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JUNE
2022

MONITORING

Briefing Note for the Monitoring Framework of the Post-2020 Global Biodiversity Framework

MONITORING FRAMEWORK

SCIENCE BRIEFS ON TARGETS, GOALS AND MONITORING IN SUPPORT OF THE POST-2020 GLOBAL BIODIVERSITY FRAMEWORK NEGOTIATIONS

JUNE 2022

Citation:

Secretariat of the Convention on Biological Diversity. Briefing note on scientific and technical issues related to the global monitoring of biodiversity. 2022. CBD/ID/OM/2022/1/INF/2. Available from: https://www.cbd.int/doc/c/0aef/09cb/0f9654d627222534df6c7a98/id-om-2022-01-inf-02-en.pdf

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Cover design:

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BRIEFING NOTE ON SCIENTIFIC AND TECHICAL ISSUES RELATED TO THE GLOBAL MONITORING OF BIODIVERSITY

KEY MESSAGES

A global biodiversity observation system is needed to fill the large gaps in taxonomic, geographic, and temporal coverage of biodiversity data required to implement the monitoring framework (CBD/SBSTTA/REC/24/2). This system is needed to accelerate the assessment of the status and trends of biodiversity at the scales needed to guide conservation action. This system would be assembled by leveraging existing capacity and data in addition to existing and developing national and regional biodiversity monitoring networks with strategic investment required to fill priority gaps. National governments and other stakeholders will need to work together to provide the capacity and resources to establish the global biodiversity observation system.

We address four components integral to an effective monitoring framework:

1. Data collection, curation and sharing of existing knowledge on biodiversity should be mobilized, along with data on drivers and their interactions. This is required to understand and forecast biodiversity change and its outcomes for ecosystems and human well-being.

2. Monitoring using FAIR and SHARE principles and best practices in biodiversity observations, data collection, statistical modeling and reporting, thereby supporting the integration of data to models and indicators, and harmonized reporting.

3. Planning of actions for conservation, sustainable development, adaptation, and mitigation of the effects of drivers. This requires models, informatic tools and engagement with data and information providers to link data to indicators and predict expected outcomes to prioritize actions, such as spatial planning for conservation and restoration.

4. Reporting progress on the indicators of the monitoring framework based on scientific monitoring to evaluate progress towards the goals and targets of the GBF and to support adaptive updates to national biodiversity strategies and action plans.

The decision on the monitoring framework, in SBSTTA 24 rec 2, should add specific language to recognize that biodiversity monitoring is essential for the operational implementation of the GBF. Supported in this way, headline indicators, supplemented by component and complementary indicators and other national indicators, will contribute to planning, reporting and review (para 5, 8).

BACKGROUND

This brief presents the connections among the different elements of the monitoring framework, which is focused on indicators and their use for tracking and reporting progress toward the goals and targets of the post-2020 global biodiversity framework (GBF, SBSTTA). We emphasize that the role of the monitoring framework and its indicators is not simply to passively report progress. The monitoring framework is central to the GBF - as it can also serve to inform scenarios that forecast and guide policies and actions, as well as evaluate their outcomes. The indicators of the monitoring framework rely on primary data and information derived from historical records and ongoing monitoring of the different dimensions of biodiversity, drivers of biodiversity change and implementation actions that are the focus of the GBF. Major taxonomic and geographic data gaps exist because most countries lack national biodiversity observation and monitoring systems. The current draft of the GBF lacks explicit targets for the establishment of national biodiversity monitoring systems needed for implementing the monitoring objectives defined by Target 20.

The planning of actions for conservation and the mitigation of the effects of drivers required to "bend the curve" of biodiversity loss also require models to account for uncertainties, and tools to link data to indicators and predict expected outcomes in order to prioritize actions. We recommend the negotiation and adoption of an overarching framework that integrates monitoring and trend (change) assessment within the monitoring framework of the GBF.

The objectives of the monitoring framework

An effective monitoring framework should allow Parties to obtain timely information to know if they are on course and when they have achieved their intended objectives. Much like a satellite-navigation system, the framework should alert when Parties are not on track and suggest alternative ways to adjust their direction and journey. Timely feedback of this type was not available to guide progress toward the previous global (Aichi) biodiversity targets. The GBF negotiations provide a unique opportunity to reflect on past short-comings and develop national and global monitoring systems that are fit for the purpose of effectively guiding progress toward the global targets and the national strategies for implementing those targets.

An overarching monitoring framework for the GBF would provide the information required by Parties to (i) assess the status and trends in biodiversity, (ii) forecast and plan actions to improve the status of different dimensions of biodiversity, (iii) evaluate the effectiveness of these actions, (iv) inform the review of progress in implementing the GBF, (v) inform the strategic actions to enhance implementation, and (vi) inform the means of strengthening implementation and resource mobilization (Xu et al. 2021).

A monitoring framework that allows Parties to track progress and inform and guide adaptive policy and action is a necessary component of achieving the GBF. The current draft of the monitoring framework (CBD/SBSTTA/24/3/ADD1) identifies the indicators for tracking biodiversity change but it requires additional information on how to utilize the indicators (CBD/SBSTTA/24/INF/38). For example, additional information (metadata, e.g. SBSTTA INF 38) is needed to guide how the indicators and baselines are operationalized, with appropriate statistical and decision criteria for defining the degree of certainty required to evaluate whether the trends in the indicator values are consistent with the targets of the GBF (Leadley et al. 2022). Also, the current CBD monitoring framework does not include an explicit strategy for utilising the outputs of many monitoring programs developed to meet local, national or regional needs and are not designed around the GBF indicators. Only a small proportion of the primary data

needed for evaluating progress towards GBF targets are likely to come from bespoke monitoring initiatives designed to support the GBF. The rest will come from a multitude of initiatives including those that are co-designed by indigenous peoples and local communities. These programs are critical for guiding and evaluating local actions needed to meet the 2030 targets and the 2050 goals, but they will often be designed around indicators that are different from the global indicators (IPBES 2019). Hence the GBF monitoring framework needs to include mechanisms for optimising monitoring so that the same sets of primary data can support more than one indicator. A global biodiversity observation and information system can provide this.

There is a clear opportunity to establish a global biodiversity observation and information system to continually collect data on biodiversity status, trends, and drivers (Scholes et al. 2012). Collaboration among countries and regions will strengthen our understanding of global and regional trends in biodiversity and guide conservation action. This system can be assembled as a network of existing and planned national monitoring systems. This action would be supported by national indicator reporting toolkits and would support new monitoring infrastructure, forecasting, and capacity where needed.

Box 1. The two facets of biodiversity monitoring
Biodiversity monitoring includes two facets (see monitoring in the glossary): 1) it is the process of gathering information about essential biodiversity and ecosystem variable(s)--and linked data on drivers of change--at different points in geographic space over time for the purpose of assessing their state and drawing inferences about changes in state over time, and 2) this information is used to estimate and report on the value of the indicators describing the change in those variables. Monitoring includes the collection of primary biodiversity data (see Figure A1), synthesis of data into an indicator, and public dissemination of past and forecasted trends in the indicator. Both facets are tightly linked to and informed by a decision-support framework designed to guide actions to achieve conservation and restoration objectives.

AN OVERARCHING FRAMEWORK

An overarching monitoring framework for the GBF interlinks four steps (Figure 1): 1) the production and sharing of data derived from the monitoring of the different dimensions of biodiversity (genes, species populations, ecosystems/habitats etc.) and the drivers that cause change; 2) the assessment of statistical trends (change) in indicators and forecasts of those indicators for scenarios that guide policy and action; 3) the use of predicted outcomes to plan and prioritize conservation and action on drivers; 4) the use of information from these steps to report on national and global progress across indicators and to update the national biodiversity strategies and action plans (NBSAPs). This framework can guide the planning and prioritization required to alter observed trends and the new or enhanced monitoring required to reduce uncertainty in these trend estimates and provide data for models used to support decisions (backward flowing arrows in Figure 1). Although many components described in Figure 1 exist, new resources and investment are required for this framework to be implemented by all Parties and to support an accurate and frequent updating of the progress towards global goals and targets. This system can be built incrementally, but it must be built rapidly if we are to be able to guide informed progress towards the 2030 targets. All Parties can contribute to this process. Below we recommend action to achieve this.

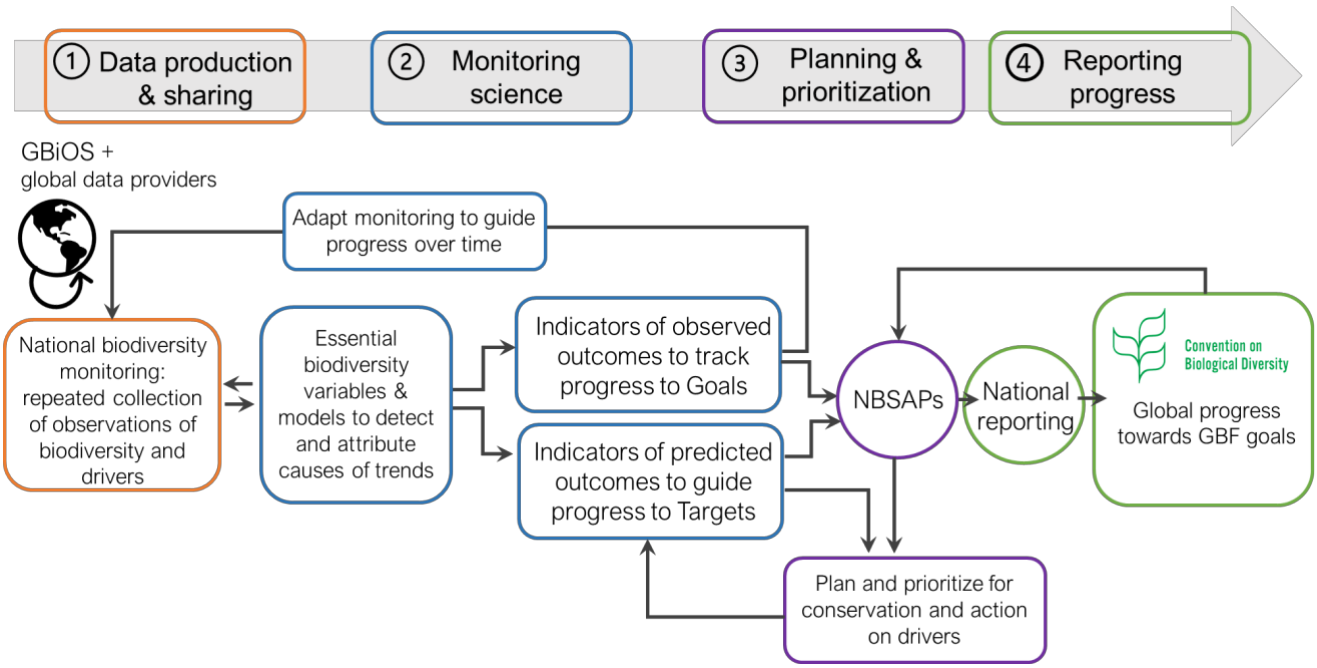

Figure 1. Summary of the global biodiversity monitoring framework and flows of information linking data to indicators for monitoring, planning, and reporting progress towards the post-2020 global biodiversity framework. The figure focuses on the national process, left to right. Starting from the left, data derives from national and regional monitoring and observation networks and a global biodiversity observation system (GBiOS) is combined with other datasets. Essential biodiversity variables (i.e., EBVs) are standardized measures of biodiversity used as inputs to calculate some indicators in the monitoring framework and may be combined with models to detect and attribute biodiversity trends, and to forecast possible scenarios of success or risk as a result of some action. Some indicators, including headline, component and complementary indicators, are used to track progress towards the GBF goals; others are used to predict outcomes to guide progress on targets arising from action on drivers of biodiversity change. Monitoring is used to support planning and updating of the national biodiversity strategies and action plans (NBSAPs). National reports that contain information on biodiversity indicators can be aggregated to support global assessments of progress towards the goals of the GBF. An important element of the basic biodiversity data is that these repeated observations provide the scientific basis for assessments and forecasts and ensure that the indicators are scientifically robust.

Implementing this integrated framework

Below we provide a series of recommendations for realizing an integrated framework for the monitoring framework of the GBF.

1. **Data collection, curation and sharing of existing knowledge on biodiversity**: *Existing knowledge on biodiversity is mobilized and shared, while additional data is collected and continually shared, building a deep knowledge and understanding of biodiversity and its processes.*

   Parties to the Convention can utilize the existing sources of biodiversity knowledge already developed by governments, non-government agencies, research institutes, indigenous peoples and local communities, and civil societies. Community-based monitoring information systems (CBMIS) that focus on local levels complemented by systematic data collected by the thousands of species population and ecosystem

monitoring schemes (Moussy et al. 2021; Table A1) can be coordinated and converted to EBVs where needed to harmonize and share biodiversity data and knowledge.

Bottom-up and top-down approaches for data collection should be linked to ensure that locally and nationally collected data are integrated with global indicators and data to allow effective scaling of indicators (Burgass et al. 2021, Eicken et al. 2021, Nicholson et al. 2021). A bottom-up and top-down approach promotes data integration from field-based observations made by different groups (e.g. professional biologists, local indigenous communities and citizens) using a range of technologies for in-situ data acquisition and sharing, with data from a top-down approach involving remotely sensed data (e.g. space agencies satellites derived products, Ferrier 2011, Kühl et al. 2020, Skidmore et al. 2021) and nationally based indicators (e.g. IUCN Red List indicators). This two-way flow of information on biodiversity is necessary to support decisions at local, national, regional, and global scales. GEO BON and its partners are developing all components of this system including assembly of interoperable tools to facilitate national-scale monitoring and indicator reporting systems.

Data gaps on taxonomic and geographic coverage should continue to be filled through prioritized data collection. Standardized data sets in public databases should be utilized (e.g. Ocean Biodiversity Information System, OBIS[1]; Global Biodiversity Information Facility, GBIF[2]) and shared following FAIR[3] and CARE[4] principles. By filling data gaps, leading indicators—indicators predictive of biodiversity trends under model scenarios—can be developed and can inform policy change and actions.

Parties will need to support technical and technological capacity. The number of monitoring schemes in a country is highly dependent on its per capita GDP (Moussy et al. 2021). Sharing lessons learned, infrastructure, tools and collaborating efforts will improve regional monitoring capacity. The institutions, platforms, curators, and users of the biodiversity data require sustained and long-term financial investments.

2. **Monitoring science**: *Common standards and protocols for best practices in monitoring and models should be followed and the establishment of links between scientists and non-professional data collectors, and the flow of information from data to indicator and policy.*

   National, multinational, and sub-global biodiversity monitoring and observation networks (Navarro et al. 2017) should be harnessed to harmonize the collection of data on biodiversity and drivers, and overcome data collection challenges for countries (Appendix 1; Figure A1, Table A1). For example, biodiversity observation networks (BONs) are partnerships of data providers and users that support the coordination and harmonization of data collection across biodiversity and other environmental observation systems for a country or large region.

   For interoperability, much of the collected biodiversity data should be processed into essential variables (e.g. essential biodiversity, EBVs; essential ecosystem services EESVs; essential ocean, EOVs, and essential climate variables, ECVs) and used as indicators, employing common, but flexible indicator methodologies that are applied at

[1] OBIS: https://obis.org/

[2] GBIF: https://www.gbif.org/

[3] FAIR: Findability, Accessibility, Interoperability, and Reuse guiding principles for scientific data management and stewardship (Wilkinson et al. 2016)

[4] CARE: Collective benefit, Authority to control, Responsibility, and Ethics guiding principles for Indigenous data governance (https://www.gida-global.org/care)

multiple (national to regional to global) scales (delivered via common, but customizable tools and toolkits).

Parties should engage with the community of data providers on global biodiversity data, models, and indicators. This will enable them to implement data workflows and pipelines using their own data to calculate headline, component, and complementary indicators.

Biodiversity information should be integrated for scale-appropriate use. Fine scale and local data sets can inform local policy and may be aggregated for global (bottom-up) assessments. Global monitoring data sets may be disaggregated (top-down) where relevant to inform local and nationally relevant actions and fill gaps (Appendix 1).

Models for forecasts and planning, using, and enhancing available data (such as from OBIS, GBIF, remote sensing, genetic and genomic data repositories, IUCN Red Lists, Key Biodiversity Areas Partnership), are developed to put national trends and maps of indicators into a global context.

The development of a global biodiversity model intercomparison program to identify pathways to sustainability (Leclère et al. 2020). A key component of continued improvement of biodiversity progress will be successive rounds of rigorous model-model and model-data comparisons (for example, similar to the World Climate Research Programme Coupled Model Intercomparison Project[5]).

3. **Planning and prioritization:** *knowledge and indicators to inform strategic planning of actions to effectively and efficiently achieve targets and goals of the GBF and enable attribution of observed biodiversity change to drivers (direct and indirect) through well-coordinated investment in monitoring and ongoing data collection.*

   Three complementary approaches to the use of indicators are needed to realise the outcomes of the GBF. The first is to track overall progress towards goals (headline indicators). The second is to progressively improve indicators to understand how drivers cause biodiversity change, thereby allowing changes in biodiversity to be attributed to changes in drivers and actions (this should be the main role of component and complementary indicators). The third approach, which is at present almost completely overlooked in the GBF monitoring framework, uses indicators to inform strategic planning (including prioritization) of actions to achieve targets and goals effectively and efficiently. This includes forecasting of biodiversity and ecological function and scenario planning to evaluate possible outcomes of management actions. For this, we need leading indicators (currently not included in the GBF monitoring framework) which use best-available understanding of these dependencies–at the time a given decision is made–to predict the expected impact of the proposed or implemented actions on biodiversity outcomes.

   All three of these approaches are critically important and must play complementary roles in an overall adaptive policy and planning framework for the GBF. The set of indicators for monitoring the GBF needs to be expanded to comprehensively cover outcomes, drivers and key interdependencies between these elements.

   Improved coordination and policy support at all scales of government will enhance the efficiency and financial support of biodiversity monitoring systems already in place.

[5] World Climate Research Programme (WCRP) Coupled Model Intercomparison Project (CMIP) https://www.wcrp-climate.org/wgcm-cmip

4. **Reporting progress:** *the integration of data and indicators should generate a monitoring framework capable of supporting a reporting structure that describes progress made on the direct and indirect drivers of biodiversity loss and their effect on biodiversity.*

   The indicators agreed for inclusion in the monitoring framework should be included in the NBSAPs and national reports (recommendation SBSTTA 24/2), and in other planning and policy instruments at national and subnational levels. Actions can be adjusted according to trends in predictive (leading) indicators.

   Compliance and accountability mechanisms, including the use of component, complementary and other national indicators, are in place to review implementation of NBSAPs and their relevance to GBF goals and targets. Reviews should be conducted on Parties' individual performance both within and beyond their borders, rather than summary reviews of global implementation trends (Xu et al. 2021).

   National monitoring is mainstreamed within national statistical systems (i.e. UN SEEA) and across key sectors that impact biodiversity (e.g. agriculture, mining, etc.).

   Financial support and opportunities should be in place, and can be updated, to support and incentivize the implementation of the GBF and monitoring framework.

Conclusion

Effective, transparent, and accountable implementation of policy stemming from the GBF requires evidence of change reflected by indicators of biodiversity and the drivers of biodiversity change derived from a coordinated and sustainable monitoring framework.

Biodiversity observations and monitoring are an essential component for an effective and informed monitoring framework. A continuous and sustained production of relevant biodiversity data will inform the assessment and reporting of progress made towards the goals and targets of the GBF as well as support the planning, review and assessments of its implementation. Existing standards, protocols, tools and methodologies exist to support the needed capacity to leverage, integrate and upgrade existing efforts to monitor the Earth's biodiversity.

Glossary

The following glossary is provided to describe terms used in this document and are adapted from CBD/SBSTTA/24/INF/31.

Term	Definition	Source
Biodiversity dimensions	Refers to different dimensions of biological diversity including genetic, trait, population, species, community and ecosystems. Biological diversity means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.	Article 2 of the Convention, https://www.cbd.int/convention/article s/?a=cbd-02
CARE (Collective benefit, Authority to control, Responsibility, and Ethics) principles	The guiding principles for Indigenous data governance which considers and engages Indigenous Peoples rights and interests.	https://www.gida-global.org/care
Biodiversity indicator	Two definitions are relevant: 1. A quantitative or qualitative variable that provides reliable means to measure a particular phenomenon or attribute of biodiversity. 2. A quantitative or qualitative variable that provides a simple and reliable way to measure the state of biodiversity, assess progress to a conservation objective, or to help assess the performance of a policy derived action for biodiversity.	Noss 1990, Walpole et al. 2017, McQuatters-Gollop et al. 2019
Driver (of biodiversity loss)	Events or processes (natural and anthropogenic) that unequivocally influence biodiversity and ecosystem states and processes.	IPBES 2019 (Chapter 1 and 2)

	Drivers, both non-human-induced and anthropogenic, affect nature directly. Direct anthropogenic drivers are those that flow from human institutions and governance systems and other Indirect drivers. Five main direct drivers are commonly assessed: land/sea use change, climate change, direct exploitation, invasive alien species and pollution.	
Essential Biodiversity Variables (EBVs)	These are geospatial and temporal measurements of the state of biodiversity. They are required to study, report and manage biodiversity change, focusing on status and trend in elements of biodiversity. There are six classes (genetic, species traits, species population, community composition, ecosystem structure, and ecosystem function) and 20 distinct EBVs.	Pereira et al. 2013
FAIR (Findability, Accessibility, Interoperability, and Reuse) principles	The guiding principles for scientific data management and stewardship to improve the findability, accessibility, interoperability, and reuse of digital assets.	Wilkinson et al. 2016
Indicators in GBF: Headline indicators	A minimum set of high-level indicators that capture the overall scope of the goals and targets of the post-2020 global biodiversity framework and which can be used for tracking national progress, as well as for tracking regional and global progress. These indicators could also be used for communication purposes. Additionally, some countries may wish to use a subset of these	Glossary for the first draft of the post-2020 global biodiversity framework[6]

[6] CBD/WG2020/3/3/Add.2/Rev.1 Glossary for the first draft of the post-2020 global biodiversity framework, 26 November 2021.

Component indicators Complementary indicators	indicators or only the goal-level headline indicators for high-level communication and outreach. A set of indicators for monitoring each component of each goal and target of the post-2020 global biodiversity framework at the national level as well as for tracking regional and global progress. A set of indicators for thematic or in-depth analysis of each goal and target and which are less relevant for a majority of countries, have significant methodological or data collection gaps, are highly specific and do not cover the scope of a goal or target component or can only be applied at the global and regional levels.	
Leading indicator	An indicator that informs and predicts the impact of implemented or proposed actions on the current and future state of biodiversity. Leading indicators should change before the subject of interest, thus informing preventative actions.	Stevenson et al. 2021
Monitoring	The process of gathering information about essential biodiversity variable(s) at different points in time for the purpose of assessing system state and drawing inferences about changes in state over time. An additional step in monitoring may include estimating and reporting an indicator: the process that includes collection of primary biodiversity data, synthesis of data into an indicator, and public dissemination of trends in the indicator.	Yoccoz et al. 2001 Jones et al. 2011
Transformative change	A fundamental, system-wide reorganization across	IPBES 2019

	technological, economic and social factors, including paradigms, goals and values.	

APPENDIX 1

Biodiversity monitoring supplies data from different tiers of biodiversity information focused on distinct priorities (Figure A1). Tier 1 includes the vast amount of data collected from broadscale monitoring from public, unstructured and local knowledge sources. Tier 2 consists of information based on data collected consistently from more focused national monitoring systems involving managed species and ecosystems. Tier 3 consists of information based on data collected from intensive monitoring for research purposes and is capable of delivering the detailed information required to manage, maintain and restore biodiversity. These tiers of information are exemplified in New Zealand's Department of Conservation Biodiversity Monitoring and Reporting System[7] and serve to provide comprehensive information about biodiversity across the national scale.

Figure A1. The tiers of biodiversity information (Source: New Zealand Government Department of Conservation).

[7] New Zealand Government Department of Conservation monitoring and reporting system (https://www.doc.govt.nz/our-work/monitoring-and-reporting-system/)

Table A1. Non-exhaustive summary of examples of international monitoring schemes, initiatives, and biodiversity observation networks (BONs).

Name	**Details**	**Link**
Asia-Pacific Biodiversity Observation Network (AP BON)	Marine, coastal, freshwater, terrestrial biodiversity observations and monitoring	http://www.esabii.biodic.go.jp/ap-bon/index.html
Circumpolar Biodiversity Monitoring Programme (CBMP)	Marine, freshwater, terrestrial, and coastal ecosystems, with community-based monitoring	https://www.caff.is/about-the-cbmp
Europa Biodiversity Observation Network (EuropaBON)	Marine, freshwater, terrestrial ecosystems and ecosystem services; Europe-wide	https://europabon.org/
European Butterfly Indicator	Population trends of European grassland butterflies across 19 European countries	https://www.eea.europa.eu/data-and-maps/figures/european-grassland-butterfly-indicator
Freshwater Biodiversity Observation Network (FW BON)	Global freshwater biodiversity observations and monitoring	https://geobon.org/bons/thematic-bon/freshwater-bon/ http://www.freshwaterplatform.eu/
Global Coral Reef Monitoring Network (GCRMN)	Monitoring and reporting on the status of coral reefs worldwide	https://gcrmn.net/
Global Observation Research Initiative in Alpine Environments (GLORIA)	Established in 2001, over 120 sites from poles to tropics	https://www.gloria.ac.at/

International Waterbird Census	Monitoring of waterbirds at wetland sites across major flyways of the world	https://www.wetlands.org/our-approach/healthy-wetland-nature/international-waterbird-census/
Long Term Ecological Research Network (LTER)	Established in 1980, with 28 sites across US, Puerto Rico and Antarctica, and different ecosystems	https://lternet.edu/
Marine Biodiversity Observation Network (MBON)	Global marine biodiversity and ecosystem functions	https://marinebon.org/
Pan-European Common Bird Monitoring Scheme	Established in 2002, a long-term monitoring initiative collecting information on changes in breeding populations in common birds across Europe	https://www.ebcc.info/pecbms/
Soil Biodiversity Observation Network (SoilBON)	Global soil biodiversity observations and monitoring	https://www.globalsoilbiodiversity.org/soilbon
Tropical Ecological and Monitoring Network (TEAM)	Monitoring of long-term trends in biodiversity, land cover change, climate and ecosystem services in tropical forests	https://www.wildlifeinsights.org/team-network

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