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Guidelines for developing national biodiversity monitoring systems

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Guidelines for developing national biodiversity monitoring systems

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PREFACE

The Secretary General of the United Nations has recognized that we face a triple planetary crisis of climate change, pollution and biodiversity loss. The causes and consequences of these issues are interlinked, and we are dependent on resolving all of them. Key to taking action is first to gain an understanding of the challenges we face. That understanding requires the gathering of information through monitoring our environment.

Guidelines for developing national strategies to use biodiversity monitoring as an environmental policy tool for member States of the United Nations Economic Commission for Europe (ECE) were developed under the ECE Working Group on Environmental Monitoring and Assessment and adopted by the ECE Committee on Environmental Policy in 2013 (ECE/CEP/2013/7).

Those guidelines pre-date adoption of the 2030 Agenda on Sustainable Development in 2015. In December 2022, the resumed fifteenth meeting of the Conference of the Parties to the Convention on Biological Diversity adopted the Kunming-Montreal global biodiversity framework, including a monitoring framework. At the ECE regional level, the ECE set of environmental indicators has been substantially revised and will be published 2023.

It was therefore opportune to review and revise the 2013 guidelines. The present revised guidelines for developing national strategies to use biodiversity monitoring help make biodiversity monitoring a practical tool for environmental policy, especially for countries of Eastern Europe, the Caucasus, Central Asia and South-Eastern Europe.

The guidelines are addressed to government officials and experts working for governmental bodies responsible for environmental policy, environmental monitoring and compliance monitoring.

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CONTENTS

LIST OF BOXES

ABBREVIATIONS AND ACRONYMS

CBD	United Nations Convention on Biological Diversity
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
COP	Conference of the Parties
CORINE	Coordination of Information on the Environment
ECE	United Nations Economic Commission for Europe
GBF	Kunming-Montreal global biodiversity framework
GIS	Geographical information system
ICP Forests	International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forests
IUCN	International Union for the Conservation of Nature
NBMS	National biodiversity monitoring system
NBSAP	National Biodiversity Strategy and Action Plan
NGO	Non-governmental organization
SDG	Sustainable Development Goal
SEEA	System of Environmental Economic Accounting

I. INTRODUCTION

The first edition of the present guidelines was prepared in 2013 (ECE/CEP/2013/7), 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 the European Environment Agency 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 present revision of the guidelines was prepared in 2021 and 2022 to reflect developments in the international policy framework, innovation in approaches and methodologies in monitoring and data management, as well as the experience and lessons learned by member States since 2013. An additional objective has been to make the guidelines more concise and reader friendly.

The aim of the present guidelines is to provide guidance to ECE member States and other interested countries (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 socioeconomic risks resulting from biodiversity loss and ecosystem degradation, as well as the maximization of benefits from biodiversity and ecosystems, are the main objectives.

The guidelines are based on an assessment and evaluation of the situation with regard to biodiversity monitoring in the target countries contained in their environmental performance reviews, prepared under the ECE Environmental Performance Reviews Programme, as well as in the sixth and seventh Pan-European Environmental Assessments. 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) and its Kunming-Montreal global biodiversity framework (GBF), the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) and the ECE Joint Task Force on Environmental Statistics and Indicators.

II. LINKING BIODIVERSITY MONITORING TO ENVIRONMENTAL POLICY

Biodiversity monitoring needs to be integrated with the national biodiversity management system (NBMS) as a central tool to inform decision-makers and the public.

Each target country's NBMS should be closely linked to explicitly stated national policy targets in the field of biodiversity conservation and sustainable natural resource use. These targets are defined by the national and international policy framework for biodiversity.

On the national level, it is recommended that target countries connect the 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.

NBMSs should also be linked to national policy on natural resource use, including forestry and fisheries, as well as on climate change mitigation and adaptation, as biodiversity policy is closely linked to all these topics and monitoring systems should be equally closely interlinked by target countries.

On the international level, the main reference framework to take into account when designing NBMSs comprises the 2030 Agenda for Sustainable Development and the Convention on Biological Diversity with its Kunming-Montreal global biodiversity framework (GBF).[1] For the ECE region, an additional important element of this framework is the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention).

Additional multilateral environmental agreements with relevance to the design of NBMSs are the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Convention on the Conservation of Migratory Species of Wild Animals and the Convention on Wetlands. Monitoring of the progress of member States towards the goals of these multilateral environmental agreements is mainly integrated with the monitoring of CBD and its GBF.

A. LINKING BIODIVERSITY MONITORING TO NATIONAL BIODIVERSITY STRATEGIES AND ACTION PLANS

The development and/or implementation of comprehensive NBMSs should be integrated within the strategic objectives and action plans of NBSAPs, in line with relevant decisions and recommendations of the Conference of the Parties (COP) to CBD.[2]

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

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1 The Kunming-Montreal global biodiversity framework was adopted by the resumed fifteenth meeting of the Conference of the Parties (COP) to CBD through decision 15/4 (CBD/COP/DEC/15/4).

2 Decisions taken at meetings of the CBD COP are available at https://www.cbd.int/decisions/cop. Relevant decisions include decision IX/8 of the ninth meeting of COP on the Review of implementation of goals 2 and 3 of the Strategic Plan (UNEP/CBD/COP/DEC/IX/8), decision X/2 of the tenth meeting on the Strategic Plan for Biodiversity 2011–2020 and the Aichi Biodiversity Targets (UNEP/CBD/COP/DEC/X/2), decision XI/3 of the eleventh meeting on Monitoring progress in implementation of the Strategic Plan for Biodiversity 2011–2020 and the Aichi Biodiversity Targets (UNEP/CBD/COP/DEC/XI/3), decision XII/2 of the twelfth meeting on the Review of progress in providing support in implementing the objectives of the Convention and the Strategic Plan for Biodiversity 2011–2020, and enhancement of capacity-building, technical and scientific cooperation and other initiatives to assist implementation (UNEP/CBD/COP/DEC/XII/2), decision XIII/24 of the thirteenth meeting on Cooperation with other conventions and international organizations (CBD/COP/DEC/XIII/24) and, most recently, decision 15/3 of the fifteenth meeting on the Review of progress in the implementation of the Convention and the Strategic Plan for Biodiversity 2011–2020 and the achievement of the Aichi Biodiversity Targets (CBD/COP/DEC/15/3).

NBMSs should include mechanisms to measure the implementation of NBSAPs, in line with the CBD COP decision on the Review of implementation of goals 2 and 3 of the Strategic Plan,[3] 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 on biodiversity as well as their drivers.[4]

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 implemented 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 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.

A country study on biodiversity that has been compiled in preparation of an NBSAP may contribute to defining the NBMS baseline. In turn, results from an NBMS should be used to update and add in-depth trend information to national biodiversity assessments.

B. ORIENTATING NATIONAL BIODIVERSITY MONITORING TOWARDS THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT AND SUSTAINABLE DEVELOPMENT GOALS

The 2030 Agenda for Sustainable Development with its 17 Sustainable Development Goals (SDGs) was adopted by the United Nations Member States in 2015 as a universal call to action to end poverty, protect the planet and ensure that by 2030 all people enjoy peace and prosperity.[5]

Biodiversity is central to SDGs 14 (life on land) and 15 (life below water) and closely linked to most other Goals.[6] The United Nations General Assembly adopted the global indicator framework for the Sustainable Development Goals and targets of the 2030 Agenda for Sustainable Development in 2017.[7] This includes a detailed list of indicators for SDGs 14 and 15.

Target countries are encouraged to consider the SDG targets and indicators as a basic orientation when setting up their NBMSs. This principle is also reflected in the selection of the ECE *Guidelines for the Application of Environmental Indicators*.[8]

C. HARMONIZING NATIONAL BIODIVERSITY MONITORING WITH THE GLOBAL BIODIVERSITY FRAMEWORK

GBF sets the global direction for biodiversity, including a set of global goals, targets and indicators, adopted by countries in order to guide the development of the definition of national biodiversity targets, progress towards which in turn should be measured by NBMSs. Therefore, Parties to CBD will be working to harmonize their national biodiversity policy frameworks with GBF and this should in turn be reflected in updated targets and in the national indicators which are part of their NBMSs.

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3 Decision IX/8 taken at the ninth meeting of CBD COP on the Review of implementation of goals 2 and 3 of the Strategic Plan (UNEP/CBD/COP/DEC/IX/8).

4 CBD Executive Secretary, "Assessment of National Biodiversity Strategies and Action Plans (NBSAPs)", information note (UNEP/CBD/COP/10/INF/11).

5 United Nations, Department of Economic and Social Affairs, "Sustainable Development", web article, available at https://sdgs.un.org/.

6 CBD, "Biodiversity and the 2030 Agenda for Sustainable Development", CBD Technical note.

7 A/RES/71/313.

8 ECE, "Guidelines for the Application of Environmental Indicators", web article, available at https://unece.org/guidelines-application-environmental-indicators, are being updated. The revised guidelines will be published in 2023.

To enable its monitoring, GBF includes a monitoring framework that includes in turn a set of headline indicators, which countries will address in national reporting under CBD.[9] The monitoring framework also includes more detailed component and complementary indicators for GBF. These provide useful practical guidance on how to link NBMSs to GBF.

While developing or updating their NBMSs, target countries should use GBF and the corresponding indicator and monitoring framework as a flexible framework. This framework should aim at the inclusion of all headline indicators and optimize overlap with the other GBF indicators, while also taking into account the specific conditions of geography, biodiversity and the policy framework and capacity in each target country. Priorities should be based on the biodiversity for which countries have particular global responsibility, the documented or inferred vulnerability of elements of a country's biodiversity and national policy priorities.

D. INTEGRATING BIODIVERSITY MONITORING WITH COMMITMENTS UNDER OTHER BIODIVERSITY-RELATED MULTILATERAL ENVIRONMENTAL AGREEMENTS

The CBD Strategic Plan reflected an integrated approach to all biodiversity-related multilateral environmental agreements, including CBD, CITES, the Convention on the Conservation of Migratory Species of Wild Animals, the Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar Convention) and the Convention Concerning the Protection of the World Cultural and Natural Heritage. Consequently, linking NBMSs to GBF and corresponding NBSAP targets would help target countries to monitor progress in their implementation of many biodiversity-related multilateral environmental agreements.

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 Interest,[10] and the status of the species and habitats that it covers.[11] The respective targets and indicators should be integrated into NBMSs.

E. REALIZING SYNERGIES BETWEEN NATIONAL BIODIVERSITY MONITORING SYSTEMS AND ECOSYSTEM ACCOUNTING WITHIN THE SYSTEM OF ENVIRONMENTAL ECONOMIC ACCOUNTING

Ecosystem Accounting within the System of Environmental Economic Accounting (SEEA) is an integrated and comprehensive statistical framework for organizing and presenting data on habitats, ecosystems and landscapes, measuring ecosystem services, monitoring changes in ecosystem assets, and linking this information to economic and other human activity.[12] As stated in the global biodiversity framework monitoring approach, there has been an attempt to maximize the use of the SEEA in the GBF headline indicators.

Ecosystem Accounting within SEEA consists of five core accounts, i.e., ecosystem extent, ecosystem condition, physical ecosystem flow, monetary ecosystem flow and changes in ecosystem assets. At least the accounts on ecosystem extent and ecosystem condition are directly linked to key variables in conventional biodiversity monitoring, that are also measured by ECE biodiversity indicators. Provision of some ecosystem services is also measured by ECE biodiversity indicators. This opens the possibility for coordinated data collection, processing, interpretation and presentation.

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9 The monitoring framework for the Kunming-Montreal global biodiversity framework was adopted by the resumed fifteenth meeting of the Conference of the Parties (COP) to CBD through decision 15/5 (CBD/COP/DEC/15/5). Headline Indicators are included in Table 1 in the annex, while other indicators are included in Table 2.

10 See also Council of Europe, "Emerald Network of Areas of Special Conservation Interest", web article.

11 Marc Roekaerts, Otars Opermanis and Kristaps Soms-Tiesnesis, "Reporting under Resolution No. 8 (2012), Period 2013–2018: Final Report" (T-PVS/PA (2020) 03), presented to the Standing Committee of the Convention on the Conservation of European Wildlife and Natural Habitats (Strasbourg, Council of Europe, 2020).

12 See also United Nations, "Ecosystem Accounting", web article, available at https://seea.un.org/ecosystem-accounting/.

Target countries are therefore encouraged to harmonize their NBMSs and SEEA Ecosystem Accounting systems, so as to realize synergies between them.

F. LINKING 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 the interdependence of biodiversity and ecosystems and climate change with its impacts. The target countries' integration efforts therefore need to focus on two key interactions:

(a) Climate change is an important and growing driver of biodiversity loss and hence needs to be integrated into national biodiversity monitoring concepts as a key pressure;

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

Target countries should, on the one hand, include targets addressing climate change impacts on biodiversity in their national policy framework for climate change adaptation; NBMSs should be optimized to measure climate change impacts and progress towards these targets, based on available indicators. On the other hand, target countries should plan, monitor and report on the contribution of their biodiversity conservation efforts, as well as greenhouse gas inventories from land use and land use change to reaching climate change mitigation and adaptation targets, in line with GBF target 8 and its indicators.

Target countries should also monitor the impacts of their climate change mitigation and adaptation efforts on biodiversity, to ensure they avoid negative impacts, in line with GBF target 8 and its indicators.

G. TARGET SETTING

Policy targets need to be set based on a detailed analysis of available biodiversity data and information, in order to define the baseline from which biodiversity management activities and the corresponding monitoring system start.

Targets need to be set based on societal choice. This is also true for specific technical targets, which are subject to trade-offs and prioritization, and a multitude of financial, cultural, logistical, ethical and social factors.

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

The 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, for example, from ecosystem services;

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

The main targets in the field of biodiversity management should be mutually coordinated and focused on the minimization of negative environmental and socioeconomic effects, and the maximization of benefits.

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

H. USE OF BIODIVERSITY MONITORING DATA IN POLICY DEVELOPMENT AND IMPLEMENTATION

1. PERMITTING

All target countries have introduced permitting procedures for activities that may have an impact on biodiversity and ecosystems, including natural resources use (e.g., hunting, fishing and the collection of wild plants) and infrastructure development. Results of biodiversity monitoring and assessment are necessary to decide on development projects or other activities that may affect biodiversity or ecosystems. Results of biodiversity monitoring should also be used during the process of environmental impact assessment or environmental expertise, and strategic environmental assessment.

2. USE BY THE BUSINESS SECTOR

The results of national biodiversity monitoring activities should also be actively promoted among the business sector (particularly among environmentally sensitive industries such as forestry, fisheries, agriculture, transport and extractive industries) in order to support the minimization of their impacts on biodiversity, and to help business direct their corporate social responsibility portfolios towards meaningful environmental purposes.

3. PRIORITIZATION OF CONSERVATION INVESTMENTS

Biodiversity monitoring results should be used systematically to prioritize conservation investments, 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, the aggravation of pressures and threats and their root causes and 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, to enable them to use monitoring results for the prioritization of their conservation actions in the same way as Government institutions.

4. COMMUNICATION, EDUCATION AND PUBLIC AWARENESS RAISING

Biodiversity monitoring results are an invaluable resource for communication, education and public awareness raising activities, which should be used to their full potential. For instance, they can underpin campaigns to change unsustainable patterns of consumption, resource use and behaviour by showing the consequences of unsustainable use for biodiversity and ecosystems.

Results from biodiversity monitoring are particularly important for inter-agency communication aimed at mainstreaming of biodiversity among Government agencies. Systematic efforts should be made by ministries of the environment to maximize the mainstreaming impact of monitoring results.

To meet their full potential as resources for communication, education and public awareness raising, 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, such as online dashboards.

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, for example, in response to climate change. 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.

Target countries that 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 and the public, the data on biodiversity should be accompanied by detailed interpretation of these data in relation to national environmental policy and multilateral environmental agreement commitments.

NBMSs should be used for reporting under CBD, particularly during preparation of national reports in line with CBD guidance on indicator-based reporting.[13]

[13] CBD, “National reports”, web article, available at https://www.cbd.int/reports/.

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. These should cover institutional set-ups including partnerships, monitoring networks, data quality management and information systems. The goal 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 methodologies and techniques and international good practice.

A. DEVELOPMENT OF CONSISTENT CONCEPTUAL FRAMEWORKS FOR NATIONAL BIODIVERSITY MONITORING SYSTEMS

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

The organization of the ECE *Guidelines for the Application of Environmental Indicators*, as currently being revised by the ECE Joint Task Force on Environmental Statistics and Indicators, is fully aligned with the United Nations Framework for the Development of Environment Statistics. This does not exclude the use and interpretation of indicators and environmental monitoring data in relation to other existing frameworks such as the DPSIR framework (drivers, pressures, state, impact and response model) of the European Environmental Agency, as these frameworks are mutually consistent.[14]

It is recommended that target countries base the development of their national conceptual frameworks on frameworks that aid the systemic understanding of the functional relationships between the state of biodiversity including ecosystems, pressures affecting them and management responses. One such framework is the DPSIR framework.

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

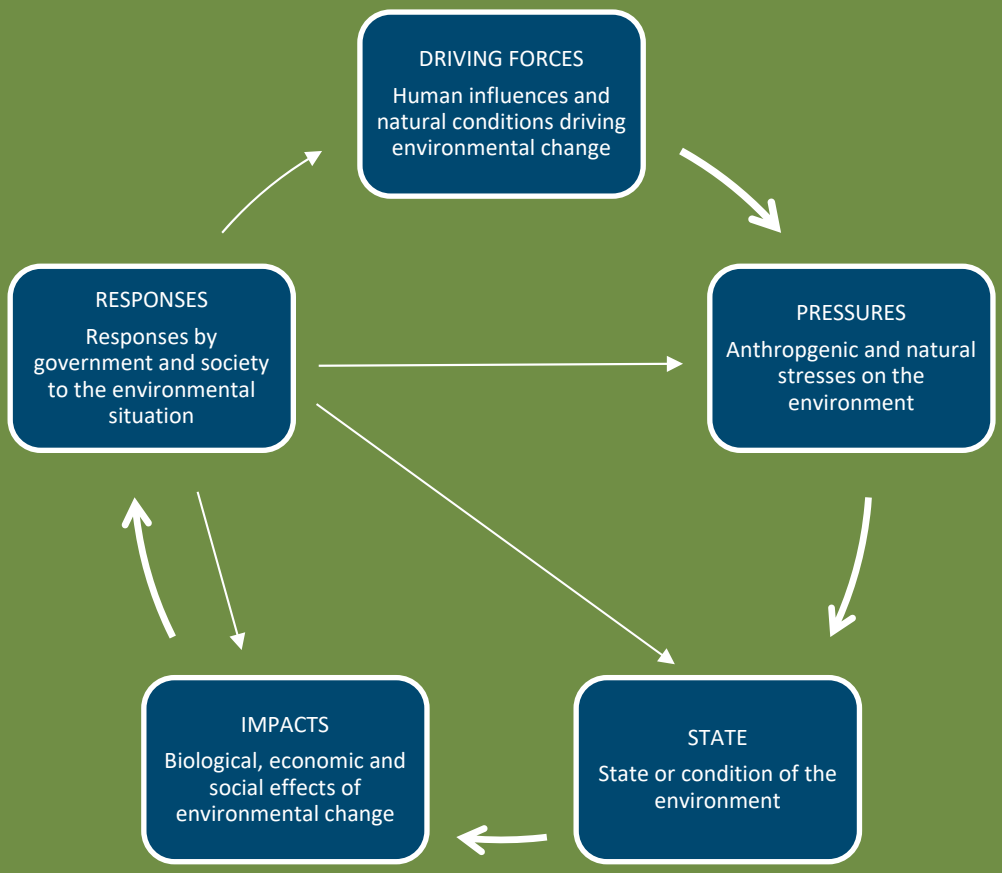
The DPSIR framework, with its clear differentiation between state, pressures and driving forces, can also be used as a tool to assemble evidence along cause-effect networks, to identify areas where policy interventions may have particular impact and decide what evidence may be effective in highlighting impacts.

B. APPLICATION OF AVAILABLE INTERNATIONAL GUIDANCE, STANDARDS AND GOOD PRACTICE 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 applying available international guidance, standards and good practice.

[14] For more information on the United Nations Framework for the Development of Environmental Statistics, see United Nations, Department of Economic and Social Affairs, Statistics Division, *Framework for the Development of Environmental Statistics (FDES 2013)*, Studies in Methods, Series M No. 92 (ST/ESA/STAT/SER.M/92). For the relation to the DPSIR framework, see Table 2.3, p. 28.

Box 1
The DPSIR framework for environmental indicators



Source: European Environment Agency (https://www.eea.europa.eu/help/glossary/eea-glossary/dpsir).

1. REVISED GUIDELINES FOR THE APPLICATION OF ENVIRONMENTAL INDICATORS

The ECE Joint Task Force on Environmental Statistics and Indicators is currently revising the ECE *Guidelines for the Application of Environmental Indicators*, including those for biodiversity and ecosystems. As a result, a comprehensive and coherent, up-to-date and regionally relevant set of key environmental indicators, including guidance on methodologies and processing, will be made available to target countries. It is recommended that target countries refer to this indicator set when developing their NBMSs.

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 an important focus for biodiversity monitoring.

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 extinction risk and hence status and trends of species. It

has been used to construct biodiversity indicators such as the Red List Index,[15] which has been adopted as an indicator of the Sustainable Development Goals and GBF.

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 NBMSs 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 the identification of 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 regional and national red lists.[16] This will contribute to both more consistent and transparent national red lists and a greater compatibility with the global IUCN Red List.

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[17] and publications and through the expert network that forms part of its institutional structure[18]) 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 agency, either under the ministry of the environment or another ministry. 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 their NBMS, in line with the recommendations in section IV.A below on coordination.

4. KEY BIODIVERSITY AREAS

Key biodiversity areas are the most important places for species and their habitats. They are the places that matter most for biodiversity conservation. IUCN has published a Global Standard for the Identification of key biodiversity areas,[19] which target countries can use as a reference when identifying priority areas for the establishment of protected areas. The overlap of protected area systems with key biodiversity areas is an important indicator for the representativeness of national protected areas systems.

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15 IUCN Red List Partnership, “IUCN Red List Index”, web article, available at https://www.iucnredlist.org/assessment/red-list-index.

16 IUCN, *Guidelines for the application of IUCN Red List criteria at regional and national levels; version 4.0* (Gland, Switzerland, IUCN, 2012).

17 ICP Forests, “ICP Forests Manual”, web article (electronic manual), available at http://icp-forests.net/page/icp-forests-manual.

18 ICP Forests, “Bodies & Structures”, web article available at http://icp-forests.net/page/bodies-structure.

19 IUCN, *A Global Standard for the Identification of Key Biodiversity Areas*, *Version 1.0*. First edition (Gland, Switzerland, IUCN, 2016).

5. PROTECTED AREAS MANAGEMENT CATEGORIES

The IUCN World Commission on Protected Areas has established a global system of protected areas management categories, which consists of seven categories that in turn are based on management objectives.[20] These are the most broadly used protected area categories globally and provide a consistent classification for reporting, international comparison and depicting global trends. To increase the compatibility and hence conclusiveness of the data on protected areas in their NBMSs, target countries are strongly encouraged to adopt these categories for their use and reporting.

6. BIODIVERSITY INDICATORS PARTNERSHIP

The Biodiversity Indicators Partnership was established in 2007 in response to a CBD COP decision on the Strategic Plan: future evaluation of progress.[21] It is a global initiative to promote and coordinate development and delivery of biodiversity indicators in support of multilateral environmental agreements, the Intergovernmental Platform on Biodiversity and Ecosystem Services, national and regional governments and other stakeholders.[22] The Partnership has compiled useful information on biodiversity indicators for use on all levels.

C. PRINCIPLES AND PRACTICAL STEPWISE APPROACH TO SETTING UP OR UPGRADING NATIONAL BIODIVERSITY MONITORING SYSTEMS

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

(a) Relevance to policy questions: NBMS should focus on providing information that is needed to answer the most important national and international policy questions or measure progress towards the most important policy goals (e.g., those described in Chapter II of these guidelines);

(b) Scientific basis, methodological good practice and international comparability: NBMS should use biodiversity indicators that are based on sound science and methodological good practice. One typical way of achieving this is the application and adaptation of established indicator protocols such as the ECE revised guidelines for the application of environmental indicators;

(c) Transparency of methodologies and accessibility of data: 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 or information need, the most cost-effective indicator, practical monitoring arrangements and data storage formats should be identified. Countries that are setting up a new NBMS 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 below in Section III.G;

(e) Cooperation: The central competent authority for 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 NBMS is provided in Chapter IV;

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[20] Dudley, N. (Editor), *Guidelines for Applying Protected Area Management Categories* (Gland, Switzerland, IUCN., 2008), with Stolton, S., P. Shadie and N. Dudley (2013). IUCN World Commission on Protected Areas *Best Practice Guidance on Recognising Protected Areas and Assigning Management Categories and Governance Types*, Best Practice Protected Area Guidelines Series No. 21 (Gland, Switzerland, IUCN).

[21] Decision VII/30 taken at the seventh meeting of CBD COP on the Strategic Plan: future evaluation of progress (UNEP/CBD/COP/DEC/VII/30).

[22] Biodiversity Indicators Partnership, Global Biodiversity Indicators, available at https://www.bipindicators.net/ (accessed 21 November 2022).

(f) Regional and subregional integration: To the extent possible, NBMS should be designed in such a way that it allows comparability and integration of monitoring results at regional and subregional levels. Indicators should also refer to established international standards and classifications such as those listed in Section III.B of these guidelines.

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

(a) Key policy questions and information needs should be identified from relevant national and international policy, and/or from identified high priority biodiversity values (e.g., species or ecosystems for which a country has a particular global responsibility), 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 NBMS institutional setup should also be decided as part of this step (see Section III.F);

(b) Identify or 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, with suitable expert support;

(c) Once the NBMS indicator set 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.E;

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

(e) Once the NMBS technical design is finalized, the institutional setup 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 setup should be refined based on the experience from 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 or targets and refinement of indicators.

The Biodiversity Indicator Partnership has developed guidelines for the design and development of individual biodiversity indicators for national use, following a stepwise approach.[23] This guidance should be considered in addition to the stepwise approach for entire NBMSs as described in this section.

D. 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 basis 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 and drivers and benefits of biodiversity, as well as policy responses) indicator sets.

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

[23] Biodiversity Indicators Partnership, *Guidance for National Biodiversity Indicator Development and Use* (Cambridge, UNEP World Conservation Monitoring Centre, 2011).

aggregating monitoring activities contributing to several indicators can be identified and monitoring protocols adjusted accordingly.

The central competent authorities of target countries will benefit from involving other institutions with relevant expertise and experience in the development and implementation of individual biodiversity indicators 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 referring to the Sustainable Development Goals, GBF and the biodiversity indicators developed by the ECE Joint Task Force on Environmental Statistics and Indicators.

The Joint Task Force 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 revised ECE *Guidelines for the Application of Environmental Indicators*, as well as additional documentation of newly developed indicators (see Box 2).

The Streamlined European Biodiversity Indicators 2020 initiative selected a set of indicators to measure and help achieve progress towards the goals of the European Union Biodiversity Strategy for 2020 and the Pan-European 2020 Strategy for Biodiversity.[24] Fourteen indicators were selected (Box 3).

E. DATA AND INFORMATION MANAGEMENT IN SUPPORT OF BIODIVERSITY MONITORING

It is recommended that a national biodiversity information system, as a subsystem of NBMS, should be updated or established in line with the principles of the Shared Environmental Information System[25] to implement the following main tasks:

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

(b) Processing and quality control of data;

(c) Indicator design and data analysis, as well as 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 socioeconomic effects;

(f) Support (e.g., data presentation, analysis and 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 ministries of the environment or their subordinate structures) or national statistics offices. Any arrangements should promote data exchange based on the principles of the Shared Environmental Information System.

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

[24] Biodiversity Information System for Europe, “Streamlined European Biodiversity Indicators”, web article, available at https://biodiversity.europa.eu/track/streamlined-european-biodiversity-indicators.

[25] See, for example, ECE, “Shared Environmental Information System”, web article, available at https://unece.org/shared-environmental-information-system.

Box 2

Biodiversity and biodiversity-related indicators from the ECE Guidelines for the Application of Environmental Indicators and related documents

Pressures and drivers

B-1.2	Annual average temperature (in country, in capital, second major city, area or region)
C-10.1	BOD in rivers
C-10.2	Ammonium (NH_4) in rivers
C-11.1	Phosphates in freshwater (rivers, lakes, groundwater)
C-11.2	Nitrates in freshwater (rivers, lakes, groundwater)
C-12.1	Chlorophyll in transitional, coastal and marine waters (trends in chlorophyll-a concentrations)
C-12.2	Phosphates in transitional, coastal and marine waters
C-12.3	Nitrates in transitional, coastal and marine waters
C-16.1	Share of total wastewater discharged to the environment after treatment
C-16.2	Proportion of domestic and industrial wastewater flows safely treated (SDG indicator 6.3.1)
C-17.1	Hazardous substances in marine organisms
C-18.1	Number of items on beach per 100 m of shoreline
C-18.2	Average marine acidity (pH) measured at agreed suite of sampling stations (SDG indicator 14.3.1)
E-1.2	Total land uptake
E-2.4	Proportion of land that is degraded over total land area (SDG indicator 15.3.1)
F-2.1	Consumption of mineral fertilizers per unit of agricultural area
F-2.3	Consumption of organic fertilizers per unit of agricultural area
F-4.1–7	Consumption of pesticides, insecticides, herbicides and desiccants, fungicides and bactericides, plant regulators, rodenticides and other pesticides (e.g., mineral oils) per unit of agricultural area
—	Invasive alien species
—	Catches of fish and other aquatic animals, aquatic animal products and aquatic plants

State

D-3.3	Share of natural forest of total forest area
D-3.4	Share of planted forest of total forest area
D-3.8	Forest fires (area burnt by forest fires)
D-3.9	Deadwood in forests (volume of deadwood per forest area)
D-4.2	Share of species threatened (mammals, birds, fishes, reptiles, amphibians, invertebrates, vascular plants, mosses, lichens, fungi, algae) (threat aspect)
D-5.1	Volume and distribution of selected species (keystone species, flagship species, endemic species and other species)

Responses

D-1.1	Share of total protected areas (IUCN categories) in the country area (else D-1.2 using national categories)
D-1.3	Coverage of protected areas in relation to marine areas (SDG indicator 14.5.1)

D-1.5	Proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas, by ecosystem type (SDG indicator 15.1.2)
D-2.2	Conservation status of habitats of high importance for biodiversity conservation (conservation status for habitats according to conservation status criteria)
D-3.1	Forest area as a proportion of total land area (SDG indicator 15.1.1)
D-3.2	Share of other wooded land in country area
D-3.6	Share of forest area designated for protection of soil, water and ecosystem services of total forest area
D-3.7	Share of forest area protected and designated for the conservation of biodiversity
D-4.2	Share of species threatened (mammals, birds, fishes, reptiles, amphibians, invertebrates, vascular plants, mosses, lichens, fungi, algae) (protection aspect)
—	Biosphere reserves and wetlands of international importance

Source: Revised Guidelines for the Application of Environmental (ECE/CEP–CES/GE.1/2022/4), to be published in 2023.

Note: Interim numbering above is as per draft revised ECE guidelines, if any.

Box 3

Ecosystem level biodiversity indicators developed by the Streamlined European Biodiversity Indicators initiative

Streamlined European Biodiversity Indicators (SEBI) indicators:

- Abundance and distribution of selected European species (SEBI 001)
- Species of European interest (SEBI 003)
- Ecosystem coverage (SEBI 004)
- Habitats of European coverage (SEBI 005)
- Livestock genetic diversity (SEBI 006)
- Nationally designated terrestrial protected areas in Europe (SEBI 007)
- Natura 2000 sites designated under the Habitats and Birds Directives (SEBI 008)
- Impact of climate change on bird populations (SEBI 011)
- Forest: growing stock, increment and fellings (SEBI 017)
- Forest: deadwood (SEBI 018)
- Agriculture: nitrogen balance (SEBI 019)
- Agriculture: area under management practices potentially supporting biodiversity (SEBI 020)
- Ecological footprint of European countries (SEBI 023)
- Public awareness of biodiversity in Europe (SEBI 026)

Source: Streamlined European Biodiversity Indicators, available from https://biodiversity.europa.eu/track/streamlined-european-biodiversity-indicators.

NBMSs 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 maximal public access to the collected data, for example through the use of dashboards.

It is recommended that data from NBMSs of target countries are shared by the national biodiversity information systems with corresponding global information systems on biodiversity, including the World Database on Protected Areas[26] and other relevant databases and information systems.

F. DEVELOPMENT OF EFFECTIVE 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) NBMS planning and coordination, including approval of indicator sets, monitoring grids and frequency, and the approval of and liaison with implementing organizations for individual biodiversity indicators;

(b) Acquisition of resources for sustainable NBMS funding;

(c) Collection, quality control, storage, processing, inter-ministerial 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 inter-ministerial level. This may be based on input received from external partner organizations involved in NBMS.

The central competent authority should coordinate and closely cooperate with additional external organizations contributing to NBMS.

The Swiss biodiversity monitoring system is an example of a centrally led, collaborative NBMS (Box 4).

Box 4

Biodiversity monitoring in Switzerland as an example of a centrally led collaborative biodiversity monitoring network

The Federal Office for the Environment 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 37 indicators with reference to biodiversity. 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 has relied 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 cost of the Swiss NBMS is approximately $3 million.

Source: Federal Office for the Environment, “Indicators”, available at https://www.bafu.admin.ch/bafu/en/home/state/indicators.html/.

[26] UNEP-WCMC and IUCN, Protected Planet: The World Database on Protected Areas (WDPA) and World Database on Other Effective Area-based Conservation Measures (WD-OECM) (Cambridge, United Kingdom, UNEP-WCMC and IUCN, 2022), available at http://protectedplanet.net/ (accessed 21 November 2022).

G. RESOURCING AND COST-EFFECTIVENESS OF NATIONAL BIODIVERSITY MONITORING SYSTEMS

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 in the long term.

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: Costs of indicator development should be minimized by using and adapting existing generic indicators sets, such as those developed by ECE, those published by the European Environment Agency,[27] or those already in use in other comparable countries;

(b) Participation of volunteer networks and citizen science to support national biodiversity monitoring: While central competent authorities often lack the resources and capacity for extensive regular field surveys, which are 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, habitats and ecosystems. For instance, indicators on trends in abundance and distribution of selected species, which in some cases focus on birds and butterflies, rely heavily on surveys by citizen scientists. Another example for a strong role of volunteers is the monitoring of Important Bird Areas and Key Biodiversity Areas, which is typically conducted by a wide range of organizations and volunteers. At the same time, the results of this monitoring 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 for which indicator development and use should be prioritized 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 like these may be derived from policy priorities as defined by NBSAPs or other policy documents.

The application of GIS-based habitat mapping in combination with remote sensing and modelling can help to interpolate species and habitat data and thereby fill gaps in the monitoring grid in a cost-effective manner. 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 scale. There is also significant potential for their application in the framework of national biodiversity monitoring. 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, using the Coordination of Information on the Environment (CORINE) Land Cover inventory, which is a standardized system for all European Environment Agency countries (Box 5). Other specific examples are related to the use and conservation status of

[27] European Environment Agency, “Indicators”, web article, available at https://www.eea.europa.eu/ims.

grasslands.[28] These tools will be increasingly integrated into national biodiversity monitoring systems;

(b) Trends in 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 various high conservation value habitats;[29]

(c) Wetland distribution and status, for example wetness or dryness: Satellite imagery has been used successfully to monitor distribution, extent and status (e.g., wetness) of coastal and freshwater wetlands.[30]

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 produce mutual understanding and overcome the knowledge gap between both communities.[31]

Box 5

The CORINE Land Cover Inventory as an example of a remote sensing-based land cover inventory and monitoring system

The CORINE Land Cover inventory has been used since 1985, and has produced outputs for 1990, 2000, 2006, 2012, and 2018. It consists of an inventory of land cover in 44 classes and additional change layers, which visualize changes in land cover.

The CORINE Land Cover System is supported by the European Environment Information and Observation Network (Eionet), a partnership network of the European Environment Agency and its 38 member and cooperating countries. The Eionet network National Reference Centres Land Cover produce national CORINE Land Cover databases, which are coordinated and integrated by the European Environment Agency. Most countries use visual interpretation of high-resolution satellite imagery to produce their CORINE Land Cover databases. In a few countries semi-automatic solutions are applied, using national in-situ data, satellite image processing, GIS integration and generalization. Since 2012, the CORINE Land Cover inventory has been part of the Copernicus programme, which has ensured sustainable financing.

Source: Copernicus Land Monitoring Service, "CORINE Land Cover", article available at https://land.copernicus.eu/pan-european/corine-land-cover.

[28] Jonas Franke, Vanessa Keuck, Florian Siegert, Assessment of grassland use intensity by remote sensing to support conservation schemes, *Journal for Nature Conservation*, 20(3), 2012, pp. 125–134, ISSN 1617-1381, https://doi.org/10.1016/j.jnc.2012.02.001.

[29] Haest B, Vanden Borre J, Spanhove T, Thoonen G, Delalieux S, Kooistra L, Mücher CA, Paelinckx D, Scheunders P, Kempeneers P. Habitat Mapping and Quality Assessment of NATURA 2000 Heathland Using Airborne Imaging Spectroscopy. *Remote Sensing*. 2017; 9(3):266. https://doi.org/10.3390/rs9030266.

[30] Liesbeth Bortels, Jonathan C.-W. Chan, Ronny Merken, Nico Koedam, 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*, 19(4), 2011, pp. 215–223, ISSN 1617-1381, https://doi.org/10.1016/j.jnc.2011.01.004.

[31] Jeroen Vanden Borre, Desiré Paelinckx, Caspar A. Mücher, Lammert Kooistra, Birgen Haest, Geert De Blust, Anne M. Schmidt, Integrating remote sensing in Natura 2000 habitat monitoring: Prospects on the way forward, *Journal for Nature Conservation*, 19(2), 2011, pp. 116–125, ISSN 1617-1381, https://doi.org/10.1016/j.jnc.2010.07.003.

IV. IMPROVING COORDINATION OF BIODIVERSITY MONITORING

A. IMPROVED COORDINATION BETWEEN STATE AND OTHER ORGANIZATIONS INVOLVED IN BIODIVERSITY MONITORING

Biodiversity monitoring — particularly monitoring the state of biodiversity — 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.

One way of achieving this is by establishing an inter-institutional working group on the country's NBMS, which supports central competent authorities in the NBMS development and implementation 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, protected areas, forestry, agriculture and fisheries (where under this ministry);

(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, and hunting and fishing associations.

An inter-institutional working group on NBMS can support the central competent authority by fulfilling the following functions:

(a) Technical advice on overall NBMS planning and implementation;

(b) Development and implementation of specific NBMS indicators 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. The involvement of volunteer networks for the use of appropriate indicators offers a particularly cost-effective way of contributing to NBMSs;

(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 and management related recommendations of NBMS 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 NBMS, 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 NBMS.

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, 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. Monitoring results from past monitoring efforts have often been recorded in their "Yearbooks of Nature" or similar documents over many years or even decades. This information 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 national policy, including their NBMSs.

The National Biodiversity Network of the United Kingdom of Great Britain and Northern Ireland and its Biological Records Centre are a long-standing example of strong volunteer involvement in national biodiversity monitoring (Box 6).

Box 6

The National Biodiversity Network of the United Kingdom of Great Britain and Northern Ireland and its Biological Records Centre as an example of strong volunteer involvement

The Biological Records Centre, established in 1964, is a national focus in the United Kingdom for terrestrial and freshwater species recording. The Centre works closely with the voluntary recording community, principally through support of national recording schemes and societies. As part of the National Biodiversity Network, it supports standardization, collation, publication and use of species-related data in the country, and 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 National Biodiversity Network consists of more than 200 governmental and non-governmental organizations and the Biological Records Centre 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 involvement of the Biological Records Centre within the National Biodiversity Network has enabled the collation of presence data for 47,000 species (over 180 million observations) from thousands of volunteers.

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

(a) Monitoring of population changes of 117 breeding bird species across the country thanks to the dedication of almost 3,000 volunteers who survey their randomly selected 1-km square each spring (British Trust for Ornithology's Breeding Bird Survey, available at https://www.bto.org/our-science/projects/breeding-bird-survey);

(b) The United Kingdom Butterfly Monitoring Scheme on over 2,000 sites by several hundreds of volunteers, annually (see https://ukbms.org/).

Sources: Biological Records Centre (see https://www.brc.ac.uk/home) and National Biodiversity Network (see https://nbn.org.uk).

B. STRENGTHENING 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 the following:

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

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

(c) Strengthened basis for a joint understanding of bilateral, subregional or regional biodiversity related challenges and for the joint development of policy responses to them.

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.

Remote sensing approaches to biodiversity monitoring are another promising field for cooperation between target countries, because of the often-large-scale nature of the data generated, and because cooperation offers benefits related to standardization of monitoring approaches between countries and the sharing of development costs.

Guidelines for developing national biodiversity monitoring systems

In December 2022, the resumed fifteenth meeting of the Conference of the Parties to the Convention on Biological Diversity adopted the Kunming-Montreal global biodiversity framework, including a monitoring framework.

The present Guidelines for developing national strategies to use biodiversity monitoring help make biodiversity monitoring a practical tool for environmental policy. The guidelines offer advice on how to:

- Develop plans and strategies for the conservation and sustainable use of biodiversity
- Mainstream biodiversity conservation objectives across policy sectors
- Assess progress in achieving policy targets and the effectiveness of conservation measures
- Minimize health, environmental and socioeconomic risks resulting from biodiversity loss and ecosystem degradation
- Maximize benefits from biodiversity and ecosystems.

The guidelines are addressed to government officials and experts working for governmental bodies responsible for environmental policy, environmental monitoring and compliance monitoring.

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