use of monitoring data. Additional guidance on cooperation in NBMSs is provided in section IV, while section III.D shows a number of examples where such cooperation has been achieved;

(f) *Regional and subregional integration*: To the extent possible, the NBMS should be designed in such a way that it allows comparability and integration of monitoring results at the regional and subregional levels (see section II.D for detailed guidance on how this can be achieved).

Based on the above principles, the following stepwise approach to setting up or upgrading the NBMS should be taken by target countries:

(a) Key policy questions and targets should be identified from relevant national policy documents, such as NBSAPs, and/or from identified high-priority biodiversity values (e.g., species or ecosystems for which a country has a particular global responsibility), as well as pressures and threats of particular concern (e.g., known alien invasive species, land degradation/desertification pressures), and prioritized. This identification and prioritization process should involve relevant biodiversity policy stakeholders, such as Government institutions, Academia and conservation NGOs. It should be specified clearly what information needs to be obtained through monitoring in order to answer each key question or to measure progress towards each target. The institutional set-up for the NBMS should also be decided as part of this step (see section III.G);

(b) *Identify/design indicators to answer key questions*: For each policy question, a suitable indicator should be identified from generic indicator sets (and adapted if necessary), or designed anew if the latter is impossible. Adaptation or design of indicator protocols should be tasked to expert institutions that have the capacity to ensure scientific and methodological soundness. Cost-effective ways of designing and using indicators should be identified in cooperation with stakeholders;

(c) Once the indicator set of the NBMS including the type and format of output data is defined, it should be underpinned by a data and information management system in line with the specific guidance provided in section III.F;

(d) Based on a clear understanding of the institutional set-up, indicator set and data/information management system, the resource needs for the setting up or upgrading of the NBMS can be determined and the necessary resources can be mobilized, following the detailed guidance provided in section III.I;

(e) Once the technical design of the NBMS is finalized, the institutional set-up is operational and the necessary resources have been acquired, the first cycle of data gathering, indicator calculation, communication and interpretation of results should commence. Individual indicators and the overall NBMS set-up should be refined based on the experience obtained in its initial implementation, following general adaptive management principles but ensuring comparability of monitoring results over

time. It is also possible that the outcomes of initial monitoring runs lead to a better understanding of the policy issues involved, and hence to a reformulation of policy questions or targets.

Those target countries that are upgrading an existing NBMS may already have passed through some of the steps in the above sequence. This sequence should be applied in an iterative manner. It can be entered at any step and repeated through successive cycles of monitoring, reformulation of policy questions/targets and refinement of indicators.

The Biodiversity Indicators Partnership has developed guidelines for the design and development of individual biodiversity indicators for national use, following a stepwise approach.[42] This guidance should be considered in addition to the stepwise approach for entire NBMSs as described in this section.

D. Good national practices

In order to develop and implement their programmes for the creation or modernization and upgrading of their NBMSs, target countries are encouraged to communicate and cooperate with other countries from the ECE region, in order to learn from their experience, share good national practices and coordinate national biodiversity monitoring systems.

The relevance of the approaches and experiences from countries of the ECE region to the development, modernization and upgrading of NBMSs will differ between the target countries. Consequently, there is no single good national practice that would be applicable to all target countries, while certain aspects of some national approaches may be widely applicable (see Boxes 3 and 4).

A recent example of a cost-effective, collaborative biodiversity monitoring system from a country in Eastern Europe, the Caucasus and Central Asia is the national biodiversity monitoring system of Georgia.[43] This system may offer the potential for replication in other target countries (see Box 5).

Box 3 Biodiversity monitoring in Switzerland

The Federal Office for the Environment (FOEN) launched a programme called Biodiversity Monitoring in Switzerland (BDM). BDM focuses on surveying common and widespread species. By surveying these species in the field, BDM covers the broadest possible spectrum of species, habitats and environmental conditions. The programme uses 15 pressure indicators, 12 state indicators and 7 response indicators. It can issue early warnings and provide evidence for action before species have to be included on the Red Lists. Naturally, the programme also publishes data on rare species. A small external coordination office is responsible for BDM and organizes the annual gathering of data. It is responsible for data management, evaluation, reporting and quality assurance. The field surveys for the main indicators of common and widespread species are put out for bid, and contracts have been awarded to the most qualified applicants for a survey period covering several years. The coordination office performs its own surveys at particularly complex sites.

Data collection for rare species relies on institutions that already deal routinely with the respective species groups. The institutions in this category are primarily the Swiss Centre for Fauna Cartography, the Swiss Flora Network Centre, the Swiss Ornithological Station, the Swiss Amphibian and Reptile Conservation Programme and the Swiss Society for Wildlife Biology.

The annual costs for the Swiss NBMS are approximately CHF 3 million.

Source: Federal Office for the Environment (http://www.biodiversitymonitoring.ch/en/home.html).

[42] See http://www.bipnational.net/.

[43] See http://biomonitoring.moe.gov.ge/index.php?lang_id=ENG&sec_id=0.

E. Indicator sets, monitoring grids and frequency

Biodiversity indicators are the core part of NBMSs, and target countries should focus their efforts to develop NBMSs on the establishment of scientifically sound, relevant (in relation to policy targets and biodiversity), realistic (in terms of national capacity and resources to implement monitoring systems) and balanced (in terms of the coverage of state, pressures/drivers and benefits of biodiversity, as well as policy responses) indicator sets. In doing so, they should pay attention to both international good practices and the peculiarities of the situation (e.g., geography, particular biodiversity values of global importance, policy framework) in each target country.

Indicator sets for biodiversity monitoring in target countries — whether framed by the DPSIR or the RPSB framework — will always consist of highly heterogeneous indicators. They include indicators focused on variables on various scales (from trends in selected species to land cover changes according to satellite imagery), and indicators on the state of natural values as well as on the effectiveness of policy and management actions. This constitutes a key difference between biodiversity monitoring systems and other systems for environmental monitoring, such as air quality monitoring. This difference entails a number of peculiarities of NBMSs, which are discussed in this and the following sections.

Sampling points and frequencies are different for each biodiversity indicator, but there are cases where several indicators can be informed by one monitoring effort. Therefore, it is recommended that indicators with their respective sampling grids and protocols are developed separately. In a subsequent step, possibilities for aggregating monitoring activities contributing to several indicators can be identified and monitoring protocols adjusted accordingly.

Box 4 The Biological Records Centre of the United Kingdom of Great Britain and Northern Ireland and the National Biodiversity Network

The Biological Records Centre (BRC), established in 1964, is a national focus in the United Kingdom for terrestrial and freshwater species recording. BRC works closely with the voluntary recording community, principally through support of national recording schemes and societies. Together with the National Biodiversity Network (NBN), it supports the standardization, collation, publication and use of species-related biodiversity data in the United Kingdom, as well as web-based public access to data. The data collated through this network are used to inform relevant indicators of the national biodiversity monitoring system, among other uses.

The NBN consists of more than 70 governmental and non-governmental organizations and the BRC is supported by almost 100 individuals, expert groups and NGOs that contribute biodiversity monitoring data, which can then be fed into the national biodiversity monitoring system. This allows for a much wider coverage of biodiversity than could be achieved by Government staff alone.

The BRC and NBN have enabled the collation of presence data (distributions) for 120,000 species (40+ million observations) from thousands of volunteers; trend estimates are possible for some 3,000 species.

Examples of related expert and volunteer network contributions to United Kingdom biodiversity monitoring include:

(a) A Breeding Birds Survey on 3,000 one-kilometre squares by 2,500 volunteers, three times a year (http://www.bto.org/bbs/index.htm);

(b) The United Kingdom Butterfly Monitoring Scheme on 1,000 transects by several hundreds of volunteers, annually (http://www.ukbms.org/).

Source: Biological Records Centre (http://www.brc.ac.uk/default.htm) and National Biodiversity Network (http://nbn.org.uk/Home.aspx).

Target countries will benefit from outsourcing the development and implementation of individual biodiversity indicators from the central competent authority to other institutions with relevant expertise and experience, where appropriate.

It is recommended that target countries develop their national indicator sets on the basis of existing sets of biodiversity indicators that have been tested widely, are aligned with international targets and are consistently used across the pan-European region and worldwide. Generic indicator sets of particular policy relevance are those of the CBD Strategic Plan, the SEBI indicator set and biodiversity indicators developed by the ECE Joint Task Force on Environmental Indicators.

The ECE Joint Task Force on Environmental Indicators is providing guidance to countries of Eastern Europe, the Caucasus and Central Asia and South-Eastern Europe on data collection and calculation methods for the biodiversity and biodiversity-related indicators included in the ECE Guidelines for the Application of Environmental Indicators in Eastern Europe, the Caucasus and Central Asia,[44] as well as additional documentation of newly developed indicators (see Box 6).

Box 5 The National Biodiversity Monitoring System of Georgia as an example of a cost-effective, collaborative biodiversity monitoring system from a country in Eastern Europe, the Caucasus and Central Asia

The NBMS of Georgia was established by a governmental initiative under the guidance of the Ministry of Environment and Natural Resources Protection of Georgia. The process started in 2009 and has been supported by the German Agency for International Cooperation.

The NBMS uses 26 biodiversity indicators within a pressure-state-response model, which is compatible with the DPSIR framework. Among the 26 indicators are 11 pressure indicators, 6 state indicators and 9 response indicators.

The implementation of the NBMS of Georgia is managed by a task group, which consists of relevant ministerial departments and agencies as well as NGOs. Additional national organizations and entities with a capacity and interest in biodiversity monitoring are invited to participate in the NBMS. This includes governmental and non-governmental organizations, consulting companies and scientific institutions. All participating organizations are invited to register for their involvement in NBMS at the Biodiversity Protection Service of the Ministry of Environment and Natural Resources Protection. These organizations form a non-formal consultative group to the NBMS. The collaborative nature of the NBMS also contributes to minimizing its costs.

The overall list of indicators and the monitoring methodologies for 17 of them were approved by Normative Act in December 2012. Up to now, calculations/recalculations have been conducted for 10 indicators. An interpretation of the results has been prepared and published in the form of "Bio-trends" for four indicators, including on landscape fragmentation, intensity of fisheries, forest area and total area of protected areas.

Source: Biodiversity Monitoring of Georgia website (http://biomonitoring.moe.gov.ge//index.php?lang_id=ENG).

The SEBI 2010 initiative, launched in 2005, was to select a set of indicators to measure and help achieve progress towards the pan-European target to halt biodiversity loss by 2010. Twenty-six indicators were selected, many of which refer to ecosystem-level trends and processes (Box 7). This set is currently being revised and streamlined with the EU Biodiversity Strategy for 2020 and the Pan-European 2020 Strategy for Biodiversity.

[44] See *Environmental Indicators and Indicator-based Assessment Reports: Eastern Europe, Caucasus and Central Asia* (United Nations publication, Sales No. E 07.II.E.9), part one. Available from http://www.unece.org/fileadmin/DAM/env/documents/2007/ece/ece.belgrade.conf.2007.inf.6.e.pdf.

Box 6 Biodiversity and biodiversity-related indicators from the ECE Guidelines for the Application of Environmental Indicators in Eastern Europe, Caucasus and Central Asia and related documents (numbering per ECE Guidelines)

Pressures and drivers

4. Air temperature
13. Biological oxygen demand and concentration of ammonium in rivers
14. Nutrients in freshwater
15. Nutrients in coastal seawaters
16. Polluted (non-treated) wastewaters
21. Land uptake
22. Area affected by soil erosion
23. Fertilizer consumption
24. Pesticide consumption

Invasive alien species (adopted in 2012)

Catches of fish and other aquatic animals, aquatic animal products and aquatic plants (under consideration)

Concentration of pollutants in coastal seawater and sediments (except nutrients) (adopted in 2012)

State

19. Threatened and protected species (threat aspect)
20. Trends in the number and distribution of selected species

Responses

17. Protected areas
18. Forests and other wooded land
19. Threatened and protected species (protection aspect)

Biosphere reserves and wetlands of international importance (adopted in 2012)

For each of the indicators, the guidelines and additional indicators adopted thereafter provide a general description, information about policy relevance, methodology and data sources and multiple references at the international level. The ECE Joint Task Force on Environmental Indicators is developing recommendations to the target countries on the use of statistical classifications, data-collection methods and procedures for the production of these indicators.

Sources: (a) ECE Guidelines for the Application of Environmental Indicators in Eastern Europe, Caucasus and Central Asia; and (b) revised informal notes by the secretariat to the fifth session of the Joint Task Force on Environmental Indicators (Geneva, 4–6 July 2012) on indicators of biological diversity not covered by the Guidelines (http://www.unece.org/fileadmin/DAM/stats/documents/ece/ces/ge.33/2012/mtg2/Add.Indicators.Biodiversity.En.29.05.2012.pdf) and on indicators of inland and seawater not covered by the Guidelines (http://www.unece.org/fileadmin/DAM/stats/documents/ece/ces/ge.33/2012/mtg2/Water-Additional-Indicators-eng.01.06.12.pdf).

Box 7 Ecosystem-level biodiversity indicators developed by the SEBI initiative

Pressures and drivers

- Critical load exceedance for nitrogen (SEBI 009)
- Nutrients in transitional, coastal and marine waters (SEBI 015)
- Forest: growing stock, increment and fellings (SEBI 017)
- Agriculture: nitrogen balance (SEBI 019)
- Aquaculture: effluent water quality from finfish farms (SEBI 022)
- Ecological Footprint of European countries (SEBI 023)

State

- Trends in ecosystem coverage (SEBI 004)
- Conservation status of habitats of European interest (SEBI 005)
- Marine trophic index of European seas (SEBI 012)
- Fragmentation of natural and semi-natural areas (SEBI 013)
- Fragmentation of river systems (SEBI 014)
- Freshwater quality (SEBI 016)
- Forest: deadwood (SEBI 018)
- Agriculture: area under management practices potentially supporting biodiversity (SEBI 020)

Responses

- Nationally designated protected areas (SEBI 007)
- Sites designated under the EU Habitats and Birds Directives (SEBI 008)

Source: European Environmental Agency, indicators web page (http://www.eea.europa.eu/data-and-maps/indicators/#c5=biodiversity&c7=all&c0=10&b_start=0).

Desertification and land degradation act as a pressure on the biodiversity of many target countries. Countries that are particularly affected by desertification and land degradation should therefore monitor the impact of these processes on their biodiversity.

A considerable range of applicable indicators for desertification and land degradation have been developed by organizations with a primary interest in these issues, such as the Food and Agriculture Organization of the United Nations[45] and the United Nations Convention to Combat Desertification (UNCCD).[46] These indicators should be adequate to measure the pressures of desertification and land degradation on biodiversity (together with those on other goods), while generic biodiversity indicators can be used to follow the state of biodiversity under these pressures.

[45] See *Data sets, indicators and methods to assess land degradation in drylands*, report of the Land Degradation Assessment in Drylands e-mail Conference (9 October–4 November 2002) (Rome: FAO, 2003). Available from ftp://ftp.fao.org/agl/agll/docs/wsrr100.pdf.

[46] See B. Schulte-Herbrüggen and others, *The UNCCD Impact Indicators Pilot Tracking Exercise: Results and Conclusions* (Cambridge, United Kingdom: UNEP World Conservation Monitoring Centre, 2012). Available from http://www.unccd.int/en/programmes/Science/Monitoring-Assessment/Documents/Pilot_Conclusion-Report.pdf.

In addition, specific indicators have been suggested that address biodiversity impacts of desertification and land degradation, such as UNCCD Impact Indicator VII.[47] However, these indicators will often duplicate already-existing state indicators of NBMSs, and may therefore be of only limited added value from a biodiversity monitoring perspective.

Those target countries particularly affected by desertification and land degradation should also monitor the effectiveness of their adaptive management to respond to resulting pressures on biodiversity. This should be achieved through a combination of response indicators on the implementation and impact of their national strategies to combat desertification, on the one hand, and response indicators for general conservation measures which also contribute to limiting degradation effects on biodiversity (e.g., Nationally designated protected areas — SEBI 007), on the other hand.

F. Data and information management in support of biodiversity monitoring

It is recommended that a national biodiversity information system, as a subsystem of NBMSs, should be updated or established in line with the principles of the Shared Environmental Information System (SEIS) to implement the following main tasks:

(a) Collection and computerized storage of biodiversity monitoring data;

(b) Processing and quality control of data;

(c) Modelling in support of answering questions related to biodiversity monitoring and to interpolate monitoring data;

(d) Assessment and modelling of trends in the state of biodiversity, pressures and driving factors, and of the effectiveness of policy responses;

(e) Assessment of indirect environmental and socio-economic effects;

(f) Support (e.g., data presentation, analysis, visualization) to reporting (both national and international) and to the publication of monitoring data;

(g) Establishment and maintenance of a system of online databases for public access to all biodiversity monitoring data via the Internet.

National biodiversity information systems are recommended to be established, preferably within those national institutions responsible for operating NBMSs (typically the ministries of the environment or their subordinate structures). If other arrangements are made they should promote data exchange based on SEIS principles and reflected in agreements/protocols between these entities.

Biodiversity monitoring data should be stored, analysed and presented in spatially explicit formats using GIS databases wherever possible.

The national biodiversity information systems of target countries should ensure the effectiveness of biodiversity data management through standardization of data collection, entry and storage methodologies across NBMSs, the use of open, transferable data management technology, and through maximal public access to the collected data, for example through the use of the Eye on Earth model — a global public information network for creating and sharing environmentally relevant data and information online through interactive map-based visualizations.[48]

[47] Ibid.

[48] Available from http://www.eyeonearth.org/en-us/Pages/Home.aspx.

It is recommended that data from NBMSs of target countries are integrated and shared by the national biodiversity information systems with corresponding global information systems on biodiversity, including the World Database on Protected Areas,[49] the IUCN Species Information Service[50] and other relevant databases and information systems.

G. Development of effective, sustainable and well-resourced institutional set-ups for biodiversity monitoring

Those target countries that have not yet done so should mandate one central competent authority with the coordination of their NBMSs. This authority will typically be the ministry of the environment or one of its subordinated agencies or services. It should be given the following responsibilities:

(a) Planning and coordination of NBMSs, including approval of indicator sets, monitoring grids and frequency, as well as the approval of and liaison with implementing organizations of individual biodiversity indicators;

(b) Acquisition of resources for the sustainable funding of NBMSs;

(c) Collection, quality control, storage, processing, interministerial communication and publication of monitoring results;

(d) Elaboration of proposals for adaptive changes to policy and management, in those cases where biodiversity monitoring indicates a need for change at the policy or management level, and promotion of the policy adjustments at the level of the ministry of the environment or interministerial level; this may be based on input received from external partner organizations involved in NBMSs.

H. Resource requirements of national biodiversity monitoring systems

The recommended stepwise, priority-driven approach to upgrading or establishing NBSMs (starting with those indicators and areas that are prioritized highest, because of vulnerability or other considerations) will allow for the target countries to optimize the needs of biodiversity monitoring in accordance with their various economic conditions.

Various additional costs must be expected for monitoring, data management and the operation of NBMSs, including the biodiversity information system.

The involvement of volunteer networks for the development of appropriate indicators offers a particularly cost-effective way of contributing to NBMSs.

I. Mobilization of funds from various domestic and external sources

The expenditures related to modernizing and upgrading NBMSs should be funded from the State budget. In the interest of the sustainability of NBMSs and the continuity of the resulting long-term data sets, the national core systems for biodiversity monitoring should not depend on external donor funding.

[49] Available from http://protectedplanet.net/.

[50] Available from http://www.iucn.org/about/work/programmes/species/our_work/#SIS.

Additional sources could be found in public (regional and municipal) budgets to support supplementary monitoring activities (regional or municipal networks).

It is also recommended that the target countries actively participate in certain international activities in order to qualify for financial support from external sources (e.g., Global Environment Facility support for activities related to CBD, such as the updating of and reporting on NBSAPs).

In addition to mobilizing funds from all available domestic and external sources, target countries are encouraged to aim at a high cost efficiency of upgraded national biodiversity monitoring and information systems. This can be achieved through a number of approaches including the following:

(a) *Use and adaptation of existing generic indicator sets instead of indicator development from scratch*: Costs of indicator development should be minimized by using and adapting existing generic indicators sets, such as those developed by ECE;[51]

(b) *Participation of volunteer networks and citizen science to support national biodiversity monitoring*: While central competent authorities often lack the resources and capacity for the extensive regular field surveys needed for some biodiversity indicators, volunteer networks engaged in nature conservation and citizen science can often be enlisted to fill parts of this gap. This is particularly true for the monitoring of the state of species. For instance, the SEBI indicator "Trends in abundance and distribution of selected species", which focuses on birds and butterflies, relies heavily on surveys by citizen scientists.[52] Another example where a strong role is played by volunteers is the global Monitoring Important Bird Areas framework[53] of the BirdLife International network, which is designed in such a way that data can be collected and compiled by a wide range of volunteers, and can also be used to inform national biodiversity indicators;

(c) *Prioritization of indicators to address the most pressing biodiversity issues*: If resources are limited, they should be concentrated on indicators that allow target countries to measure the most relevant biodiversity related trends, pressures and responses. Key questions to determine the order of priority for indicator development and use will vary between target countries. They may be related to important known pressures on biodiversity (e.g., from desertification and land degradation) or address species and ecosystems for which target countries have a particular global responsibility. Key questions may also be derived from policy priorities as defined by NBSAPs or other policy documents;

(d) *Inclusion of remote sensing data while using indicators*: The still limited experience from the use of remote sensing information for biodiversity monitoring shows that for some thematic areas (e.g., ecosystem coverage, habitat fragmentation, wetland status) these emerging tools provide a more cost-effective way of environmental monitoring than traditional survey work on the ground. One recent example where the potential of remote sensing techniques to increase cost efficiency has been demonstrated is a project being carried out by the United Kingdom.[54] Therefore, target countries should consider the applicability of remote sensing data as part of their NBMSs, including from a cost-efficiency perspective.

[51] For more information, see http://www.unece.org/env/europe/monitoring/iandr_en.html.

[52] See, EEA, *Biodiversity monitoring in Europe: The value of citizen science monitoring for biodiversity*, Brochure No. 2/2013 (Copenhagen, 5 March 2013). Available from http://www.eea.europa.eu/publications/biodiversity-monitoring-in-europe.

[53] See BirdLife International, *Monitoring Important Bird Areas: a global framework*, version 1.2 (Cambridge, United Kingdom: 2006). Available from www.birdlife.org/regional/americas/apm_documents/Background%20paper%2011.2_IBA%20Monitoring%20Framework.pdf.

[54] See United Kingdom, Department for Environment Food and Rural Affairs and the Joint Nature Conservation Committee, *Making Earth Observation Work for United Kingdom Biodiversity Conservation — Phase 1*, Part A — Final report (EnvSys/TEO_07_A) (June 2011). Available from http://jncc.defra.gov.uk/pdf/Making_EO_work_for_UK_biodiv_PART_A_final.pdf.

Environmental Monitoring and Assessment

IV Improving coordination between State and other institutions involved in biodiversity monitoring

Biodiversity monitoring — particularly monitoring the state of biodiversity, as opposed to pressures, driving forces and responses — differs from other types of environmental monitoring in that many indicators require observational data rather than data that can be generated with automated measurements on the basis of available statistical data. In addition, the use of most biodiversity indicators requires specific expertise. The staff of environmental ministries and relevant public administration institutions at the national, regional and local levels usually lack the time, resources and expertise to collect the necessary observation data.

Therefore, the institutional set-up for national biodiversity monitoring should enhance central capacities and involve additional institutions and organizations — both governmental and non-governmental — to enable the implementation of comprehensive indicator sets on a broad geographical basis.

It is recommended that target countries establish an inter-institutional working group on NBMSs, which supports the central competent authority in the development and implementation of the NBMS and consists of representatives of the following types of organizations:

(a) Departments or subordinate agencies of the ministry of the environment, especially those responsible for biodiversity conservation, forestry and fisheries (where under this ministry) and protected areas;

(b) Other relevant ministries and/or their subordinate agencies, such as the ministries of agriculture, planning and infrastructure development;

(c) Relevant academic institutions, including university departments and institutes of national academies of sciences, such as those on geography, botany and zoology;

(d) Relevant NGOs, such as those active in the field of nature conservation and sustainable natural resources use, including nature conservation NGOs as well as hunting and fishing associations.

The inter-institutional working group on NBMSs should support the central competent authority by fulfilling the following functions:

(a) Technical advice on the overall planning and implementation of NBMSs;

(b) Development and implementation of specific indicators of NBMSs on a contractual basis, on behalf and under the supervision of the central competent authority; this may particularly apply to indicators that require specialist skills or extensive observation, which often can only be afforded through the involvement of extensive volunteer networks;

(c) Input to the central competent authority regarding proposals for adaptive changes to policy and management, in those cases where biodiversity monitoring indicates a need for change at the policy or management level;

(d) Liaison with academic institutions and relevant NGOs, in order to mainstream the results and policy/management related recommendations of NBMSs into project prioritization, fund-raising and practical management activities of academic institutions and NGOs.

In addition to the central competent authority and the organizations represented in the working group on NBMSs, target countries should leave open the possibility that additional organizations, including consulting firms, support the development and implementation of NBMSs on a contractual or informal basis. Such organizations should be invited by the central competent authority to register their interest in supporting NBMSs.

It is recommended that the central competent authority has the power to coordinate all biodiversity monitoring and data processing activities in each target country. This power should

be accompanied by certain rights and responsibilities with regard to data management (e.g., data flow, data validation and comparison) and support services, training of staff, the publication of manuals and the organization of expert training.

In most target countries, regular monitoring of the state of biodiversity currently takes place predominantly or exclusively in protected areas. Both the monitoring results from past monitoring efforts, which often have been recorded in their "Yearbooks of Nature" over many years or even decades, and the expertise and experience of the scientific staff of protected areas, present a valuable resource for both baseline formulation and future development of those parts of NBMSs that deal with the state and trends of species, habitats and protected areas. It is therefore recommended that target countries develop appropriate procedures to standardize, collect and use the information on the state of biodiversity accumulated through monitoring of protected areas (including for baseline formulation where appropriate) and that they connect current monitoring efforts in protected areas to their NBMSs.