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European Biodiversity Partnership

EUROPEAN PARTNERSHIP

Strategic Biodiversity Monitoring Governance Document (Phase III)

Recommendations towards harmonised biodiversity monitoring on transnational and national scales across Europe

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What is Biodiversa+

The European Biodiversity Partnership, Biodiversa+, supports excellent research on biodiversity with an impact for policy and society. Connecting science, policy and practice for transformative change, Biodiversa+ is part of the European Biodiversity Strategy for 2030 that aims to put Europe's biodiversity on a path to recovery by 2030. Co-funded by the European Commission, Biodiversa+ gathers partners from research funding, programming and environmental policy actors in European and associated countries to work on 5 main objectives:

1. Plan and support research and innovation on biodiversity through a shared strategy, annual joint calls for research projects and capacity building activities
2. Set up a network of harmonised schemes to improve monitoring of biodiversity and ecosystem services across Europe
3. Contribute to high-end knowledge for deploying Nature-based Solutions and valuation of biodiversity in the private sector
4. Ensure efficient science-based support for policy-making and implementation in Europe
5. Strengthen the relevance and impact of pan-European research on biodiversity in a global context.

More information at: https://www.biodiversa.eu/

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List of acronyms

AnaEE ERIC	Analysis and Experimentation on Ecosystems ERIC
CBD	Convention on Biological Diversity
CEOS	Committee on Earth Observation Satellites
CoL	Catalogue of Life
CSA	Canadian Space Agency
DEIMS-SDR	Dynamic Ecological Information Management System - Site and dataset registry
DiSSCo	Distributed System of Scientific Collections
EBOCC	EU Biodiversity Observation Coordination Centre
EBV	Essential Biodiversity Variable
EEA	European Environment Agency
EMBRC ERIC	European Marine Biological Resource Centre ERIC
EO	Earth Observation
EOSC	European Open Science Cloud
ESA	European Space Agency
ESVD	Ecosystem Services Valuation Database
ERIC	European Research Infrastructure Consortium
FAIR	Findability, Accessibility, Interoperability and Reusability of data
GBIF	Global Biodiversity Information Facility
GEO	Group on Earth Observations
GEO BON	Group on Earth Observations Biodiversity Observation Network
GLOSOLAN	Global Soil Laboratory Network
GRSciColl	Global Registry of Scientific Collections
HELCOM	Baltic Marine Environment Protection Commission
ILTER	International Long Term Ecological Research
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IUCN	International Union for the Conservation of Nature
JAXA	Japan Aerospace Exploration Agency
JRC	Joint Research Centre (European Commission)
LifeWatch ERIC	e-Science research facilities ERIC
LTER-Europe	Long-Term Ecosystem Research in Europe
MIRRI ERIC	Microbial Resource Research Infrastructure ERIC
MSFD	Marine Strategy Framework Directive
NASA	National Aeronautics and Space Administration
NBMCC	National Biodiversity Monitoring Coordination Centre
NETSOB	International Network on Soil Biodiversity
OBIS	Ocean Biodiversity Information System

PPP	Purchasing Power Parity
RS	Remote sensing
SDG	Sustainable Development Goals
SEEA-EA	System of Environmental-Economic Accounting, Ecosystem Accounting
TDWG	Taxonomic Databases Working Group
WFD	Water Framework Directive

Executive Summary

Biodiversity loss in Europe is accelerating, while the data needed to guide policy and measure progress remain fragmented, uneven, and insufficiently coordinated. Despite extensive national monitoring efforts, current systems remain fragmented, resulting in significant gaps in spatial, temporal, and taxonomic data coverage, as well as limited interoperability and accessibility of data across countries.

This Phase III report of Biodiversa+ presents a synthesis of progress and sets out strategic recommendations to advance a coordinated, transnational biodiversity monitoring framework across Europe. Building on earlier phases, it focuses on recommendations for strengthening governance structures, harmonising monitoring practices, and improving the long-term sustainability and usability of biodiversity data.

A central recommendation is the establishment of a multi-level governance model combining a European-level coordination mechanism (such as the proposed European Biodiversity Observation Coordination Centre), supported by National Biodiversity Monitoring Coordination Centres and reinforced by existing expert networks acting as Thematic Hubs. This structure would enable streamlined coordination, interoperable data flows, and the delivery of reliable, EU-wide biodiversity information.

The report outlines key operational functions for national coordination centres, including coordination of monitoring activities, capacity building, data management, funding support, and stakeholder engagement. These centres are envisioned as flexible, country-adapted structures that build on existing institutions while serving as focal points for transnational collaboration.

To strengthen transnational biodiversity monitoring, the report proposes common minimum requirements for monitoring protocols and identifies pathways for developing sustainable, long-term monitoring schemes through bottom-up, top-down, or hybrid governance approaches, supported by stable core funding and flexible, innovation-driven modules.

Significant attention is given to the opportunities and challenges associated with deploying novel technologies (e.g. eDNA, remote sensing, bioacoustics), highlighting the need for standardisation, capacity building, shared infrastructure, and improved stakeholder confidence. Addressing these barriers is critical for enhancing monitoring efficiency, coverage, and data quality.

Finally, the report emphasises the importance of aligning biodiversity monitoring with user needs across policy, research, management, and the private sector. A structured, demand-driven approach to setting monitoring priorities is proposed to maximise the societal relevance and impact of monitoring efforts.

In conclusion, Biodiversa+ provides a clear roadmap towards a harmonised, efficient, and policy-relevant European biodiversity monitoring system. Achieving this vision will require sustained political commitment, strengthened collaboration across countries and sectors, and long-term investment in coordination, infrastructure, and capacity building.

1. Introduction

With biodiversity declining at an alarming rate both in Europe and globally (European Environment Agency 2025; IPBES 2019), it is critical to ensure that policy development, measures, and the assessment of their effectiveness are based on accurate data (Gonzalez et al. 2023). Biodiversity monitoring, defined as long-term *periodic and standardized data collection or measurement in a specific sample area aiming to highlight changes in any form of biodiversity* (Silva del Pozo et al. 2023), forms the basis for evidence-based decision-making for all policies linked to nature and ecosystem services from conservation to agriculture and natural resources management. In Europe, however, biodiversity monitoring schemes are not well, or even at all, connected between countries, leading to data gaps and biases in taxonomy, spatial coverage, and temporal resolution (Moersberger et al. 2024).

In a comprehensive review of user and policy needs for biodiversity monitoring in Europe, Moersberger et al. (2024) demonstrate that the top challenges to current monitoring efforts include inadequate data integration, biased data coverage, insufficient data availability and limited financial resources. Suggested solutions start with improving coordination and cooperation, continuing with standardizing data collection and sharing, employing novel technologies, increasing financial resources, and enhancing capacity building and stakeholder engagement (Moersberger et al. 2024).

To strengthen biodiversity monitoring at the European scale, transnational cooperation is needed. The European Biodiversity Partnership, Biodiversa+, aims to help lay the foundations for a transnational network of harmonised biodiversity monitoring schemes with the goal of improving the monitoring of biodiversity and ecosystem services across all land and sea habitats in Europe.

As illustrated in *Figure 1*, the overall strategy of Biodiversa+ is to first analyse the landscape and start to build a collaborative community with common activities. In the next phase, solutions to improve transnational monitoring are identified and then promoted and implemented during the last years of the current partnership.

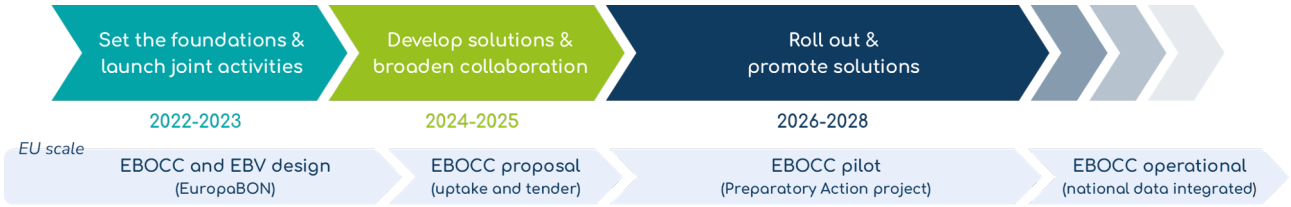


Figure 1. Theory of Change for transnational biodiversity monitoring under Biodiversa+ WP2. Piloting of EBOCC at EU scale will take place 2026-2028.

The most strategically relevant findings of Biodiversa+ on transnational biodiversity monitoring are presented in a series of Strategic reports. This third, and penultimate, report provides a **mid-term overview of the results and recommendations from the partnership to move towards harmonised biodiversity monitoring at transnational and (sub)national scales across Europe**. It proposes elements and recommendations to strengthen biodiversity monitoring in Europe, both in terms of improving governance and cooperation, and of specific operative elements of biodiversity monitoring. It

builds on both the Strategic Phase I report (Vihervaara et al. 2023) that presented the state-of-the-art transnational biodiversity monitoring in Europe at the beginning of the partnership, and the Phase II report (Lipsanen et al. 2024) that summarised the results of Biodiversa+ during the first two years and presented first conclusions and recommendations for improving transnational monitoring (*Text box 1*). The final Strategic Phase IV report will present the key results of Biodiversa+ in 2028.

This report is structured as follows:

- Chapter 2 proposes elements to complement the emerging European multiscale governance model for biodiversity monitoring by introducing the concept of **national biodiversity monitoring coordination centres** and **transnational Thematic Hubs**
- Chapter 3 gives recommendations for **harmonised and effective biodiversity monitoring** in terms of protocols, sustainable long-term monitoring schemes, novel methodologies, citizen science, priority-setting and the use of monitoring data
- Chapter 4 presents an overview of the current **funding for biodiversity monitoring** across Europe
- **Conclusions and a summary** of all recommendations will be provided in Chapter 5

Text box 1

Conclusions of the Biodiversa+ Strategic Phase II report, summarizing the findings from the two first years of the partnership

- **Biodiversity monitoring must meet specific needs to be effective.** Building a relevant framework to identify these needs, i.e. identify actors who use biodiversity monitoring results and compile their use cases, is a necessary step to properly set biodiversity monitoring priorities. This includes identifying needs for harmonising, and where needed, developing common indicators that can be communicated from local to global scales.
- **The establishment of common biodiversity monitoring frameworks is essential for effective mainstreaming of existing biodiversity data and emerging tools (i.e. novel technologies) into policy.** Overcoming this constraint requires the deployment of collaboration tools and effective capacity building efforts. Such a collaborative approach helps to ensure data quality, interoperability, and stakeholder engagement. The proposed harmonisation framework aims to align stakeholder interests, foster collaboration, facilitate data sharing, and promote effective biodiversity monitoring across various scales.
- **For a better use of outputs from biodiversity monitoring schemes by the end-users (both public and private), it is necessary to design full workflows from biodiversity observations, via data processing and towards the uptake of such information in decision making processes.** Such workflows are ideally implemented via a federated approach, involving (multiple centres of) experts, research infrastructures and actors in policy making and businesses.
- **In terms of governance, each country (or sub-national region) should promote the establishment of a biodiversity monitoring coordination centre.** When a more complex structure

is not feasible, as a minimum requirement, well-resourced focal points with a comprehensive overview of the national or subnational biodiversity monitoring systems should be in place to allow for efficient transnational cooperation.

- The Biodiversa+ biodiversity monitoring pilots have demonstrated that **when developing new monitoring schemes at the transnational scale, several new operational issues and bottlenecks emerge and need to be addressed and solved.** For instance, in monitoring involving physical samples that need to be transported and analysed in a centralised laboratory (e.g. soil biodiversity monitoring), the monitoring scheme will have to overcome hurdles related to national rules for collecting, sending and receiving of these samples. Solving such legal and administrative challenges is often underestimated and would need specific attention when establishing operational transnational biodiversity monitoring systems. New schemes should be built on and learn from the experiences of existing transnational monitoring schemes.

2. Transnational and national governance solutions

2.1. Need and options for a European transnational coordinative body

To effectively counteract the loss of biodiversity, temporally, spatially, and taxonomically robust biodiversity data is needed to inform policy-making. European countries produce a vast amount of biodiversity monitoring data, but from a transnational perspective, it is often fragmented and disconnected and therefore hard to use (Moersberger et al. 2024; Liquete et al. 2024). To improve the availability and accessibility of data, coordination and governance models are needed at national, European and where relevant, regional level, i.e. Mediterranean, Alps etc.

To clarify the terminology, both cooperation and coordination aim at achieving jointly defined goals. Drawing from literature on inter-organizational relations, in cooperation these goals are pursued "in a manner corresponding to a shared understanding about contributions and payoffs", while the notion of coordination takes things further, emphasizing deliberate and orderly alignment of partners' actions (Gulati et al. 2012). Governance can be understood as relations regulated on one hand by formal contracts, and on another hand by trust and relational norms (Roehrich et al. 2020). Contractual and relational governance often support and complement each other (Cao & Lumineau 2015, Poppo & Zenger 2002).

The Biodiversa+ partners prefer to see further coordination developed both at national and transnational European levels, in the form of national and EU-level coordination centres (Vihervaara et al. 2023). It remains obvious that transnational governance cannot only consist of national-level structures but needs a truly transnational node to function. As outlined in the Strategic Phase I and II reports, the discussions held within Biodiversa+ and together with various stakeholders and networks, including European Environment Agency, Eionet, GBIF and the European Commission, have strongly focused around the EU Biodiversity Observation Centre (EBOCC)[1], which would coordinate the implementation of a European-wide biodiversity monitoring system, based on the proposal prepared by the EuropaBON project (see section 2.1.1 for further details). In these discussions and consultations, it was agreed that the most valuable role for Biodiversa+ would be to complement the emerging European transnational monitoring governance by focusing on establishing a network of National Biodiversity Monitoring Coordination Centres, as national counterparts for EBOCC (*Figure 2*). This report reflects these discussions and shares the co-created vision for transnational governance from the Biodiversa+ partners and other stakeholders.

In a dynamic political landscape, however, the exploration of a more diverse set of governance options is increasingly relevant. Therefore, this chapter will also address other possible transnational governance options, in addition to a governance model based on EBOCC. These options may be further explored and evaluated during the coming years of Biodiversa+.

Since the proposal for an EU-level centre to coordinate monitoring activities across Europe has already been completed by another Horizon 2020 project, EuropaBON, the focus for Member States, supported

[1] Initially labelled Biodiversity Monitoring Coordination Centre (BMCC), as referred to in Vihervaara et al. 2023.

and facilitated by Biodiversa+, is to develop national biodiversity monitoring coordination centres that would coordinate biodiversity monitoring on a national scale. Their proposed functions are described in chapter 2.2. Connecting national centres or nodes to a transnational node is key to forming a comprehensive transnational network for biodiversity monitoring in Europe. The upcoming biennial European Biodiversity Monitoring Weeks, which aim to gather the entire European monitoring community from monitoring professionals to researchers and policy makers, will form a major platform for strengthening the network of National centres (first edition in France in the Spring 2026).

Approaching biodiversity monitoring only through Member States would, however, not include important players in European biodiversity monitoring governance landscape. Examples are the various existing transnational networks of monitoring communities and experts that work within a specific focus area, such as Butterfly Conservation Europe and European Bird Census Council. This report suggests that these kinds of transnational networks should perform the role of *Thematic Hubs*, that provide expertise and use harmonized methods to collect valuable data for both national and European needs. Their nature and possible roles are further elaborated in *chapter 2.3*. The suggested general coordination model based on EBOCC (or similar), National centres and Thematic Hubs is presented in *Figure 2*.

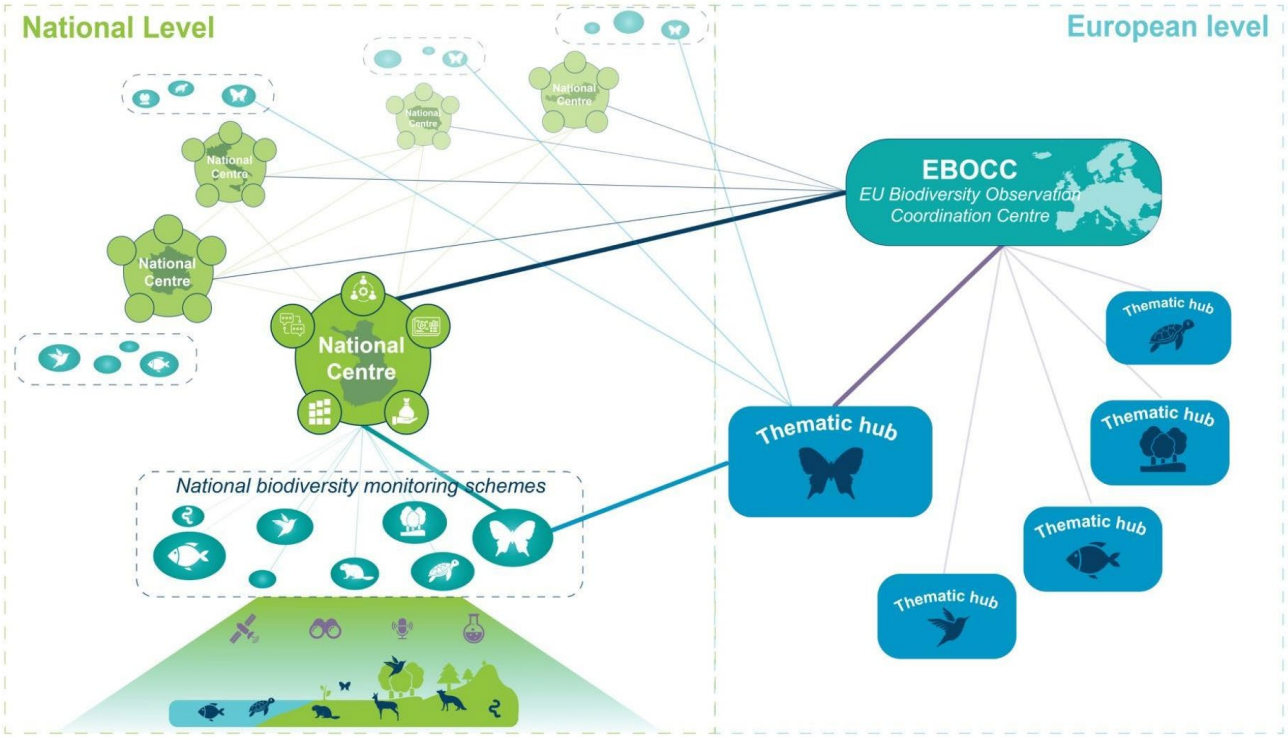


Figure 2. Suggested governance model for biodiversity monitoring in Europe by Biodiversa+ based on the EuropaBON proposal

2.1.1. Governance model based on the European Biodiversity Observation Coordination Centre

From the perspective of Biodiversa+, a key initiative in the field of transnational biodiversity monitoring governance in Europe has been the EU Biodiversity Observation Coordination Centre (EBOCC) for which the terms of reference were proposed by the EuropaBON project (Liquete et al. 2024; Kissling et al. 2026)[2]. This project was funded by the European Commission, and investigated the feasibility of setting up a centre to coordinate monitoring activities across Europe.

As per Liquete et al. (2024), the strategic vision suggested for the EBOCC is to **operationalise harmonised biodiversity monitoring data flows** for the conservation and sustainable use of Europe's terrestrial, marine, and freshwater ecosystems. Its mission is to help coordinate biodiversity-related monitoring efforts in Europe and establish a shared European biodiversity monitoring framework. This is suggested to be achieved by implementing three key functions:

1. **Coordination:** supporting coordination between Member States and organisations involved in monitoring, and assisting them to maintain, enhance and align existing monitoring schemes and developing novel techniques
2. **Data integration:** integrating the results of the monitoring schemes and implementing clear data flows in ways that allow for the harmonisation, or at least the interoperability, of monitoring data at local, national and EU levels.
3. **EU-wide data analysis, including Essential Biodiversity Variables (EBVs):** Analysing the information at EU level, including quality control and modelling to derive indicators and to support policies and stakeholders

In this model, biodiversity monitoring and data collection would continue to be carried out by the EU Member States[3] (Liquete et al. 2024). Smooth operation between the transnational level and Member States is critical, and calls for better national-level coordination and centralised governance structure uniting all relevant organisations involved in biodiversity monitoring in each country. To address this need, Biodiversa+ is exploring the establishment of National Biodiversity Monitoring Coordination Centres, that, accompanied by a transnational coordinative body (EBOCC or similar) could form a European network of national single entry points to biodiversity monitoring in each country. The centres could also be established on a sub-national level, where relevant. A proposal for the concept of National centres is presented in *chapter 2.2*. Although the EBOCC's geographical scope is limited to the European Union, European countries outside the EU may benefit from developing similar national coordination mechanisms as discussed in this report.

The governance of relations between EBOCC and EU Member States, represented by National Biodiversity Monitoring Coordination Centres, have been outlined in the EBOCC proposal (Liquete et al. 2024) and are not repeated in detail here. In this proposal, the National centres would have a direct membership in EBOCC, and would also play a strategic and executive role through EBOCC's General

[2] EuropaBON project, funded by the EU Horizon 2020 programme, identified user and policy needs for biodiversity monitoring and investigated the feasibility of setting up a centre to coordinate monitoring activities across Europe. More information about the project available here: https://europabon.org/

[3] The geographical scope of EBOCC is European Union. Biodiversa+ is a network both EU Member States and countries outside the EU.

Assembly. As outlined in the EBOCC functions listed earlier in this chapter, EBOCC secretariat would support coordination between Member States and assist them to maintain, enhance and align existing monitoring schemes and in developing novel techniques; EBOCC would integrate results of monitoring schemes and implement data flows; and finally, produce EU-wide analysis, including through EBVs. (Liquete et al. 2024.)

Based on the proposal by EuropaBON, the European Commission launched a tender for Preparatory Action in 2026-2028 to pilot some activities suggested for EBOCC and biodiversity monitoring. They include six thematic topics (Essential Biodiversity Variables, EBVs) covering terrestrial, freshwater, and marine realms (European Commission 2025). A consortium, led by the consultancy firm Adelphi, was chosen as the service provider and the pilot was launched in January 2026. It is worth noting, that the tender covers only a limited part of the original EBOCC proposal, having excluded the majority of the governance aspects referred to above. Since it remains unclear, in what form EBOCC might be established after the pilot, if at all, it is necessary to explore additional options for establishing transnational European governance for biodiversity monitoring.

2.1.2. Options for other transnational coordination nodes

As noted previously, a transnational governance model cannot rely only on national-level structures but requires a truly transnational node to function properly. Biodiversa+ partners strongly support the establishment of an EU-level coordination centre to improve coordination (Vihervaara et al. 2023). Aside from the proposed EBOCC, other options could include an extension of the role of GBIF, EuropaBON, GEO BON, EEA/Eionet, or Biodiversa+, if the partnership is continued beyond 2028. These options should be further explored and evaluated during the coming years of Biodiversa+.

2.2. Proposal for national biodiversity monitoring coordination centres

2.2.1. Background and purpose of the concept

The concept for a National Biodiversity Monitoring Coordination Centre (NBMCC) is meant to serve as a general level recommendation for countries and, where relevant, sub-national regions, on how to govern biodiversity monitoring and facilitate transnational collaboration. These centres are suggested as national counterparts for a transnational coordinating entity, thereby enhancing the coordination of biodiversity monitoring on a transnational level in Europe and beyond.

The benefits are manyfold. At national or subnational scales, systematic coordination and governance of monitoring activities may increase collaboration across various organisations, sectors, and scales; improve a smooth flow of monitoring data and information across scales; provide a better understanding of data availability and existing gaps in biodiversity monitoring; and, importantly, support national reporting obligations under multilateral and EU frameworks, such as Kunming-Montreal Global Biodiversity Framework, EU Birds and Habitats Directives and the EU Nature Restoration Regulation, among many others. For biodiversity monitoring experts, increased use of monitoring data could bring wider acknowledgement of expertise and new collaboration possibilities. A coordination mechanism would bring synergies between various cooperation fora and should be understood as an umbrella gathering relevant biodiversity monitoring related focal points and nodes together (see chapter 2.2.3 for

further elaboration). More centralised coordination for biodiversity monitoring on a national scale has also been called for by the United Nations Economic Commission for Europe (UNECE 2022).

At transnational, European and global scales, a shared concept of governing biodiversity monitoring provides a starting point for establishing coordination mechanisms in countries where such a governance structure is missing. For those countries that already have such a structure in place, it offers suggestions for further development and alignment with other European countries. Having somewhat similar governance structures will facilitate transnational cooperation on biodiversity monitoring. For the EU level, the proposed governance framework enables data-driven decision making, improved cost efficiency through wider use of data, as well as increased transparency.

There have been two key principles in developing the concept: 1) the concept is formulated to be general and flexible enough to accommodate administrative, historical, and cultural differences between the countries and 2) the concept is recommended to be implemented in a manner that avoids duplication by building on existing structures and arrangements in each country. In other words, the concept is meant to serve as a source of inspiration and can be adapted flexibly based on the context within each country. The case study from Finland (*Text box 2*) demonstrates flexible yet practical developments towards better coordination on a national level. This proposal has been co-developed in the time when it is still somewhat unclear what (if any) kind of functions and services EBOCC would eventually perform. The proposed model for transnational governance, building on the EuropaBON proposal for the EBOCC, national centres and Thematic Hubs, will need to be finetuned and further developed based on the first experiences and lessons learned from the upcoming piloting phase of EBOCC.

The current name, National Biodiversity Monitoring Coordination Centre, is a working title and may be adjusted during the process, but the preferred name by consensus among the Biodiversa+ partners. Regardless of the final name of the concept, all countries are encouraged to name their respective centres in their own languages, using wording that fits in their context and society. The centre does not have to be an individual organization, but can be understood as an entity, hub or a network, as long as it implements the essential functions presented below in a coordinated manner. A somewhat similar proposal is the concept of national biodiversity observation networks (BONs) promoted by GEO BON (Gonzalez et al. 2023).

2.2.2. Key elements

This chapter describes the key components of the concept, laying out objectives, long-term vision as well as suggested functions and activities. These key elements have been co-designed within Biodiversa+ partners in a series of workshops in 2023-2025, and in consultation with stakeholders such as the Global Biodiversity Information Facility (GBIF) and the European Environment Agency (Eionet network). The proposal presented here represents the viewpoint of the Biodiversa+ network.

Vision and objectives

National Centres would actively contribute to the long-term vision of enhanced biodiversity monitoring governance in Europe, the wide availability of harmonised biodiversity monitoring information across scales, enabling evidence-based conservation and sustainable use of biodiversity. Ultimately, easier, and wider availability of biodiversity information at local, national, European, and even global scale are expected to support informed decision-making on conservation and the sustainable use of natural

resources for the benefit of, not only biodiversity itself, but the whole natural environment, human health and security in the future.

Table 1. Long term vision and Specific objectives of a National Biodiversity Monitoring Coordination Centre

Long-term vision of NBMCC*: harmonized biodiversity monitoring information is widely available across scales and enables evidence-based conservation and sustainable use of biodiversity*
Specific objectives of NBMCC
Facilitate **coordination and cooperation** across scales between organisations and communities involved in biodiversity monitoring
Promote **capacity building**, **technological advancement, and harmonisation** in biodiversity monitoring
Provide **access to biodiversity monitoring information** for all user groups

The specific objectives include facilitation of coordination and cooperation between organisations and communities, promotion of capacity building, technological advancement and harmonisations as well as provision of access to biodiversity monitoring information for all user groups. The two first objectives focus on actions within the biodiversity monitoring communities, whereas the last one directly addresses the benefit for society as a whole.

Functions and activities

The functions and activities describe the operations that the centre should be able to run to match the objectives and contribute towards the long-term vision. Here, the activities are divided into two categories, based on resource availability: priority activities are activities that should be prioritised, if the resources are scarce; additional activities describe more advanced possibilities, subject to the availability of resources. The functions can be taken up gradually, preferably starting from Function 1 (Coordination), e.g. through establishing a coordinating working group of relevant institutions.

Function 1: Coordination

The most important function that a national biodiversity monitoring coordination centre should fulfil is coordination of monitoring activities. The centre should coordinate and enhance cooperation among national (and sub-national) biodiversity monitoring communities and organisations, and serve as a national focal point for international biodiversity monitoring platforms.

Table 2. Examples of activities for the coordination function

Priority activities	Additional activities
• Identify monitoring needs and gaps (from both policy and scientific perspective); • Collect and maintain information on existing monitoring schemes and activities; • Connect monitoring communities and experts at national and transnational scale, including across sectors and realms; • Act as a national focal point for regional and international cooperation platforms concerning biodiversity monitoring (including possible EBOCC); • Coordinate monitoring efforts, as needed, to seek possible synergies and opportunities for synchronisation.	• Facilitate and streamline reporting and periodic assessments.

Function 2: Capacity building and training

The centre should facilitate learning across organisations and communities involved in biodiversity monitoring. Through providing access to training and resources on various aspects of monitoring, the centre should support national biodiversity monitoring schemes and increase acceptance and support for collaborative national and international biodiversity monitoring initiatives.

Possible topics for training could include e.g. fieldwork protocols, data management, quality control, novel methods, as well as network and community management. Through capacity building activities, the centre should promote harmonisation, standardisation, and interoperability of monitoring data as well as mainstream the FAIR principles. The centre should also provide training on calculating Essential Biodiversity Variables (EBVs) and similar metrics.

Table 3. Examples of activities for the capacity building and training function

Priority activities	Additional activities
• Facilitate access to training and capacity building resources • Produce and disseminate guidelines and supporting resources	• Where needed, conduct training sessions, organise symposiums and field visits.

Function 3: Data management

The centre should maintain, and where lacking, be the initiator of a centralised national biodiversity monitoring (meta)data infrastructure. This could be either a centralised database or single entry point for decentrally available data, based on national preferences. To enable meaningful, especially large-scale

and cross-border analysis on biodiversity, all countries should be capable of handling the entire life cycle of their data, from generation, to storing, and accessing them (for further analysis on national and international biodiversity infrastructures, please see Güntsch et al. 2024; Manrique et al. 2021), and the national centre should be seen as a mechanism to support that. The centre should facilitate data mobilisation and work to maximise the use of existing monitoring data, for example by producing and interpreting aggregated knowledge and indicators, including EBVs, to inform policy-making processes and by facilitating data sharing with relevant international infrastructures, such as the Global Biodiversity Information Facility (GBIF) and Ocean Biodiversity Information System (OBIS). Establishing common infrastructure facilities to support the deployment of novel methods should be considered.

International biodiversity data infrastructures provide various services, such as software tools and training programmes that support the development of national biodiversity data infrastructures (Güntsch et al. 2024). Many European countries are already part of the GBIF, an international network and data infrastructure funded by governments and aimed at providing open access to data about all types of life on Earth (GBIF 2025). Other platforms that allow biodiversity information sharing and provide tools and services for data harmonisation include Catalogue of Life and World Register of Marine Species (WoRMS), in which taxonomic data are published. It is recommended for countries to join such networks to gain their manifold benefits.

Table 4. Examples of activities for the data management function

Priority activities	Additional activities
• Establish, where lacking, and maintain centralised biodiversity monitoring (meta)data infrastructure; • Facilitate data mobilisation; • Facilitate standardisation, harmonisation and sharing of biodiversity monitoring data (e.g. with GBIF and OBIS).	• Promote existing standards for data management plans and quality assurance; • Standardise and publish interpreted datasets and indicators (including EBVs); • Address, and advise on, issues of data ownership and intellectual property rights.

Function 4: Support to funding

Sustainable and long-term funding is needed to implement the centres' activities, but the centre itself should also perform functions related to funding issues. The centre should play a role in advocating for stable funding, identifying new funding models and partnerships and models for resource allocation.

On options for funding the activities of the centre, please see chapter 4.2.

Table 5. Examples of activities for the support to funding function

Priority activities	Additional activities
• Provide guidance for funding institutions on priorities for funding allocation; • Support diversification of funding sources; • Obtain an overview of monitoring funding at all levels, from local to international.	• Establish flexible funding mechanisms to adapt to changing and emerging needs; • Develop of new funding mechanisms to achieve long-term support for biodiversity monitoring, for instance partnership co-funding or private co-funding or mixed models

Function 5: Communication and societal engagement

The centre should implement communication activities to highlight the importance of long-term biodiversity monitoring, raise awareness of its results and benefits to society, and engage the public in citizen science initiatives. There should be several target groups: policy makers and governments, media and the general public.

Table 6. Examples of activities for the communication and societal engagement function

Priority activities	Additional activities
• Communicate biodiversity monitoring results, including indicators and trends in biodiversity; • Communicate with funding agencies, policymakers and the private sector to highlight the importance of monitoring efforts; • Facilitate the identification of needs for biodiversity monitoring information in society, from policy to private sector and society more broadly; • Identify and connect with existing and potentially emerging stakeholders, e.g. new users of biodiversity monitoring data and information.	• Work with media, providing training sessions for journalists on biodiversity monitoring topics; • Organize communication activities and events to engage citizens in monitoring activities; • Facilitate the participation of the private sector in biodiversity monitoring both by helping them to find data and by advocating for investment.

2.2.3. Proposed structure of the centre

A National Biodiversity Monitoring Coordination Centre should be understood as an umbrella that brings various relevant biodiversity monitoring related focal points and nodes together on a national level. We propose a general structure here, the detailed operational structure of the centre will be determined independently by each country. To help make choices we have presented some examples of different national governance models in the report of governance pilot of Biodiversa+ (Lipsanen et al. 2023),

included a case study from Finland on their approach towards better coordination at national level (*Text box 2*) and added suggestions below, based on discussions with our network.

To implement the activities and run the operations, the centre first and foremost needs staff. To ensure effective and meaningful coordination, the agencies and other organisations that implement biodiversity monitoring need to be an integral part of the centre and contribute to its activities. As the centre is meant to bring together and build on existing structures, existing focal points and nodes of transnational cooperation structures and platforms should also be included. Ministries or other national authorities that steer (and often fund) biodiversity monitoring could have a steering role to oversee the activities, to set the appropriate legal and normative framework assuring the cooperation among different actors and decision makers, and to ensure the communication of information needs for policy processes - however, differences in administrative cultures may result in different roles and responsibilities for ministries in the centres.

The centre should be hosted by a relevant, preferably governmental organisation, for instance an Environmental Protection Agency. The internal governance system of such a centre should be determined by each country independently to respect the existing administrative practices and current mandates of organisations. The relations of NBMCCs, EBOCC and national biodiversity monitoring schemes are illustrated in *Figure 3*.

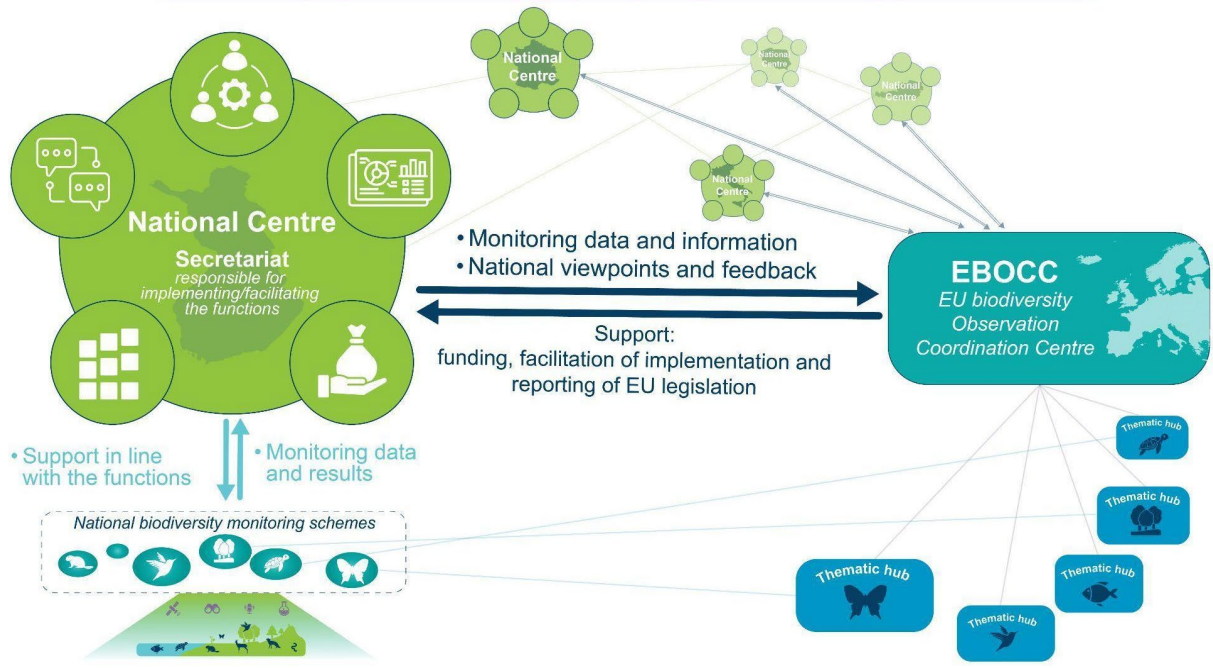


Figure 3. National Biodiversity Monitoring Coordination Centres

Text box 2

Towards better national-level coordination of biodiversity monitoring – case Finland

Like in many countries, in Finland there remain critical gaps in both monitoring of biodiversity and ecosystem services as well as in the use of existing information. The monitoring schemes have been

set up to respond to very different needs, there remains taxonomic, spatial and temporal gaps, there's little coordination between the schemes and the overall landscape is poorly, if at all, coordinated. Existing data are underused, and their interoperability leaves room for improvement.

To address these gaps, **Finland's National Coordination Group for Nature Information** (Lukki) was established in 2023. The coordination group consists of 17 different member organizations, whose purpose is to jointly develop the production, use and sharing of nature related information produced in Finland.

On a national scale, Lukki and Biodiversa+ are very closely linked, as the key experts are involved in both initiatives. The work of Biodiversa+ on National Biodiversity Monitoring Coordination Centres has served as a pacemaker for the national level discussions, and provides inspiration for further aspirations.

Lukki is organized in **four thematic expert groups** that each promote a different aspect of nature related information 1) Use of Nature Related Information, 2) Monitoring, 3) Novel Methods and 4) Data Interoperability. The Finnish Environment Institute provides secretariat functions. Thematic expert groups set their own meeting schedules, and most of the work is asynchronic writing. There's no specific funding for Lukki, except small annual support for the secretariat by the Ministry of Environment; the experts take part in the work on top of their regular duties. One of the four thematic groups, Monitoring, is funded partially through the national Priodiversity LIFE project, within which the development and coordination of biodiversity monitoring schemes are carried out. The Finnish Environment Institute also hosts Finnish Nature Information Hub, a platform that provides an overview of biodiversity monitoring schemes in Finland, serves as a (meta)data search for biodiversity information produced by various organisations, and presents other knowledge services about the state of biodiversity and ecosystems.

Currently, Lukki is working on a **National Roadmap for Biodiversity Monitoring**, that presents practical steps towards the vision that by 2035, Finland will have a comprehensive, coordinated, cost-efficient and interoperable biodiversity monitoring system. The process started by mapping the current landscape and needs, focusing on legally binding monitoring obligations from legislation and multilateral conventions. Needs from municipalities, regions, private sector and research were less included, but could be better integrated in the future. One of the aims of the roadmap is to help prioritization in the time of shrinking resources for biodiversity monitoring; through analysis of legally binding obligations, it has been possible to identify new links and potential for synergies between different schemes and contributing organisations.

A concrete manifestation of improved coordination on a national scale has been the **Biodiversity Information Day**, that has gathered experts and organizations engaged in biodiversity monitoring to one room to share knowledge, exchange on topical issues and discuss common priorities. Previously, large-scale events organized for experts in biodiversity monitoring were held twice, in 2021 and 2022. Those earlier events focused on species monitoring, whereas the 2026 event covered all levels of biodiversity — including the monitoring of genetic diversity and habitats in addition to species. One

result has simply been to get to know each other – collaboration is easier, when key experts from different organizations are, at least, familiar faces.

2.3. Thematic Hubs as coordination mechanisms for transnational schemes

A key opportunity for future work lies in strengthening the connections between European and national biodiversity monitoring coordination centres and existing monitoring communities. By linking existing monitoring communities within specific focus areas, these hubs provide a platform for exchanging best practices, standardising methodologies, promoting data sharing through common models and vocabularies, and facilitating data integration across various monitoring initiatives. Thematic Hubs play a crucial role in fostering harmonisation and collaboration, operating at supranational scales where scientific, technical, and governance expertise converge (*Figure 4*; Silva del Pozo et al. 2025).

Importantly, this report does not propose the creation of new Thematic Hubs. Instead, the focus is on identifying and linking existing networks to form well-coordinated, functional hubs that enhance cooperation and data interoperability. This proposition strongly aligns with the results of the marine biodiversity monitoring study (JRC et al. 2025), suggesting 1) to strengthen coordination in order to harmonise existing monitoring programmes, 2) to implement common guidelines, and 3) to rely on experts to define effective combinations of methods to address the complexity of ecosystems.

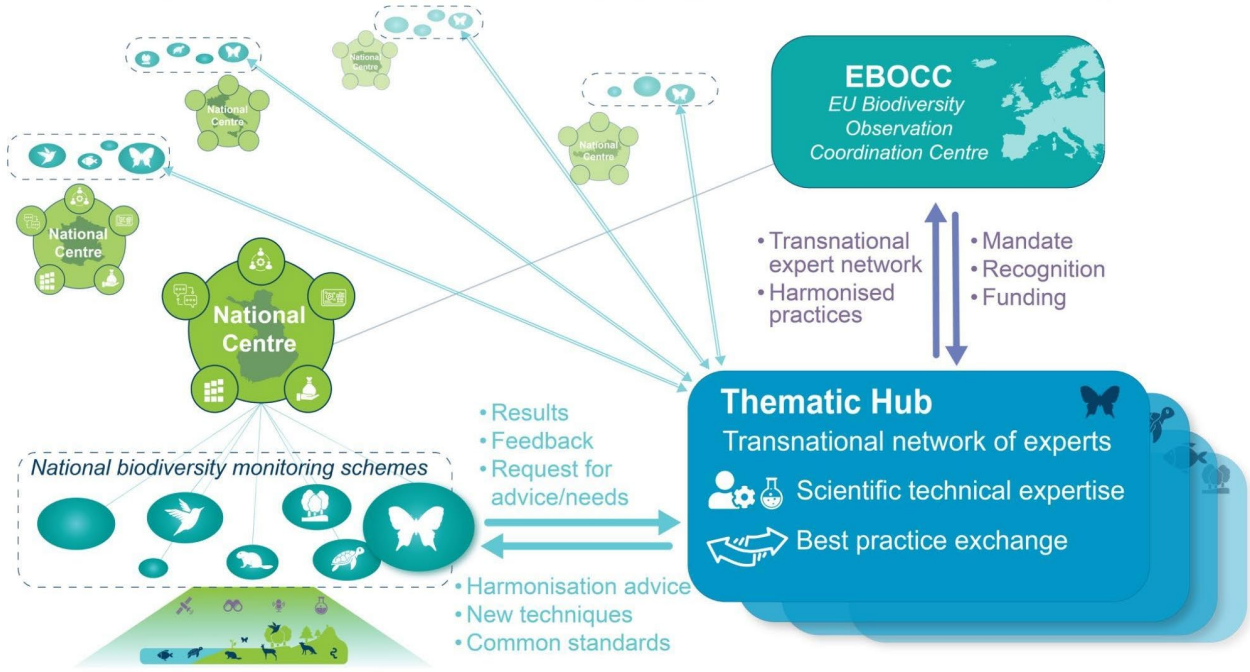


Figure 4. Thematic Hubs in the transnational governance for biodiversity monitoring including in relation to European-level coordination instruments such as a potential EBOCC

2.3.1. Defining a monitoring community

A monitoring community typically shares a common thematic focus and collaborates across multiple stakeholders. Key characteristics include:

- A shared interest in specific biodiversity themes (e.g., pollinators, soil biodiversity, ponds, marine mammals).
- Collaboration among researchers, institutions, national representatives, and citizen science groups.
- Regular data collection and monitoring activities, meetings, workshops, and conferences with an emphasis on data integration.

2.3.2. Types and representation of monitoring communities in Europe

Currently, an estimated 60 active monitoring communities exist across Europe, varying in structure and scope (Silva del Pozo et al. 2025). These include:

- Expert groups: formal working groups, such as the ones defined under OSPAR-HELCOM, that focus on specific monitoring topics (e.g. HELCOM Expert Group on Benthic Habitats and Biotopes (EG Benthic), OSPAR Marine Mammal Expert Group. (OMMEG), etc.).
- Volunteer networks: often involving citizen science initiatives, for example common with birdwatching and butterfly monitoring programmes, but not only (e.g. MECO (Mediterranean Elasmobranch Citizen Observation)).
- Non-Governmental organisations (NGOs): international organisations such as BirdLife International and Reef Check.
- Institutional partnerships: collaborations between academic institutions, government agencies, etc. (e.g. Global Alliance of Continuous Plankton Recorder Surveys (GACS)).
- Intergovernmental agreements & conventions: networks established through frameworks such as the Bern Convention.

Thematic Hubs exist across terrestrial, marine, and freshwater realms, and the interfaces, encompassing diverse scopes of interest (*Figure 5*). These hubs typically form around:

- Specific taxonomic groups or species (e.g., bats, Posidonia oceanica seagrass, pollinators).
- Habitats and ecosystems (e.g., wetlands, forests, Alpine ecosystems).
- Regional monitoring communities (e.g., Carpathian Mountains, Baltic Sea, Danube River).

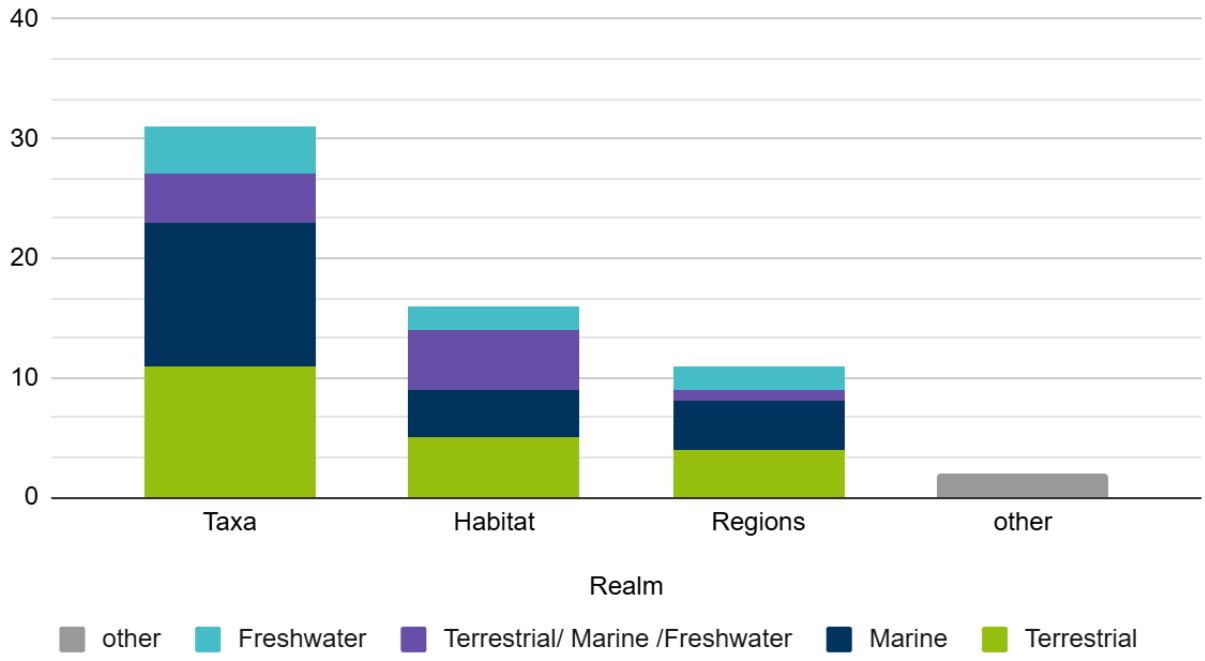


Figure 5. Estimated number of biodiversity monitoring communities by realm (terrestrial, marine, freshwater, and interface realms) and type (c.f. Mapping done under Biodiversa+ Task 2.2.1, publication of an upcoming Biodiversa+ Guidance note on specifications for cross-scale inclusion of harmonised biodiversity monitoring protocols, Silva del Pozo et al. 2025)

Structural diversity: established vs. emerging communities

Thematic Hubs vary in their level of maturity, particularly in monitoring practices and data harmonisation efforts. Some well-established hubs have dedicated expert groups focused on defining standardised or joint monitoring activities. Others are still in the early stages of development, primarily serving as networking platforms where communities gather - often annually - to present their work, exchange knowledge, and share best practices. As these hubs evolve, strengthening coordination and fostering collaboration with relevant other initiatives will be essential for advancing harmonised biodiversity monitoring across Europe.

2.3.3. Functions of a Thematic Hub

Thematic Hubs act as crucial technical backbones for their respective areas of monitoring, serving as a platform of best practice exchange with the scientific technical expertise on the topic. These hubs are intended to run long-term, maintained as long as the monitoring community remains active, addressing the need for sustained collaboration and coordination. Their key possible functions may include:

- **Developing and Aligning Standards on Protocols and Tools:** Hubs are responsible for creating, testing, and harmonising methodologies, data collection protocols, and tools within their specific field. This ensures that data collected across different countries for the same thematic area can be compared and integrated.

- **Producing European-scale Trends and Biodiversity Information:** Thematic Hubs leverage the harmonised data to generate aggregated data and analyses at the European scale, providing insights into biodiversity status and trends. They also work to align these trends across different spatial and temporal scales. While these trends are generated by the hubs for broader use, EBOCC could gather this information to support wider European assessments and reporting needs.
- **Sharing Best Practices and Lessons Learned:** By bringing together experts, hubs facilitate the exchange of valuable experiences, successful approaches, and challenges encountered in monitoring, fostering continuous improvement.
- **Facilitating Data Harmonisation and Integration:** Actively promote and implement data harmonisation and integration efforts within their specific thematic area. This includes promoting the use of existing, well-established standards and vocabularies of (meta)data structures, and defining if necessary common extension for their specific domain.
- **Serving as Entry Points to the Wider Biodiversity Observation System:** For stakeholders less connected to broader European coordination bodies, Thematic Hubs offer accessible points of entry to the complex landscape of biodiversity observation, helping to disseminate information and engage a wider audience.

Links with National Biodiversity Monitoring Coordination Centres:

The integration of monitoring efforts also requires strong connections between Thematic Hubs and National Biodiversity Monitoring Coordination Centres. Many Thematic Hubs host experts who are directly involved in national centres. This dual role of experts enables efficient knowledge transfer and ensures that harmonisation parameters agreed at the EU level with the support of Thematic Hubs, are effectively communicated and implemented nationally.

National Biodiversity Monitoring Coordination Centres would have the authority to advise and support the uptake of the harmonised protocols from the Thematic Hubs within their respective countries. The inclusion of representatives from major Thematic Hubs within national frameworks might reinforce crucial feedback loops. This ensures that national implementation challenges and successes are communicated back to the Thematic Hubs, allowing for adaptive management and refinement of harmonisation strategies.

Links with the potential European Biodiversity Observation Coordination Centre:

Thematic Hubs could support a potential EBOCC with domain-specific transnational technical expertise, harmonised transnational protocols, and providing European scale biodiversity trends and information.

A potential EBOCC could provide the Thematic Hubs with a broader, cross-domain framework that includes common minimum requirements, data standards, good practice guides, access to key infrastructures and financial support. The Thematic Hubs would then share and explain these requirements with their own communities, ensuring their implementation and sending community-based feedback to EBOCC.

A continuous dialogue between EBOCC and Thematic Hubs could facilitate technical and institutional interoperability and ensure that monitoring objectives are aligned with policy needs. Thematic Hubs could act as science-based bridges between EBOCC and national monitoring schemes.

To be fully effective, Thematic Hubs require an official mandate to ensure recognition of their community's existence and expertise, as well as strong, recognised links to a potential EBOCC (or similar European-level coordination instrument) and national schemes. This institutional backing would empower them to enforce agreed harmonisation parameters and contribute actively to the development of the European biodiversity monitoring system.

Pathways for cross-community collaboration:

The success of Thematic Hubs in harmonising biodiversity monitoring hinges on their strategic integration within a broader framework. EBOCC represents the scale at which the different biodiversity monitoring themes can collaborate at the European level.

To enhance cross-community coordination, a key area to explore would be the development of common minimum requirements for monitoring protocols. This would lead to defining the foundational elements that establish a shared baseline for all topics, and therefore a central step toward achieving a harmonised approach of biodiversity monitoring across Europe.

Within EBOCC, an inter-community expert group should be established to gather all Thematic Hub representatives. By leveraging existing expert communities experience, the inter-community expert group will ensure that the overarching coordination efforts by EBOCC to develop those minimum requirements are technically sound and relevant to specific biodiversity challenges across domains.

By reinforcing these connections, Thematic Hubs can drive more cohesive and effective biodiversity monitoring efforts across Europe.

3. Recommendations for harmonised and effective biodiversity monitoring

3.1. Common minimum requirements for monitoring protocols

This chapter illustrates the general recommendations from Biodiversa+ on defining necessary common minimum requirements for monitoring protocols with the aim of harmonising European biodiversity monitoring.

Harmonisation allows data to be comparable and integrated across different scales. Common minimum requirements in a monitoring protocol play a crucial role in the harmonisation process by defining baseline standards for monitoring efforts, ensuring data quality, and interoperability. Establishing these minimum requirements helps maintain consistency across studies while allowing some flexibility. This would mean identifying the elements within a protocol that can and should be harmonised while maintaining statistical robustness.

While harmonisation does not require full standardisation of every protocol component, certain elements must be shared or aligned to ensure data comparability. The following main recommendations emerged from our activities, notably from a collaborative expert workshop focused on defining flexible yet robust minimum requirements for protocol sampling designs (Silva del Pozo et al., 2025):

- **Clearly define and share monitoring objectives**

  Defining clear and shared objectives is the cornerstone of harmonisation. These objectives determine variable selection, sampling design, and analytical approaches. They should be aligned with existing frameworks such as Essential Biodiversity Variables (EBVs) or European indicators for biodiversity (e.g. Naeslund et al. 2023), using a shared vocabulary across countries and governance levels.

  It is equally important to define key concepts (e.g. what constitutes a monitoring site, statistical units in space and time) to enable meaningful data comparison and integration.

  These objectives—and their implications—should be communicated with policymakers and implementing agencies to ensure coherence across scales.

- **Minimum vs. Optimal Effort**

  While flexibility in implementation is necessary for national and ecological adaptation, a shared backbone is essential for comparability, particularly at the reporting level.

  To ensure statistical robustness, sampling effort and frequency must meet minimum thresholds (e.g., via power analysis) to detect trends. Further upscaling efforts are encouraged based on each country's capacity.

  Carefully address: measurement errors (e.g. observer variability, species misidentification); sampling errors (e.g. inadequate replication, missing data); systematic biases (e.g. effort imbalance, site selection).

  Statistical methods must be chosen based on variable type and required data structure.

Common Protocol Structure: Balancing Standardisation and Flexibility

Building on these main recommendations for harmonisation, the following elements are proposed as part of a draft common protocol structure. These guide the harmonisation process by identifying which protocol elements must be standardised and which allow flexibility.

- **Strict elements** that demand consistency across studies include the **Objective** of the monitoring protocol. This foundation defines the purpose and guides all subsequent decisions, so it must be clearly stated and aligned with policy goals using a shared vocabulary (e.g., EBV grammar, EU directives). The **Object of Monitoring** – the "what" (species, communities, habitats, or processes) – must also be precisely defined based on referential lists to ensure consistent data collection. It is strongly recommended to document the underlying taxonomic concept of these lists with a citable and persistent identifier. The **Sampling Unit**, or the smallest unit to which a value is attributed (e.g., plot size), requires strict consistency for comparable measurements, necessitating standard unit templates and clear guidance.
- Elements that offer **flexibility with core strict components** include **Scale (Spatial/Temporal)** and **Variables Measured**. While ecological, logistical, and political contexts vary, minimum spatial and temporal coverage is strictly required to ensure comparability and aggregation, especially concerning policy needs. Beyond these minimums, scaling up is possible. For **Variables Measured**, fixing core variables allows harmonisation, provided definitions and units are agreed upon. Optional variables can enrich protocols, with extended versions allowing additional variables. Similarly, **Sample Size & Frequency** has a strict core for minimum effort to ensure statistical power for detecting change. However, expanded sampling frequency or site numbers can be increased based on specific needs, with power analyses guiding the definition and adjustment of minimum effort.
- Lastly, some elements are designated as **Flexible**, recognising the need for adaptability. The **Sampling Strategy** (e.g., stratified, systematic, random) offers flexibility in design within a statistical framework, as it depends on habitat conditions and objectives. However, once defined, it must remain fixed for implementation. Connecting with a biostatistician is strongly recommended for ensuring high quality while developing the statistical sampling strategy, with stratified sampling often advised for robustness and including substitution options for site accessibility. **Governance** is also flexible; there's no need to harmonise the implementation of monitoring schemes, as they are often managed at national or sub-national scales, maintaining valuable close links with observers for data quality and cultural adaptation.

These recommendations form the basis for a common, flexible, and robust foundation for biodiversity monitoring across Europe and beyond. The next step will be translating these principles into concrete tools and support structures for practitioners across countries and governance levels.

3.2. Elements of sustainable transnational long-term monitoring schemes

Establishing transnational biodiversity monitoring schemes requires a structured approach to collecting and integrating data across multiple countries through harmonized and standardized protocols. Achieving this goal necessitates either a centralized database accessible to all contributing partners or robust

workflows that ensure prompt data exchange among stakeholders. In both cases, the development of clear data agreements that outline procedures for data sharing, benefit distribution, and a shared vision for long-term sustainability are strongly necessary. Such agreements require an ongoing dialogue among stakeholders, with particular effort needed to involve decision-makers and provide them with information that supports transnational efforts. Partnerships such as Biodiversa+ play a key role in facilitating these agreements by offering a platform for dialogue, gathering information on governance structures and existing mechanisms, and supporting joint data analysis to tackle the main barriers to collaboration.

Transnational networks, facilitated by Thematic Hubs, could be particularly challenging for biodiversity monitoring efforts involving physical sample collection, where the choice between centralized versus decentralized storage facilities must be carefully evaluated. Considerations such as anticipated testing volume, existing infrastructure, transportation costs, legal constraints, and accreditation possibilities should inform this decision as well as establishing clear logistic and legal frameworks for shipping samples should be established to support the network knowledge exchange and data analysis. Additionally, risks posed by catastrophic events—such as wildfires and floods—must be accounted for to ensure the security and longevity of stored samples and data repositories.

3.2.1. Three approaches to establishing transnational sustainable monitoring schemes

The choice of governance model (bottom-up, top-down, or hybrid) should be guided by the primary challenge. The participatory processes promoted by Biodiversa+ helped identify the most common governance pathways, while also improving trust and transparency among stakeholders involved. By coordinating structured exchanges between researchers, monitoring practitioners, and decision-makers, Biodiversa+ helped clarify needs, highlight existing mechanisms and drivers of commitment, and uncover both bottlenecks and opportunities in governance and coordination. The governance approaches described below do not aim to redefine biodiversity monitoring objectives or indicators established under EU legislation, but identify pathways for different levels of implementation context, capacity distribution, and coordination needs. Core directives (Bird and Habitats Directives, WFD, MSFD) already define legally binding objectives and in several cases detailed assessment and reporting frameworks.

Bottom-Up approach (harmonisation & coordination centres)

This model is suitable when multiple research institutes, NGOs, or citizen science networks already collect biodiversity data, but lack coordination or a shared framework. This approach should focus on incentivizing the formation of coordinating bodies such as the Thematic Hubs (c.f. Chapter 2.3.3) to harmonise methodologies, ensure interoperability, and integrate fragmented datasets to allow existing data collection efforts to be aligned with transnational monitoring frameworks, maintaining local flexibility while promoting standardized reporting. This situation characterises large parts of biodiversity monitoring under the Birds and Habitats Directives, where Member States operate established monitoring programmes for species and habitats, including within the Natura 2000 network. In such cases, the priority is to harmonise methodologies, integrate datasets, and ensure that national monitoring outputs can be aggregated and used consistently for EU reporting and assessments.

Top-Down approach (establishing data collection frameworks)

This governance model is suitable when data collection is inconsistent or missing entirely, requiring a centralized framework to define monitoring protocols before decentralization can be considered. In such contexts, strong central guidance is required to establish monitoring schemes in a harmonised manner from the outset. The first step is to provide clear guidelines on what, where, and how data should be collected to meet policy and conservation needs, before responsibilities can be gradually transferred to national and regional stakeholders, shifting the central body's role from direct management to oversight. In the European context, such structured approaches are often embedded in EU environmental legislation. Several directives establish mandatory monitoring obligations and detailed methodological frameworks to ensure comparability across Member States. For example, the Water Framework Directive requires coordinated monitoring programmes within international river basin districts and relies on intercalibrated ecological assessment methods, while the Marine Strategy Framework Directive is supported by Commission Decision (EU) 2017/848, which defines criteria and methodological standards for assessing Good Environmental Status.

Hybrid approach (balancing standardisation and local adaptation)

Different countries have different levels of implementation for a monitoring scheme in taxonomic expertise, data management and analysis power, and access to financial and technical resources. For cases where some regions **already have extensive monitoring efforts**, while others lack sufficient coverage, an approach that combines bottom-up coordination in data-rich regions with **top-down standardisation** in data-poor areas to create a fully integrated transnational monitoring network is suggested. The network of NBMCCs would form a solid basis for such peer-learning. Countries with well-established programmes can provide methodological references, protocols, and operational experience that help guide the development of monitoring schemes in countries where such systems are still emerging, allowing their systems to converge toward comparable standards while avoiding unnecessary duplication of effort. A comparable hybrid approach can be observed in the development of the EU Pollinator Monitoring Scheme. The design and testing of the scheme relied heavily on existing scientific expertise and monitoring initiatives across Europe, which was then used by the European Commission to provide a common monitoring framework and methodological standards. Through pilot projects like the SPRING project and expert networks, the monitoring approaches developed in countries with established monitoring capacity were used to guide the implementation of these harmonised schemes in countries where monitoring infrastructures were less developed.

Sustaining biodiversity monitoring over time requires embedding it into existing and emerging policy frameworks, such as the EU biodiversity strategy 2030, to ensure continued governmental support. However, long-term sustainability must extend beyond political cycles, requiring diversified and resilient funding models that balance institutional stability with adaptive innovation. A sustainable transnational biodiversity monitoring network can be structured using a **Core operations + Modular expansion** model. This model ensures that fundamental monitoring activities remain stable and continuously funded, while allowing for flexible, innovative, and adaptive expansions through targeted modules.

Core operations refer to the essential functions and infrastructure required to maintain the long-term continuity of biodiversity monitoring at the transnational level. These can include:

- Maintaining databases and ensuring data accessibility across spatial and temporal scales.

- Supporting the harmonisation of methods to facilitate comparability and integration.
- Coordinating data collection efforts among participating stakeholders.
- Ensuring governance and oversight to maintain scientific and policy alignment.

To guarantee stability and continuity, core operations should be funded through stable institutional sources, such as governmental funding, EU programmes, and dedicated endowments. In the European context, many biodiversity monitoring obligations are already established under EU environmental legislation, and several directives rely on shared indicators and monitoring frameworks to support multiple policy objectives. For example, monitoring systems developed under the Birds and Habitats Directives, the Water Framework Directive, and the Marine Strategy Framework Directive increasingly contribute to broader biodiversity assessments and to the implementation of the Nature Restoration Regulation. Supporting these shared monitoring infrastructures through stable funding mechanisms therefore allows the same data and indicators to serve multiple reporting and policy needs, while avoiding duplication of effort. Continuous dialogue with policy-makers remains essential to ensure that monitoring systems remain aligned with evolving policy requirements and maintain long-term institutional support.

Modular expansions allow biodiversity monitoring schemes to grow, adapt, and integrate new technologies or regional priorities without compromising the stability of core operations. Unlike core functions, modular activities do not necessarily require long-term financial security and can be funded through competitive grants, short-term research projects, and public-private partnerships. However, it is important to recognize that if modular activities are successfully integrated into the scheme, they may generate additional costs for permanent core operations. Modular expansions can include:

- Technology piloting: testing and implementing new monitoring tools (e.g., ai-driven image recognition, eDNA, remote sensing) to enhance cost-efficiency and data quality.
- Citizen science expansion: engaging the public in biodiversity data collection to supplement traditional monitoring networks.
- Training and capacity building: organizing workshops, certification programmes, and expert exchanges to expand the technical expertise available for monitoring efforts.
- Regional adaptation modules: adjusting monitoring strategies to address specific ecological, climatic, or socio-economic conditions in different regions.

The National Biodiversity Monitoring Coordination Centres play a critical role in ensuring the long-term sustainability of biodiversity monitoring within a transnational network. At the national level, they should oversee and manage Core Operations by providing the functional infrastructure to support local initiatives of biodiversity monitoring. In addition to maintaining core functions, the centres should actively collaborate with the transnational network to support, implement, and align modular expansion activities at the pan-European scale. By acting as intermediaries between local monitoring initiatives and international frameworks, the centres can ensure that expansion modules are adapted to national contexts while remaining harmonized at the transnational level. A well-integrated system of national centres will allow the transnational network to balance stability with adaptability, ensuring that core biodiversity monitoring efforts remain resilient and policy-relevant, while modular innovations continue to drive scientific and technological progress.

Although the network of national centres should be designed to be self-sustaining, the establishment of a European-level coordinating body is essential to ensure long-term stability, methodological coherence, and strategic guidance at the transnational level. This kind of European-level body should safeguard the continuity of Core Operations at the international scale and act as a reference point for the national centres, while collaborating with networks such as eLTER and the proposed Thematic hubs, which have complementary responsibilities in achieving transnational monitoring (e.g. harmonization). In line with the autonomy principles of the countries, this entity should function as a facilitator and support structure, rather than by centralizing control, thereby making it possible for national centres to operate effectively within a cohesive yet adaptable transnational framework.

3.3. Gaps, constraints and potential solutions for deploying novel methodologies across Europe

The use of novel technologies in policy relevant biodiversity monitoring programmes is growing due to the multiple advantages they can offer to study and observe many aspects of biodiversity. Novel technologies can ensure efficient and more precise data collection and analysis, increasing spatial and temporal resolution and coverage as well as data volume, while overall decreasing sampling time and effort. Their use can also provide access to otherwise hard to reach or even inaccessible ecosystems, and they often use non-invasive approaches ensuring animal welfare and minimal on site intervention. Furthermore, current technological advancements on novel technologies are evolving towards automatization and multi-taxa monitoring opportunities, and thus, monitoring data from novel technologies is becoming rapidly a key, efficient source of information. The use of novel technologies offers great opportunities to be seized for biodiversity monitoring, but their deployment can still be perceived as risky for some governments and relevant stakeholders due to this fast development and rapidly changing context. We have identified challenges in the deployment of novel technologies at European scale, and we try to propose solutions to help support their use among European countries for biodiversity monitoring. Establishing robust workflows and common infrastructure facilities to aid in the deployment of novel technologies could be a key responsibility of National Monitoring Coordination Centres.

3.3.1. Current challenges in the deployment of novel technologies

In Biodiversa+, we explored the current state of deployment and potential use of novel technologies among partners within their national or sub-national biodiversity monitoring programmes, as well as their current constraints and challenges for implementation in the report "Biodiversa roadmap on novel technologies and approaches" (Ramilo-Henry et al. 2024). This report is based on the results of a survey responded by partners in Biodiversa+, i.e., representatives of several European and associated countries. This report identified which novel technologies are currently being deployed or wish to be deployed, including bioacoustics, sensor networks, eDNA, UAVs/drones and camera traps. It also looked at which taxa they are targeting, what EBVs are being monitored and compared the results to those presented by EuropaBON (Dornellas et al. 2023). In addition, we also asked partners to identify any challenges or constraints they face in the implementation of these novel technologies. Overall, we identified several challenges in the deployment of novel technologies for biodiversity monitoring across Europe.

Technology readiness level: A technologies' readiness level refers to the level of implementation and deployment of the novel technology in the actual environment. These aspects were extensively examined by previous work done by EuropaBON (Dornelas et al. 2023). The lack of validation by experts can still be a hurdle for the applications of some methods, but this is highly variable depending on realms (terrestrial, marine, freshwater) and targeted taxa. Although the technology readiness is likely to improve over time with further advancement of ongoing research and innovation projects, many novel technologies are currently ready for implementation for certain taxa and EBVs in biodiversity monitoring programmes, such as remote sensing, eDNA and citizen science approaches (Dornelas et al. 2023).

Lack of awareness: Some novel technologies and their associated advantages still go unnoticed by relevant stakeholders, preventing and/or hindering their implementation, even if the technologies have been established among specialists. One example of this is the lack of knowledge partners reported about sensor networks, despite their many advantages for habitat and species monitoring (Ramilo-Henry et al. 2024), and their popularity among other scientific non-exclusively biodiversity sectors, like micro-climatists. The lack of awareness of the advantages of using novel technologies in comparison to traditional methods can also be a drawback for their use.

Associated costs and lack of funding: High initial investment costs—particularly for expensive equipment and potentially for specialized technical staff—pose a major hurdle to the implementation of novel technologies. Nonetheless, long-term this investment tends to be highly cost-effective. Novel technologies often require less maintenance in comparison to traditional monitoring approaches, while producing much larger volumes of data than traditional monitoring, reducing sampling efforts, and drastically increasing accessibility in hard-to-reach areas.

Data issues and constraints: The most frequently reported challenges by Biodiversa+ partners on the use of novel technologies related to data, specifically: data storage, data analysis and data synthesis (Henry-Ramilo et al. 2024). Many countries reported difficulty in generating the capacities for managing, analysing, validating and storing large volumes of generated data not only on a digital level (relevant for imagery-based approaches, bioacoustics, remote-sensing, among others), but also for physical samplestorage for some novel technologies, like eDNA. In addition, these issues can also be extended into the difficulty of sharing and managing data ownership along FAIR principles, especially in an international context.

Lack of standardisation and harmonisation in protocols and pipelines: The development of novel technologies, as well as their validation and application, often occurs at regional and/or local scales, which leads to duplication of efforts for similar strategies and the establishment of different protocols and pipelines. Although there are examples of efforts are being made towards standardization for novel technologies (e.g., the International eDNA Standardization Task Force (IESTF) for eDNA, International Quiet Ocean Experiment (IQOE) for marine bioacoustics, some working groups within the TDWG Biodiversity Information Standards, etc.), this continues to be one of the main challenges for their implementation at a higher scale, since lack of comparability and integration among monitoring schemes increases the perception of novel technologies as not suitable for broad implementation at national, let alone transnational, levels.

Perception by governments and key stakeholders: Many aspects can intervene into how decision-makers perceive the use of novel technologies:

- *Reliability in results and changing methodologies:* The lack of well-established protocols and procedures at relevant scales, and the need to justify changes in methodologies can produce mistrust and feelings of uncertainty under funding bodies. This is a direct consequence of the lack of harmonisation and standardisation, and the lack of awareness surrounding novel technologies. In addition, changing well-established traditional methodologies can also represent a big step for stakeholders as traditional methodologies have been functional for many years.
- *Scalability challenges:* Novel technologies are often driven and tested at local scales, leading to their later establishment at regional level. How to overcome challenges of upscaling to national and trans-national scales is currently being explored by many countries and projects, and for this purpose standardisation can play a role in holding the ability to upscale. To advance in this direction, there is a need for infrastructure, expertise and capacity, and maybe explore possible integration into broader networks.
- *Negative perspective of loss of fieldwork-based ecology research and education:* As in most cases with the use of novel technologies, there is a loss or at least a decrease in fieldwork or hands-on data collection, which could bring negative consequences to several aspects of science and education in ecology, i.e., affecting knowledge and skills acquisition, attitudes and behaviour, which foster a deeper interest and understanding of nature (Soga and Gaston 2024).
- *Technical difficulties and lack of capacity and training:* Many countries report limitations for increasing capacities to help them implement novel technologies, technical problems (like finding adequate software, automatization, etc.) and lack of training and expertise.

3.3.2. Proposed solutions to overcome challenges in the implementation for novel technologies

In order to overcome the barriers against the use and implementation of novel technologies for biodiversity monitoring, we identify here some key points that could facilitate deployment among and across countries, supported by the National Biodiversity Monitoring Coordination Centres:

Promote transnational collaboration and international agreements on minimal commons. Favouring the creation of spaces or entities where key stakeholder groups (researchers, managers, decision-makers and community of users) can engage in common discussions about novel technologies would help advance many aspects, e.g., identify synergies, share common knowledge and experiences, avoid duplicating efforts, favour comparison allowing identification of most effective approaches, etc. This collaboration could help reduce costs in implementation and promote sharing efforts and expertise, foster development of relevant agreements and address transboundary challenges. One example of this cooperation is the recently established (2023) International eDNA Standardisation Task Force (IESTF, International eDNA Standardization Task Force) for eDNA qPCR and metabarcoding. The proposed future EBOCC, as well as Thematic Hubs, could also play a key role for this in the near future (Liquete et al. 2024).

Promotion of standardisation and harmonisation of pipelines, protocols and databases. Establishing standardized protocols for data and metadata collection, processing and storage for each novel methodology is crucial for long term usage. For this purpose, there are several proposals that could

help move forward the establishment of this standardisation and harmonisation procedures on minimal requirements:

- **Development of standard sampling protocols and data interoperability platforms:** Data obtained from different novel technology methodologies are often incompatible due to differing data types, formats and metadata. Thus, data collection, processing and storage has a direct effect on data integrity. There is a need for increasing the involvement of experts from different disciplines to develop protocols and capacity building activities that facilitate data harmonisation and interoperability.
- **Explore how to ensure FAIR principles on large volumes of data and (standardized) metadata.** To overcome challenges associated with managing large volumes of data, it is not only relevant to share data, metadata and results, but also pipelines, workflows and specific details on methodologies; as well as to develop and promote the use of standardized metadata schemas for different types of novel data including information about data provenance, collection methods, processing steps, and data quality. Collaboration with existing data platforms should be encouraged to enhance data traceability, access and integration, as well as collaboration with manufacturers to adopt open data formats and APIs (application programming interfaces).
- **Centralise calibration processes and training sessions.** The variability in recording equipment, models and sensors from different manufacturers (e.g., acoustic recorders, eDNA samplers, remote sensing platforms) produce data in changing formats and with different levels of accuracy and precision, which creates data integration and comparison gaps. Joined centralized calibration processes and training sessions could help develop standardized performance criteria and calibration protocols for different types of equipment.
- **Publishing guidelines and success stories on the integration of traditional methodologies and novel technologies outputs.**

Common data management and storage platforms: Common data platforms can help reduce individual costs for implementation both for the digital and physical level. Developing common protocols and technical applications for shared data, data management and analysis may be a more difficult path initially than working unilaterally, but in the long term it can generate scale multiplier effects in the use and application of novel technologies. Collaboration with key projects dealing with these challenges on a European level, like Biodiversity Meets Data and Biodiversity Genomic Data, can help us identify more precise solutions and bring closer collaborations among ongoing activities facing similar challenges. In addition, new pathways for storage could be explored with data management experts to overcome problems, like the burdens associated with managing large volumes of data that require large storage capacity. Considering cloud-based storage systems, developing data management plans, comprising data organisation and backup, archiving and access control are some of the key elements that could help us generate adequate data management systems accessible for most where data harmonisation could be encouraged. For genomic-based and AI-based approaches, increasing the quality of reference databases is necessary, as well as recruiting experts for performing validation of results and outputs that will help us foster reliability.

Capacity building and promotion: Exhibiting, promoting and showcasing novel technologies outputs, results and applications can help overcome lack of awareness and increase networking. Promoting examples of success stories for deployment can help increase capacities among countries with the desire

to deploy novel technologies or overcome reliability barriers in perception for decision makers. Relevant methods of doing this include workshops, webinars or seminars, conferences, etc. From Biodiversa+, we have launched a series of capacity building webinars on eDNA, bioacoustic and sensor networks during late 2024 and 2025 (available in Biodiversa+ Youtube channel: (2490) Biodiversa+ - YouTube), we held a Science Fair event in Barcelona centered around novel technologies in May 2025, and we are pushing forward the first Biodiversity Monitoring Week at European level for 2026. In the future, the NBMCCs would also have a strategic role in promotional activities on national levels.

Aiming for institutional support and exploring new financing possibilities: Recognizing well established novel technologies as valid methodologies that are already prepared for being widely deployed for biodiversity monitoring could be essential to foster their application and deployment in (sub)national programmes, e.g., for biodiversity reporting requirements. In addition, relevant entities could also explore new financing possibilities that can allow countries with budget constraints for biodiversity monitoring to overcome financial challenges to start the deployment for novel technologies, especially in the early stages of deployment. Initiatives like Nature Credits, developed to incentivise private investments into actions that protect and preserve nature, could potentially complement public funding and provide opportunities favouring novel technology implementation in key nature positive actions.

3.3.3. Future perspectives

In the coming years, overall recommendations for boosting the use of novel technologies are creating communities of users and experts for different taxa and realms to increase exchange of information, capacity building, and agreements on minimal requirements for standardisation. Advancing towards automatization for continuous monitoring and multi-taxa approaches at common monitoring stations and at different trans-national scales will help us reduce costs and save time. There is already a need for cross technology integration methods, and technologies involving interdisciplinary approaches to machine learning and statistical modelling can help in the integration of data gathered by various novel technologies.

3.4. Methodology for setting priorities for biodiversity monitoring

Biodiversity monitoring does not run in a vacuum. Rather, it serves the purpose of providing data and results from biodiversity monitoring programmes to other uses, such as assessment or management. In Biodiversa+, a ‘supply-and-demand’ framework (Basille et al. 2024) has been developed to help setting biodiversity monitoring priorities. The general principle is to list uses of biodiversity monitoring information (the ‘supply’ part of the framework), in order to identify users of such information, and in turn consult them on their information needs (the ‘demand’ part of the framework).

In detail, we identified 5 broad categories of direct usage of biodiversity information[4] (Figure 6):

1. **Assessment**, which corresponds to the act of evaluating the biological state (status and/or trend) of species or habitats (such as IUCN red lists, or reporting for the Habitats and Birds Directives, Nature

[4] It is important to note that policy making is not a direct usage of biodiversity information as defined here. Rather, policy makers make use of “digested” information, either from assessments or syntheses (e.g. indicators), and as such, come in a second rank of users. In the proposed framework, needs from policy makers should be apparent through the responses of assessors and communicators who are in relation to policy makers.

Restoration Regulation, Water Framework Directive or Marine Strategy Framework Directive), or the progress of action plans and public policies;

2. **Awareness**, which covers activities synthesising information to convey a message (communication) in order to mobilise society in a general sense;
3. **Management**, in all its dimensions: 1) preventive, i.e. efforts to minimise external influences on species, habitats and ecosystems through conservation and protection; 2) corrective, i.e. efforts to revert to a state of reference (to be defined) through manipulation such as restoration and rewilding; 3) exploitative, i.e. sustainable use of natural resources;
4. **Research**, whether it is the production of new and increasing knowledge to understand the natural world, or the production of forecasts and scenarios;
5. **Economy & finance**, i.e. environmental perspective in the economic sector. This includes investment under green (or sustainable) finance, i.e. the comprehensive understanding of nature-related risks for companies and financial institutions, and effective strategies for managing them, as well as the assessment and improvement of corporate environmental performance. This category is somewhat transversal to the others, but in effect relates to public and private investors (through financial markets) as well as business stakeholders (generally speaking, the private sector) that makes it worth its own category.

Once these 5 categories and associated users (assessors, communicators, managers, researchers, and investors and business stakeholders) have been identified (*Figure 6*), we propose a general survey-based methodology precisely targeting these users to set biodiversity monitoring priorities, and revise them over time. This inversion of perspective highlights the cornerstone of our approach: biodiversity monitoring priorities should follow from users' demand with a bottom-up approach, as opposed to a top-down approach where users can only rely on available information without any possibility to influence it. First of all, this approach allows to balance demands by sector (i.e. usage), or on the contrary prioritise sectors, so that biodiversity monitoring data and results effectiveness is maximised. Second, efforts can then be prioritised following users' needs, which ensures that biodiversity monitoring programmes best answer actual demands from all stakeholders that use their data and results.

Here we introduce an overview of the priorities survey, and highlight the reasoning behind it (details can be found in Basille *et al.* 2024). The priorities survey is meant to be repeated every other year, to provide an updated assessment of needs over time, and adjust biodiversity monitoring priorities accordingly. The survey itself is designed with a simple structure with closed-ended questions in the form of lists of topics, which represents candidate priorities. Respondents are simply asked to score each topic on a 6-point scale (0-5) for priority ranking. Topic lists are addressed by realm (marine/freshwater/terrestrial) and biological level (species/habitat or ecosystem), which results in 6 combinations of realm×biological level. The number of topics (candidate priorities) for each combination is limited to 15–20, and evaluated through an individual score instead of ranking among items, given the difficulty to rank such a long list of items (some priorities might be deemed equally important or unimportant, hence blurring answers past the very first items). Having simple priority scores also makes the analysis easier to manage.

The key to the success of the priorities survey will be to share it as largely as possible, through all population targets. We specifically ask respondents to provide specific information about their background (organisation type, country, realm of expertise, category of uses of biodiversity monitoring information), in order to be able to acknowledge and account for the diversity within the respondents and identify potential bias.

Altogether, the priorities survey introduces several benefits in the process of setting biodiversity monitoring priorities:

- **Relevance**: This approach ensures biodiversity monitoring aligns with actual user needs.
- **Adaptability**: It provides a dynamic framework for addressing changing priorities.
- **Collaboration**: It fosters a coordinated European approach to biodiversity monitoring.
- **Engagement**: It encourages active participation from a wide range of stakeholders.

By prioritising user input and adapting to changing needs, this methodology could contribute to coordination between national centres and the possible future European Biodiversity Observation Coordination Centre (EBOCC) or similar European-level coordinating body in establishing and aligning priorities. In particular, in this proposal the national centres could have the responsibility to share the survey and ensure representative participation (e.g. via reminders or targeted campaigns), and, most importantly, relay the priorities to national and subnational levels in order to orient biodiversity monitoring programmes and fill in gaps. The methodology allows to have priorities that are topic-centered, and that can follow new or emerging needs over time. Update of the priorities should however respect/adhere to the need for long-term biodiversity monitoring, and thus the priorities should be used as a way to leverage action to fill in urgent gaps, not to remove existing schemes.

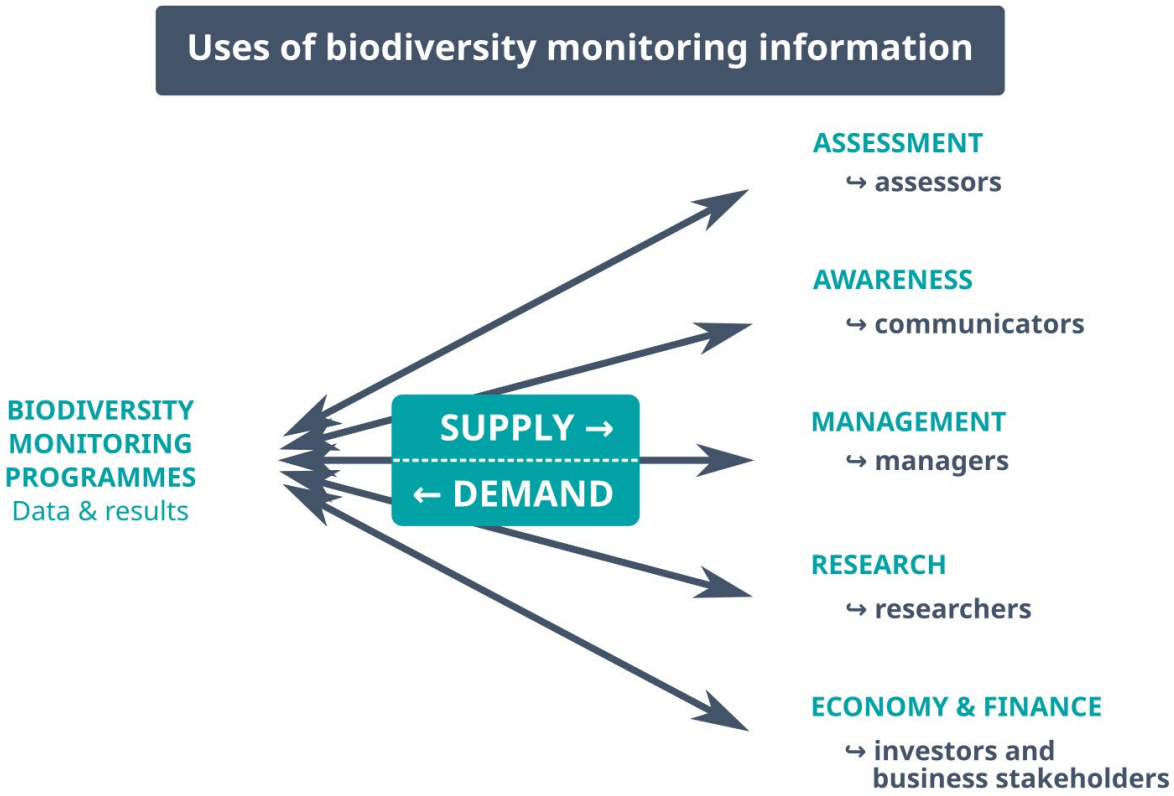


Figure 6. The supply perspective highlights the five main uses of biodiversity monitoring information, which in turn allows to identify/deduce the main users of biodiversity monitoring data and results (demand perspective).

3.5. Enhanced use of monitoring data by research, decision-making and private sector

3.5.1. Use of biodiversity monitoring data in research

Already in the first Biodiversa+ strategic report (Vihervaara et al. 2023) it was noted that enhanced data flow and increased IT support for the research community is needed to help overcome current knowledge and capacity gaps. The main advantage of an enhanced use of monitoring data would be:

- Acceleration and improvement of scientific advancement itself;
- Improved analysis of biodiversity related spatial patterns and past trends, which will be most helpful for policy evaluation and raising awareness at different levels of scale and both for public as well as private decision making;
- Enhancement of modelling exercises of biodiversity related scenarios, which supports the understanding of future trends and stimulates policy development.

Here we further elaborate some of the aspects of major concern.

Integration of biodiversity monitoring data derived from different methods and tools

For better integration of biodiversity monitoring data, further alignment of existing infrastructures will be crucial. At the moment there are dedicated infrastructures (sometimes even multiple) for specific types of monitoring data such as field (count) data; eDNA and other molecular biology-based approaches; functional ecological parameters (biological traits, ecosystem function rates); satellite remote sensing data; data derived from airborne surveys and/or drones; bio -acoustics data; imagery and sound recordings derived from standalone devices by professionals or citizen scientists or gathered via automated and standardized biodiversity sensor networks.

It is of strategic importance to help overcome barriers to the use of these research infrastructures by biodiversity scientists in the European Research Area. Activities undertaken so far have revealed a list of potential steps to take (which partly already are underway):

- Support the accessibility to and re-usability (according to FAIR principles) of data produced by Biodiversa+ funded projects via repositories such as GBIF (e.g. by becoming an endorsed publisher or liaising with existing ones) and by providing guidelines and training on where to deposit data + their format (including tools for formatting to specific long-term repositories);
- Mediate the hosting of Raw data (including eDNA);
- Support the open publication of scripts, algorithms, machine learning approaches and workflows used to align existing research infrastructures and integration of different data types / sources (including improved metadata).
- Promote the long-term communication, maintenance and further growth of datasets resulting from Biodiversa+ funded projects by stimulating the consortia to disclose them in a communicable format (e.g. via GBIF hosted portals or using Horizon Europe open cloud solutions). A first step could also be the publication of general information on Cordis;
- Provide specific support to local stakeholders and (communities of) citizen scientists on data allocation into repositories;
- Promote interoperability between research infrastructures, including by exploring legal national characteristics that could prohibit collaboration;
- Support the communication of an overview of research infrastructures (in the form of a list / map / matrix) including contact info and key characteristics and conditions;
- Promote the application of data standards (and thus support quality control, traceability of data, curation and aggregation);
- Check that generated data is FAIR at the end of funded projects;
- Advocate for long-term commitments to Research Infrastructures (while focussing on a smaller set of them rather than invoking a wide proliferation of different and temporal infrastructures that over time do not get maintained);
- Identify essential non-overlapping infrastructures (in terms of geographical coverage, specialization etc.) and place them in a hierarchical overview as a way to support a better coherence of the current

landscape of infrastructures, including (but not limited to) e.g. Major research infrastructures for biodiversity, such as GBIF (through its European and national nodes); EMBRC ERIC/OBIS; LTER-Europe/ILTER; GEO BON; TDWG; CoL; DiSSCo/GRSciColl; LifeWatch ERIC; the Analysis and Experimentation on Ecosystems ERIC AnaEE; MIRRI ERIC; ESVD; synthesis research centres for biodiversity located in Europe etc.; EOSC;

- Promote the sustained interactions between the in-situ data collection communities and Earth Observation related organisations, including (but not limited to) e.g. ESA (openEO platform), NASA (virtual biodiversity centre), CSA, JAXA, CEOS (biodiversity team), GEO secretariat;
- Stimulate the combination of spatially oriented data sources with the outputs from study sites aiming at the generation of temporal data (e.g. LTER-Europe/ILTER sites disclosed through DEIMS-SDR);
- Promote knowledge transfer regarding Research infrastructures by building up mentor/trainees' schemes and provide funding options for mobility schemes.

Assessing biodiversity status, dynamics, and trends

Better insights in biodiversity status, dynamics and trends can help to safeguard biodiversity and to reverse biodiversity loss. Knowledge needs include a better characterization of the uncertainties associated with the established figures. Also, a better understanding of the effects of combined threats, multiple stressors, and extreme events is needed.

More specifically current challenges are:

- Improved statistical methods for the analysis of biodiversity monitoring data, including spatial patterns and past trends. These are most relevant for policy evaluation and raising awareness. Specific consideration needs to be given to the differences in communicability of different trend metrics in which the same basic data can be expressed (e.g. trends in the number of observations, in the number of individuals, in occurrence within grid cells at different granularities, in total area of occurrence, in population size etc.).
- Enhanced use of biodiversity monitoring data in modelling exercises of biodiversity related scenarios. These are most relevant for exploring future trends and for policy development (see also next paragraph).

3.5.2. Use of biodiversity monitoring data in public decision making

Policy needs

Biodiversity monitoring data play a central role in shaping effective public policies. By translating complex environmental data into actionable indicators, decision-makers can track progress, identify gaps, and prioritize actions.

In Europe, directives such as the Birds and Habitats Directives, the Marine Strategy Framework Directive (MSFD), the Water Framework Directive (WFD), as well as the Nature Restoration Regulation incorporate a range of biodiversity indicators. Globally, the Convention on Biological Diversity's (CBD) Kunming-Montreal Global Biodiversity Framework recently has adopted a set of indicators.

An overview of European and global indicators highlights that although there is substantial work done, there is still need for harmonisation of data and variables used for indicators as well as monitoring methodologies, while also setting thresholds to natural biological and physical boundaries i.e. biogeographic or local variation (Naeslund et al 2023). This was identified as particularly challenging for habitats, where questions of habitat condition, extent and connectivity have got new actuality with the goals in the EU Biodiversity Strategy for 2030 of establishing a functional network of protected areas and the EU Nature Restoration Regulation. New proposals for mapping European ecosystems and their services, and ecosystem accounting (SEEA EA) remain untested at larger scales, and the forest strategy and soil monitoring law also introduce habitat and ecosystem indicators. Additionally, there is a need to monitor and adopt indicators for pressures on various scales that allow for adaptive management, e.g. targeting land use change and invasive alien species addressing restoration targets.

In consultations carried out among ministries of environment, environmental protection agencies and other relevant partners Biodiversa+, the partners likewise confirmed these challenges (Naeslund et al 2023).

They highlighted a similar need for greater harmonisation of methodologies, improved integration of data sources, and the development of coherent approaches that can be applied across biogeographical regions. It has been particularly emphasised that the indicators used must rely on data and be adapted to the intended scale, so that, for example, measures implemented at the local level can be related to trends at the regional, European or global level. This underscores the importance of coordinated efforts to ensure consistency and comparability in monitoring and reporting across initiatives, strategies and legislative frameworks. The partners also emphasised that their own prioritised work aligns closely with the gaps identified in the European and global overviews, particularly in assessing a coherent network with functional connectivity and measuring progress in managing and restoring habitats and ecosystems.

The overview and partners priorities were used to guide the initial indicator work within Biodiversa+ emphasising continuous updates of priorities, see *Chapter 3.5*, taking into account legislative demands and timelines.

Biodiversa+ Support for using Biodiversity Monitoring Data in Policy

Biodiversa+ has set up a joint working group exploring the needs and priorities for indicator harmonisation and development. A joint workshop on connectivity was conducted on the 27th of March 2025 on Zoom with the aim to strengthen transnational collaboration and sharing of best practices (Naeslund et al 2026). Indicators of habitat condition are essential for policymakers to assess environmental health and evaluate the need for, or impact of, restoration efforts. A landscape perspective is crucial in this context, and connectivity indicators are proposed as tools for assessing restoration needs, such as the development of ecological corridors and protected area networks. Remote sensing (RS) techniques are frequently suggested for generating these indicators, but significant technical and ecological challenges must be addressed to ensure that they are reliable. The workshop focused on discussing two policy-relevant indicators in this context:

1. **Natural Area Connectivity on land**[5] Selected to be included in the EU Biodiversity Strategy dashboard to monitor progress towards target 1 regarding the integration of ecological corridors as part of a True Trans-European Nature Network.
6. **Forest Connectivity Indicator** [6], adopted under the EU Nature Restoration Law.

While also discussing ecological theory, conceptual design and modelling approaches to support policy needs.

The workshop underscored the importance of capacity building, better access to high-quality data, and stronger science–policy interfaces to ensure indicators are relevant, credible, and widely adopted. Participants recommended a multi-scale, multi-indicator framework grounded in ecological principles and aligned with policy priorities to advance biodiversity connectivity monitoring and support nature restoration goals across Europe. Structural metrics, such as Forest Area Density within the forest connectivity indicator, provide a practical, operational starting point for EU-wide accounting. At the same time, network-based indicators rooted in ecological theory are emerging as powerful tools for local and regional planning; future efforts should examine how these can be aggregated for broader reporting. Balancing these approaches will keep monitoring feasible today while ensuring scientific robustness over time.

Efforts have also been made to work on one of the CBD headline indicators “area under restoration”. A workshop was set up within the ESA organized Biospace25 conference to bring together data and service providers, end users and stakeholders to foster dialogue on the role of Earth observation technologies, also in conjunction with the implementation of the EU Nature Restoration Regulation. A major outcome of the workshop was that it stated to more: “Strengthen multi-stakeholder dialogue: having continued and iterative conversations and collaboration between Member States, NGO’s, institutions, the EO industry (including ground data expertise), and public and private users with interests in restoration activities...”. The question was raised if it could be a role for ESA to facilitate such a “continued process of knowledge co-creation”.

A planned expansion of Biodiversa+ indicator work (2026–2028) will focus on supporting harmonisation and development of data used for public policy evaluation and indicators for EU and global strategies, such as the EU Biodiversity Strategy for 2030 and CBD’s Global Biodiversity Framework. It is recommended focusing the work on the following key issues to support priority policy areas:

- Exploring required data and Essential Biodiversity Variables (EBVs) at different scales.
- Assessing needs for new monitoring methods and protocols.
- Investigating possibilities for harmonizing analytical methods.

[5] Natural area connectivity on land, indicator 1.3.1 EU Biodiversity Strategy dashboard. https://dopa.jrc.ec.europa.eu/kcbd/EUBDS2030-dashboard/?version=1#COHERENT%20NETWORK%20OF%20PROTECTED%20AREAS
[6] Forest Connectivity Indicator. as developed by FAO, Vogt P., et al., FAO – State of the World’s Forests: Forest Fragmentation, JRC Technical Report, Publications Office of the European Union, Luxembourg, 2019

Recommended actions

- Continue sharing best practices and discussions on using biodiversity monitoring data for policy.
- Explore supporting the development of guidelines for selected indicators.
- Strengthen coordination with ongoing indicator initiatives and guidance from expert groups under the European Biodiversity Platform (EUBP), EEA, the EuropaBON network, Biodiversity Meets Data (BMD), IPBES, as well as CBD-related groups.
- Organize expert workshops to enhance collaboration and improve biodiversity indicators based on local monitoring data.
- Suggested future work to support continued exchange of good practices, integration of national biodiversity data, and long-term support for indicator development beyond the Biodiversa+ project period.

3.5.3. Use of biodiversity monitoring data in private decision making

The use of biodiversity monitoring data is becoming increasingly important for private companies. All businesses, whether directly or indirectly, rely on biodiversity (Sihvonen et al., 2022). However, according to the Nature Benchmark by the World Benchmarking Alliance, no company currently assesses or discloses its dependencies on nature in a holistic way. This lack of transparency hinders efforts to reduce the private sector's negative impacts on biodiversity. For companies to effectively identify and address their nature-related dependencies, access to high-quality biodiversity data—and the capacity to interpret it—is essential.

The 2022 Kunming-Montreal Global Biodiversity Framework (KMGBF) directly addresses this challenge through Target 15, which calls for businesses to assess, disclose, and reduce biodiversity-related risks and negative impacts. Governments are expected to ensure that companies—particularly large, transnational corporations and financial institutions—regularly monitor, evaluate, and transparently report their impacts and dependencies on biodiversity. This applies across their operations, supply chains, value chains, and investment portfolios. In addition, companies are encouraged to inform consumers to support sustainable consumption, comply with access and benefit-sharing measures, and work progressively to minimize negative impacts, enhance positive contributions to biodiversity, reduce biodiversity-related risks, and foster sustainable production practices.

In alignment with KMGBF Target 15, the EU Biodiversity Strategy for 2030 and the broader European Green Deal aim to drive corporate action toward reducing biodiversity impacts and supporting nature restoration. Key regulatory initiatives include the EU Taxonomy for sustainable economic activities and the Corporate Sustainability Reporting Directive (CSRD)[7], both of which are designed to steer businesses toward greater accountability and sustainability.

Easing the use and access of public biodiversity data to private companies is therefore of high importance. That's why Biodiversa+ is soon going to release a guide for private companies to help them

[7] Eur-Lex. EU Directive (EU) 2022/2464 of the European Parliament and of the Council of 14 December 2022 amending Regulation (EU) No 537/2014, Directive 2004/109/EC, Directive 2006/43/EC and Directive 2013/34/EU, as regards corporate sustainability reporting https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32022L2464

accelerate their use of public biodiversity data in the private sector. As part of the work to develop such a guide, led by KPMG Netherlands and Naturalis, private companies were surveyed and interviewed on the challenges they face to use publicly available biodiversity data. **Five key challenges have been identified:**

1. **Knowledge, capacity, and company culture:**

   A lack of internal understanding often prevents private companies from using biodiversity data effectively. There is limited awareness of what biodiversity encompasses, and no shared vocabulary—many companies refer more broadly to "nature" instead. Biodiversity is sometimes perceived as complex or intangible. In addition, companies often lack the internal capacity to access and analyse biodiversity data, and are generally unaware of the data and tools that are already available.

2. **Data availability, quality, and affordability:**

   Public biodiversity data presents several challenges for companies. These include insufficient resolution, data gaps—especially in marine environments and offshore contexts—outdated or static datasets, and a general lack of supply chain transparency. Licensing issues, affordability concerns, and limited availability of ecosystem-level data also create barriers.

3. **Data fragmentation and complexity:**

   Like other biodiversity data users, private companies face challenges related to the fragmentation and technical complexity of biodiversity data. Issues include poor interoperability between datasets, lack of standardised metadata, and difficulty in navigating scattered data sources.

4. **Policy, regulation, and incentives:**

   Companies report uncertainty around current and upcoming biodiversity-related regulations. Many are unclear about future reporting requirements and also face a lack of clear financial or environmental, social, and governance (ESG) incentives to act.

5. **Integration and application barriers:**

   Biodiversity is often not integrated into early-stage business decision-making. Companies point to a lack of standardised metrics, difficulties in tracking changes over time, and uncertainty around defining appropriate baselines—all of which hinder meaningful integration of biodiversity considerations into operations and planning.

But private companies have already identified some ways forward to overcome these challenges by:

- **Being innovative to integrate biodiversity data** and combining public biodiversity data that they can access with additional data that they collect. Novel technologies such as remote sensing or eDNA techniques are of interest. Collaborating with NGOs and researchers to collect more biodiversity data is also frequently used. Hence, reinforcing the connection between private companies, researchers and biodiversity monitoring scheme managers appears to be of high importance for future work. Biodiversa+ is planning to continue in future work in this direction.
- **Reinforcing their "biodiversity" communication to build a corporate culture around biodiversity.** Within private companies, biodiversity data experts are raising internal awareness through storytelling and the use of dashboards giving more visibility to biodiversity. Several companies

explained that this is very important to successfully overcome the challenge of knowledge, capacity and culture as well as the integration and application barrier challenge. Externally a company using biodiversity data can also better engage with local communities and stakeholders, hence helping them also to build their local legitimacy. Better using biodiversity data and integrating such knowledge into decision making processes of the company ends up to be beneficial for the economic activity of the company.

- **Adopting processes and methodologies to monitor biodiversity.** For example by creating internal checklists or guidance, adding biodiversity as a procurement criterion, piloting biodiversity metrics in supplier programmes, adopting TNFD LEAP[8] and Science Based Targets Network (SBTN)[9] methodologies, developing internal risk models.

Biodiversa+ would also suggest exploring how Essential Biodiversity Variables could simplify/help the metrics developed by several initiatives for private companies to assess their biodiversity impact.

3.6. Lessons on transnational governance from the Biodiversa+ pilots

The Biodiversa+ pilot programme offers a window to understand the challenges and opportunities involved with the establishment of transnational monitoring programmes. Biodiversa+ is launching three waves of pilot programmes. The first wave of pilots included the governance pilot, which formed the basis for conceptualising the national coordination centres mentioned above. It also included the Soil biodiversity pilot (Soil pilot) and the Invasive alien species pilot (IAS pilot), which both started in 2023 and have been extended until the end of 2026 and 2027 for the Soil and IAS pilot, respectively. A second wave of three pilots was launched in 2024; Toward a European rocky reef fish monitoring network (EURockFish pilot) and Remote sensing for habitat monitoring (Habitat pilot) and Automated Biodiversity Monitoring Stations (ABMS pilot). A third wave of pilots has just been selected to start in 2026, and these include Biodiversity monitoring of ponds: evaluating the applicability of novel methods and identification of obstacles to wide use (BiodivPond), Monitoring insects using Malaise traps and DNA metabarcoding (MetaBug) and Sensing forest-habitat conditions by remote sensing (Sense-Forest). The Soil and IAS pilots provide the biggest opportunity for extracting lessons learned which is elaborated on below based on their 1st year and 2nd year reports.

The IAS pilot is pioneering scalable, image-based monitoring approaches for terrestrial invasive alien plants and insects, employing advanced camera systems (CamAlien) and automated insect traps (AMI) across 11 countries. These technologies enable rapid, cost-effective detection and mapping of IAS along transport corridors, leveraging deep learning and citizen science data for species identification. The pilot has established robust data management pipelines, fostered collaboration with key infrastructures like Pl@ntNet and GBIF, and demonstrated the feasibility of real-time, automated monitoring at continental scale. Two modules—CamAlien for plants and AMI traps for insects—are deployed to collect image data across biogeographical regions. The CamAlien system, mounted on vehicles, records roadside vegetation, while AMI traps use UV light to attract and photograph nocturnal moths. Lessons from the pilot highlight the importance of harmonised protocols, centralised data management, and shared infrastructure to enable efficient transnational monitoring. The pilot demonstrates that adaptive recording

[8] The LEAP approach: https://tnfd.global/wp-content/uploads/2022/03/tnfd-the-leap-approach.pdf
[9] Science Based Targets Network: https://sciencebasedtargetsnetwork.org/

schedules and tagging mechanisms significantly reduce redundant data and improve model training. Integration with Pl@ntNet and GBIF facilitates automated species identification and data sharing. However, challenges remain, such as hardware reliability, GPS limitations in train-based monitoring, and the need for standardised metadata structures. The pilot also reveals the potential of using global citizen science datasets to train deep learning models for species classification, enabling early detection of IAS across borders. The insect module shows promise in identifying macro moths, including the box tree moth, with relatively low false positive rates. The pilot's centralised data infrastructure allows for seamless partner integration and supports real-time data flow to decision-making platforms like EASIN and GBIF. Future steps include refining IT systems, reducing time lags in data processing, and publishing observations to GBIF and EASIN and the modelling of Essential Biodiversity Variables. The pilot underscores the value of transnational collaboration, shared technological resources, and scalable monitoring frameworks in addressing the complex challenge of IAS. It also highlights the need for continued investment in infrastructure, training, and stakeholder engagement to ensure long-term sustainability and policy relevance.

The Soil pilot is advancing harmonized protocols for both traditional and molecular methods, enabling robust, standardized assessments of soil biodiversity across diverse forest types and countries. By integrating pitfall traps, hand-sorting of soil cores, and eDNA metabarcoding, the pilot improved our understanding of soil ecological communities, highlighting the strengths and limitations of each method, and identifying key areas for methodological innovation, such as primer development and reference database expansion. This work directly supports European and international policy goals, providing essential data and protocols for conservation, restoration, and sustainable soil management. The pilot, involving ten European and associated countries, aims to establish a harmonised approach to soil biodiversity monitoring in protected, near-natural forests. One of the key governance challenges identified so far is the coordination of diverse national partners with varying capacities, expertise, and logistical constraints. Despite a shared step-by-step protocol, implementation varied due to differences in equipment, field conditions, and institutional practices. This highlighted the need for flexibility within harmonised frameworks, allowing for minor deviations while maintaining core methodological consistency. Bilateral meetings between coordinators and national partners proved essential for site selection, ensuring representation across biogeographical regions and forest types, while also accommodating national constraints such as protection status and naturalness. The pilot underscores the importance of clear communication channels and collaborative decision-making to navigate these complexities. Governance also extended to data management and analysis, where centralised processing of eDNA samples helped reduce handling bias and ensured comparability. However, the reliance on external contractors for morphological and molecular analyses introduced dependencies that must be managed through transparent agreements and quality assurance protocols. The pilot revealed that transnational governance must balance scientific rigour with practical feasibility, especially when scaling up monitoring efforts. Legal and administrative issues, such as sample transport regulations and data sharing agreements, were flagged in the Year 1 report and remain critical for future implementation. The pilot also demonstrated the value of integrating national initiatives (e.g. RMQS in France, MBAG in Belgium) into a broader European framework, leveraging existing infrastructure while promoting standardisation. Furthermore, the pilot's alignment with EU policies (e.g. Biodiversity Strategy for 2030, Soil Monitoring Law), EU infrastructures (e.g. EU Soil Observatory, JRC) and international frameworks (e.g. SDGs, NETSOB, GLOSOLAN) illustrates how transnational governance can support policy

coherence and global biodiversity goals. The involvement of regional actors like Catalonia, despite limited sampling, shows that governance structures must accommodate varying levels of participation while ensuring data quality and representativeness. Finally, the pilot highlighted the need for ongoing evaluation of governance mechanisms, particularly in relation to methodological challenges, data interpretation, and the development of Essential Biodiversity Variables (EBVs). As the pilot progresses, questions around sampling frequency, seasonal variability, and taxonomic resolution will require coordinated responses. Overall, the Biodiversa+ pilot demonstrates that successful transnational governance in biodiversity monitoring hinges on inclusive collaboration, methodological harmonisation, adaptive protocols, and alignment with policy frameworks. These lessons are crucial for scaling up soil biodiversity monitoring across Europe and beyond.

The Soil pilot relies on sample collection locally and sample processing centrally. In the IAS pilot, image-based methods for plants and insects are tested. Again, the raw data is collected locally, and digital data is uploaded to a central data storage facility, where image processing takes place. In both cases, this division of labour resembles the idea of national monitoring experts, possibly supported by NBMCCs, and a Thematic Hub.

To establish new permanent long-term transnational biodiversity monitoring schemes, resources will be needed to secure necessary transnational coordinative bodies. While coordination bodies are needed at both the European level (e.g. EBOCC) and national level (e.g. NBMCC), there is also a clear need for a consultative body composed of experts and representatives from the monitoring community. As presented in Chapter 2.3, Biodiversa+ proposes that this kind of transnational communities should be recognized as Thematic Hubs in the future governance of biodiversity monitoring in Europe. In the case of supporting sensor-based biodiversity monitoring, Research Infrastructures like eLTER or possibly LifeWatch ERIC, could be instrumental in adopting the technologies for the longer term.

Table 7. Necessary tasks for transnational monitoring on national and transnational levels, derived from Biodiversa+ pilots

Pilot	Tasks of the national-level partners in the pilot = role of national monitoring experts, possibly supported by future NBMCCs?	Tasks of the pilot coordinator = role of future Thematic Hubs?	Comments and observations
Soil biodiversity	Collection of invertebrate samples	Taxonomic identification, establishment of reference collections	Capacity building on taxonomic identification could happen nationally
Soil biodiversity	Collection of soil samples	Analysis of soil properties, eDNA processing, Bioinformatics	Challenges related to the international shipping of soil material speaks for local analysis of soil properties, while lab bias advises centralized DNA sequencing and bioinformatics.
Invasive alien species	Installation of insect camera traps, upload of raw and metadata	Image recognition pipeline, metadata standards, publishing occurrence data to GBIF	Data ownership, privacy and costs of storage speaks for national or on board image processing using centralised pipelines
Invasive alien species	Survey campaigns with mobile cameras on vehicles (cars, trains and boats)	Image recognition pipeline, metadata standards, publishing occurrence data to GBIF	Data ownership, privacy and costs of storage speaks for national or on board image processing using centralised pipelines

A key lesson learnt across the pilots is that it is surprisingly difficult to upscale monitoring activities to the transnational level and that none of the pilots have achieved their objectives within a single season. All three pilots in the first wave were originally planned for one year, and only the governance pilot, the only pilot which did not involve fieldwork, could complete its activities within one year. Subsequently, all new pilots have been planned for two or more years. The Soil and IAS pilots are now in their third year and only now are they able to explore options for implementation into long-term monitoring. Various activities took longer than expected. First, in pilot projects involving substantial investment in monitoring equipment, procurement rules placed severe constraints on some partners. Manufacturing and delivery of specialised equipment was an additional challenge and trouble-shooting equipment that was either not tested and functioning properly prior to delivery or damaged during transport added to the delay in onset of data collection. For pilots involving taking physical samples, permits and shipping restrictions challenged the centralised processing and analysis of sample content. Finally, the sharing of data to centralized data storage facilities identified IT infrastructure constraints across the partnership.

Nevertheless, by leveraging existing research networks and EU initiatives, the Biodiversa+ pilot sets a precedent for integrating automated biodiversity monitoring into broader conservation strategies, offering a blueprint for future transnational governance of ecological threats.

The lessons learnt from the Soil and IAS pilots suggest that the Biodiversa+ pilots offer a strong foundation for long-term transnational biodiversity monitoring in several key ways:

1. **Harmonized Protocols and Standardization:** Both pilots have developed and tested harmonized protocols for data collection, sample processing, and analysis across multiple countries and habitat types. This standardization is essential for generating comparable data at the European scale, enabling robust assessments of biodiversity trends over time and space.
2. **Integration of Innovative Technologies:** The pilots have pioneered the use of advanced technologies, such as eDNA metabarcoding for soil biodiversity and automated image-based monitoring (using CamAlien and AMI traps) for IAS. These scalable, automated methods allow for efficient, high-resolution, and cost-effective monitoring, making it feasible to expand efforts across large geographic areas and over long periods.
3. **Centralized Data Management and Open Access:** Both pilots have established centralized data management systems that ensure data are stored, processed, and made accessible according to FAIR (Findable, Accessible, Interoperable, Reusable) principles. This facilitates data sharing, integration with global databases (like GBIF and EASIN), and supports transparency and reproducibility.
4. **Capacity Building and Collaboration:** By involving a wide network of partners across Europe, the pilots foster collaboration, knowledge exchange, and capacity building. This networked approach is crucial for sustaining long-term monitoring and for responding to emerging biodiversity challenges.
5. **Policy Support and Early Warning:** The pilots generate actionable data that directly support European and international biodiversity policies, such as the EU Biodiversity Strategy for 2030 and the Kunming-Montreal Global Biodiversity Framework. The IAS pilot, in particular, enables early detection and rapid response to new invasions, which is vital for effective management.
6. **Scalability and Flexibility:** The infrastructure, protocols, and digital tools developed in the pilots are designed to be scalable and adaptable. This means new partners, regions, or taxa can be integrated as monitoring needs evolve, ensuring the system remains relevant and effective over time.

In summary, the Biodiversa+ pilots demonstrate how harmonized, innovative, and collaborative approaches can underpin a sustainable, long-term, and transnational biodiversity monitoring network—providing the data and tools needed for science-based policy, conservation, and management across Europe.

4. Current funding and future needs for monitoring biodiversity

4.1. Overview of existing funding

As identified by the EuropaBON project (Breeze et al. 2023) and Biodiversa+ (Vihervaara et al. 2023), lack of funding or unstable funding is one of the main challenges in establishing long term biodiversity monitoring schemes. Integrating (sub-)national biodiversity monitoring schemes into a pan-European and global system also requires additional funding. In this context, Biodiversa+ studied how much budget is currently spent to monitor biodiversity in different countries to better identify future funding needs to improve and support transnational and harmonised biodiversity monitoring (see chapters 4.1.1 and 4.1.2). Additionally, Biodiversa+, also has implemented national biodiversity monitoring activities on habitats, protected areas, soil biodiversity, marine biodiversity, insects, wildlife diseases, invasive alien species, and transversal activities for a total of 27.6M€ between October 2021 and September 2023. This effort, co-funded by the European Commission, ultimately aims at reinforcing national biodiversity monitoring schemes or creating new complementary ones (see chapter 4.1.3). Such efforts will be continued until the end of the Biodiversa+ partnership.

The information presented in sub-chapters 4.1.1 and 4.1.2 is based on survey responses submitted by 16 Biodiversa+ partners in 2024, which are presented in this chapter for the first time. The survey questions are presented in Annex 1. Only some of the figures were reported to be verified from actual budgets, whereas others reported to rely on expert assessment. Some partners were able to provide the requested information on behalf of all national level organisations involved in biodiversity monitoring, while others were able to include only a limited view of the current budgets. **Therefore, the numbers presented should not be considered as an accurate description of the current budget allocated by partners to annual biodiversity monitoring in their own countries, but rather as an explorative approach and a first step to assess the topic.** The figures reported by partners have not been validated externally and may include inaccuracies or overlaps. Information presented in chapter 4.1.3 is presenting Biodiversa+ activities which do not aim at providing an encompassing picture of all national biodiversity monitoring activities but rather at presenting funding needs from Biodiversa+ countries to monitor biodiversity in the long term and in a more transnational way.

4.1.1. Main trends over the last 10 years to fund biodiversity monitoring

In 2024, Biodiversa+ ran a survey in its network of Ministries of Environment and Environmental Protection Agencies to understand how much budget countries have been dedicating to biodiversity monitoring over the last 10 years. 17 respondents from 16 countries or sub-national regions[10] completed at least one question of the survey. Survey respondents estimated that their budget figures were considered by 31.6% of the respondents as rough estimations, 43.9% as verified figures, 5.8% coming out of a cost model, and 1.8% coming from previous surveys[11].

[10] Responding partners (countries or sub-national regions): Austria, Azores (Portugal), Bulgaria, Catalonia (Spain), Czech Republic, Denmark, Estonia, Finland, France, Ireland, Israel, Moldova, Norway, Slovakia, Sweden, Switzerland. Biodiversa+ partners include both national and sub-national level organizations.
[11] 17% of the respondents didn't answer this question.

Overall, the survey identified **very different levels of investments** among the studied countries to monitor biodiversity for the terrestrial, freshwater and marine realms: going from more than 50 million euros per year for marine biodiversity in France to less than 500k€ for one realm per year in several countries. Looking at these results, investments in monitoring freshwater biodiversity seems to be generally at a lower level than investments in other realms. Terrestrial biodiversity monitoring is usually getting more or equal funding than the freshwater and marine realms (see *Figure 7*).

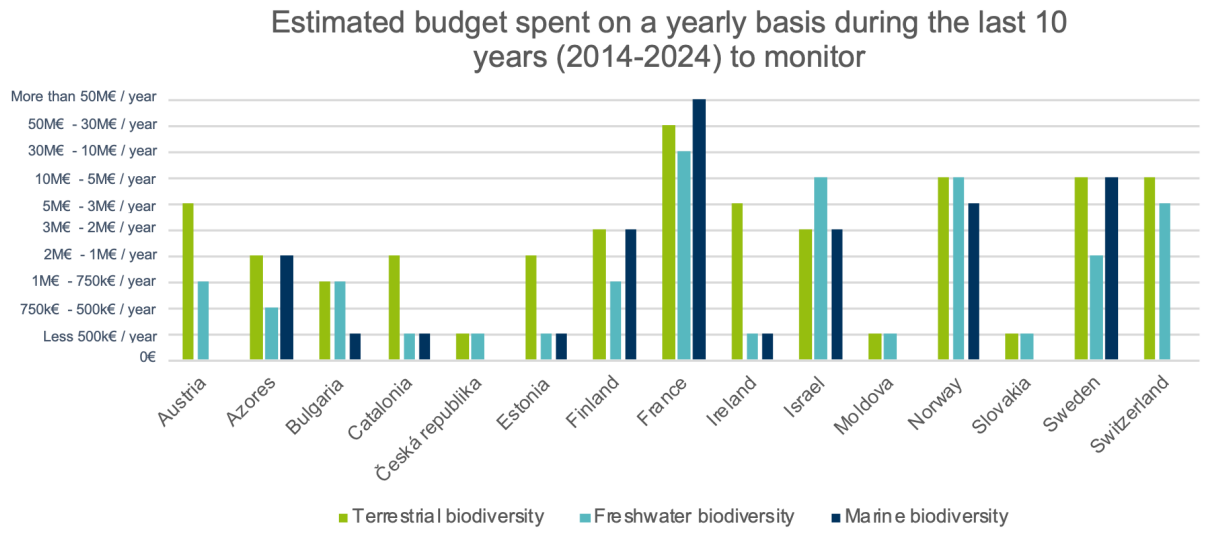
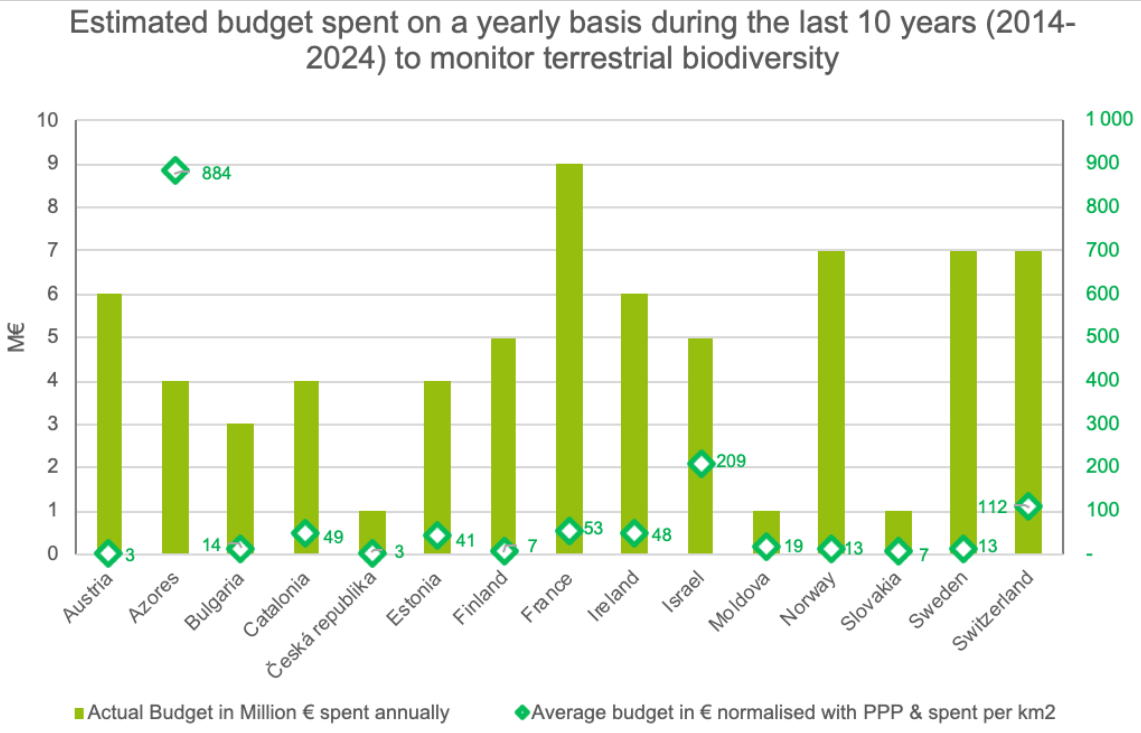
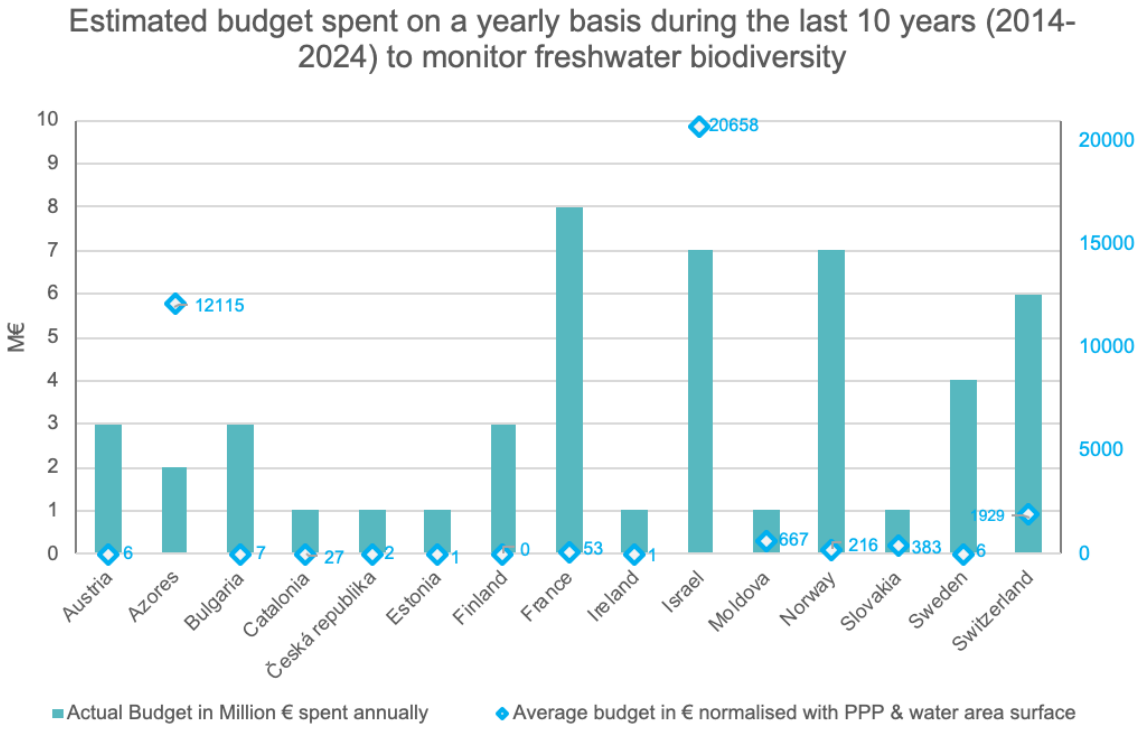


Figure 7. Estimated annual budget spent to monitor biodiversity

The pattern is however more complex. To account for the size of a country (including its marine waters) and also the cost of living, the below figures were normalized with a Purchasing Power Parities (PPP) index, based on OECD figures for 2022. Although the PPP index can have some limits, it remains a good economic indicator to compare national economies. For all realms, the estimated annual budgets were re-calculated with PPP. These PPP budgets were then reported to the surface area of the studied country (terrestrial), to the water surface area of the studied country (freshwater) and to the exclusive economic zone size of a country (marine).

Interestingly, with these normalised calculations, it was revealed that the Azores (Portugal) and Israel are proportionally spending much more budget per km^2 than the remaining countries and sub-national regions, while other countries such as France which had the highest budget in *Figure 7* for all realms remain with an above average spending for terrestrial and freshwater environments only (see *Figure 8*).


Estimated budget spent on a yearly basis during the last 10 years (2014-2024) to monitor terrestrial biodiversity
M€
1 000
900
800
700
600
500
400
300
200
100
-
884
3
14
49
3
41
7
53
48
209
19
13
7
13
112
Austria
Azores
Bulgaria
Catalonia
Česká republika
Estonia
Finland
France
Ireland
Israel
Moldova
Norway
Slovakia
Sweden
Switzerland
Actual Budget in Million € spent annually
Average budget in € normalised with PPP & spent per km2


Estimated budget spent on a yearly basis during the last 10 years (2014-2024) to monitor freshwater biodiversity
M€
20000
15000
10000
5000
0
20658
12115
6
7
27
2
1
0
53
1
667
216
383
6
929
Austria
Azores
Bulgaria
Catalonia
Česká republika
Estonia
Finland
France
Ireland
Israel
Moldova
Norway
Slovakia
Sweden
Switzerland
Actual Budget in Million € spent annually
Average budget in € normalised with PPP & water area surface

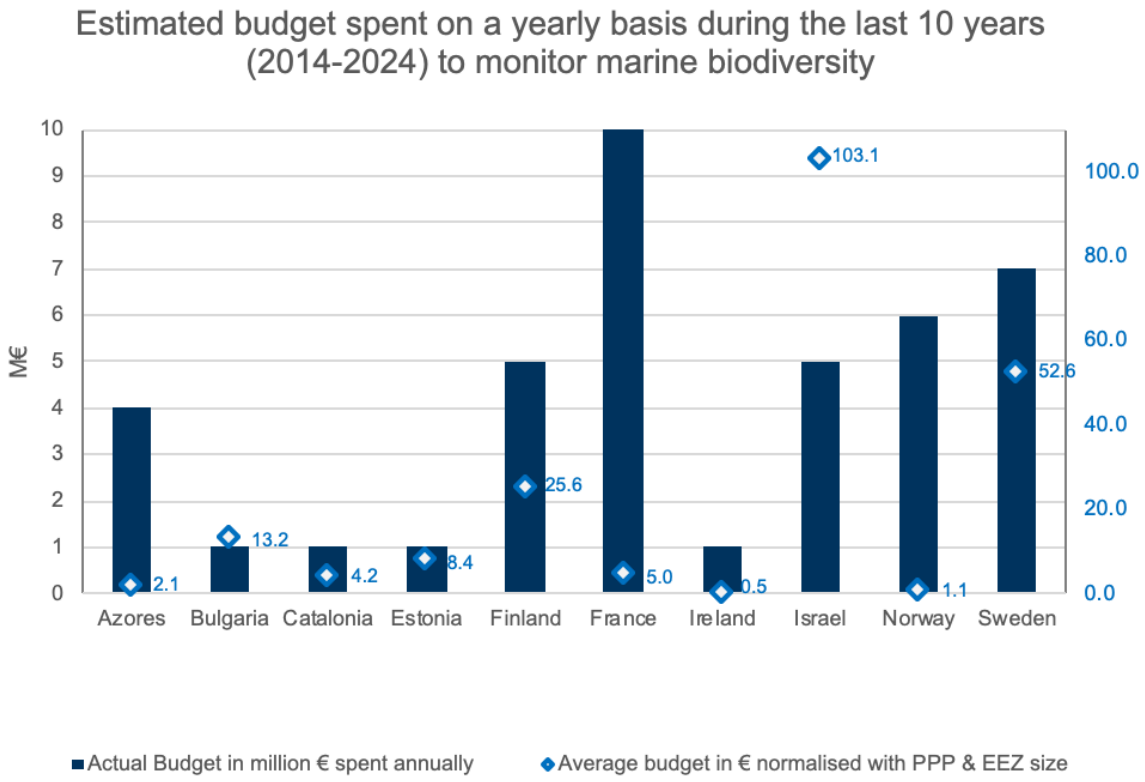


Figure 8a-c. Estimated average budgets spent for one year to monitor terrestrial (a, on top), freshwater (b) and marine (c) biodiversity over the last 10 years. Actual budget normalised by PPP and size of a studied realm.

Regarding **funding stability**, referring to whether funding is continuous rather than project-based, the survey identified that there are major differences between the responding countries (see *Figure 9*), and most of the countries were heavily dependent on project-based funding sources. Securing funding for biodiversity monitoring is a challenge for most of the countries. When stable funding (e.g. through the Ministry of the Environment) is limited or not available, other sources, such as EU grants, funding of other Ministries, national research grants, and international instruments gain more importance. Only a combination of several of these grants allows responding countries to monitor biodiversity in most countries. As recommended by the United Nations Economic Commission for Europe, the sustainability and long-term continuation of biodiversity monitoring would require funding from the State budget (UNECE 2022). In addition, novel funding models such as public-private partnerships, or integrating financial investments as well as environmental impact assessments with support of public data sources could have high potential to stabilise biodiversity monitoring efforts, globally, which needs to be investigated more in the future.

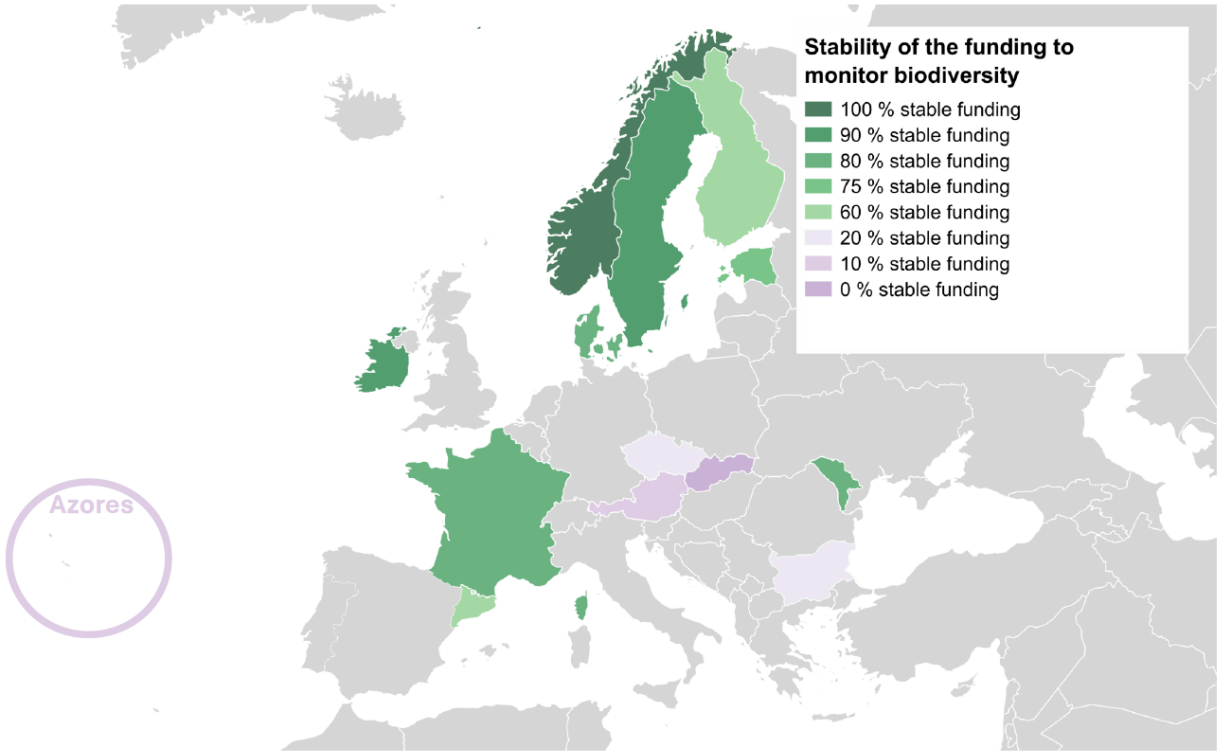


Figure 9. Stability of biodiversity monitoring funding, according to the respondents of a Biodiversa+ survey

As a conclusion, funding allocated to biodiversity monitoring over the last ten years at national level remains very diverse - although it is possible that the respondents were biased to have better knowledge of stably funded schemes than of those that rely highly on project-based funding.

4.1.2. Main bats and soil biodiversity monitoring funding trends over the last 10 years

The survey also focused on two detailed case studies, i.e., how bats and soil biodiversity were being monitored from 2014 to 2024 in the responding countries (see *Figure 10*). These two topical case studies were selected as they fall under the Biodiversa+ biodiversity monitoring priorities (Basille et al. 2023), and they can provide more elaborated and quite different examples to understand financial challenges to run monitoring programmes. Additionally, bats were expected to be monitored in most of the partner countries, while more gaps were expected for soil biodiversity. Another reason to choose soil biodiversity as a topic was to complete the work carried out under the Biodiversa+ soil pilot which is exploring how a transnational biodiversity monitoring scheme for soil biodiversity could be implemented.

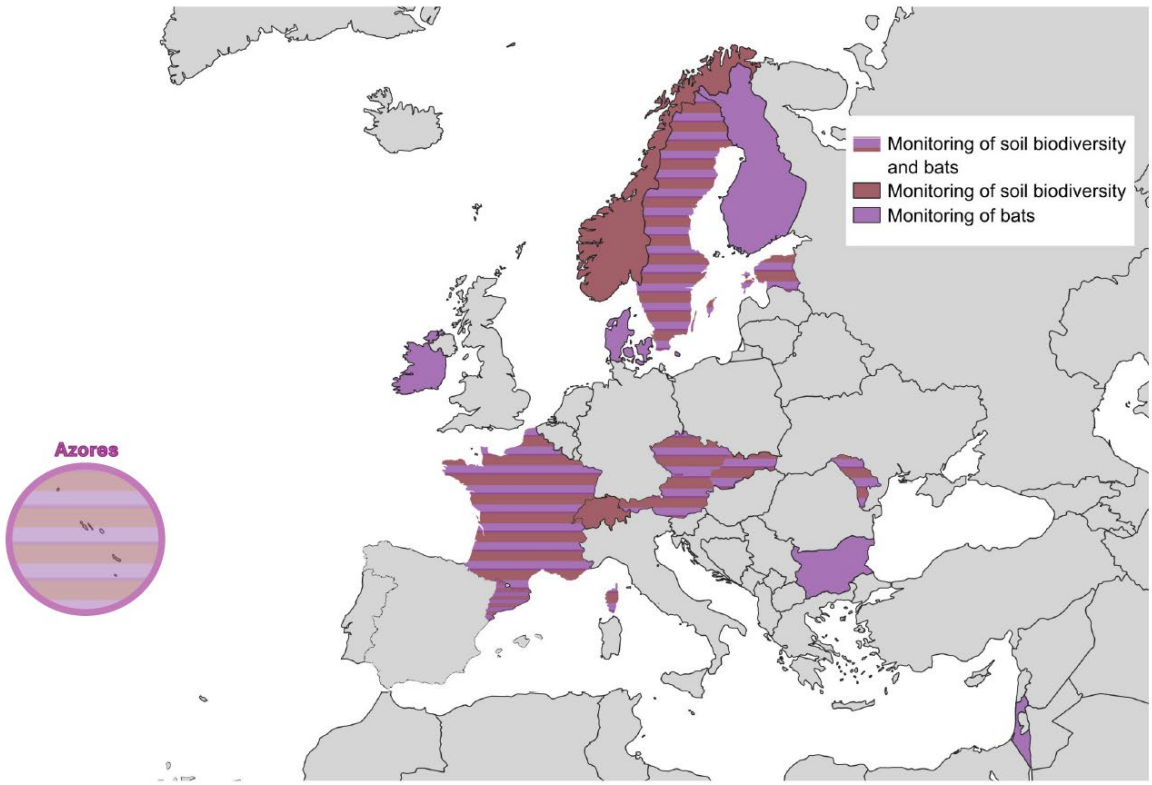


Figure 10. Respondents indicating if bats and/or soil biodiversity is monitored in their country, according to their knowledge

Bat monitoring

From the survey results, it was identified that the 13 responding countries spend annually to monitor bats: 6 countries less than 50k€, 3 countries between 50k€ and 75k€, 2 countries between 75k€ and 100k€ and 2 countries between 100k€ and 150k€. However, it is interesting to identify that smaller, in surface area, sub-national regions such as Catalonia and the Azores both spend more than this average budget. The Azores invest between 75k€ and 100k€ per year and Catalonia is investing a similar budget range as France to monitor bats: between 100k€ and 150k€.

To monitor bats, the survey respondents were asked to estimate how much of their budget was spent for:

- coordination, administrative work and communications
- fieldwork
- data management and storage
- equipment and maintenance
- other subcontracted services

Interestingly here the results varied significantly across the 8 out of the 13 different respondents which completed this question. On average, 26% of the budget is dedicated to coordination, administrative work and communications, 28% to fieldwork, 7% to data management and storage, 12% on equipment and

maintenance and 27% on services from other subcontracted sources. Yet, for the budget importance of the coordination work, it varies significantly from one respondent to another: from 5% to 85% of the total budget. This strong variation echoes the different needs identified by the survey respondents which could be addressed in case of budget increase. Some would increase sampling efforts (6), some would invest to retain their experts (3), some would cover increasing costs such as fuel or inflation (3), and one would better address policy needs (1). Hence, even for Catalonia and France which are spending the highest budget to monitor bats, there is still an avenue to reinforce bat monitoring in Europe.

Soil biodiversity monitoring

The survey results showed that of the 8 responding countries, 2 countries spend less than 50k€ a year on monitoring soil biodiversity, 1 country between 50k€ and 75k€, 3 countries between 100k€ and 150k€, 1 country between 200k€ and 300k€ and 1 more than 500k€ a year. Six respondents indicated that if the budget for monitoring soil biodiversity would be increased, they would like to increase sampling efforts, hence highlighting a need to reinforce (sub-)national soil biodiversity monitoring schemes. The other 2 respondents would like to cover increasing costs, to be able to maintain their current soil biodiversity monitoring scheme or to better answer policy needs which also showcases a need to reinforce their soil biodiversity monitoring schemes. Despite 5 respondents reporting an increase over the last 10 years in the budget for soil biodiversity monitoring, it seems that more financial investment is still needed.

Same as for bat monitoring, the survey respondents were asked to estimate how much of their budget was spent on different activities. The results, coming from 5 respondents, were more consistent than for bat monitoring. On average, 19% of the budget to monitor soil biodiversity is dedicated to coordination, administrative work and communications, 37% to fieldwork, 17% to data management and storage, 6% on equipment & maintenance and 21% on other subcontracted services.

Based on these two case studies, future work could identify through a more qualitative approach how to best invest funding to monitor soil biodiversity and bats.

4.1.3. Recommendations on how to better reinforce and expand national biodiversity monitoring efforts through additional co-funding

During the first two years of Biodiversa+, partners have been implementing national biodiversity monitoring activities on selected topics, as prioritised by the Partnership (Basille et al. 2023 p.14-15). These national biodiversity monitoring activities are aimed at reinforcing biodiversity monitoring schemes, or creating new complementary ones to lay the groundwork for harmonised and coordinated transnational monitoring[12].

Key outcomes of this work were:

- **Co-funding of biodiversity activities by partners and the European Commission was a strong incentive for Biodiversa+ partners to join the Partnership** and stay involved over the years, despite administrative difficulties related to such co-funding mechanisms. Within this framework, partners contribute in-kind resources, notably building on nationally funded biodiversity monitoring activities, which are complemented by EC co-funding to support coordination, harmonisation and reinforcement of biodiversity monitoring efforts across national and transnational scales. This co-

[12] Partners and countries involved in these activities during the first two years of Biodiversa+ are listed in detail in Basille et al. (2025)

funding was an incentive both for lower and higher income countries. The success of this approach is illustrated by the number of partners willing to actively participate in these efforts, **from 15** in the first two years of Biodiversa+, when the instrument was new to all partners, **to 21** in year three and four.

- These co-funded activities illustrate that reinforcing national biodiversity monitoring schemes locally and/or nationally is necessary and also **requires addressing challenges which can be country specific**. There is a need for co-funding mechanisms that support transnational biodiversity monitoring to remain flexible and abide by the subsidiarity principle. I.e., to have funding mechanisms that can adapt to local needs, allowing member states or sub-national organisations to have a say when needed.

Based on these national activities, so far the Biodiversa+ recommendations to build bridges between national biodiversity monitoring schemes and programmes, also at transnational scales, are to financially support:

- The **coordination** of national biodiversity monitoring schemes. This ties in with support of Biodiversa+ to a potential EBOCC, or similar EU structure, as well as making connections with existing Thematic Hubs and national biodiversity monitoring coordination centres. In eight countries, Biodiversa+ national activities helped improve coordination of biodiversity monitoring schemes on a specific topic or the general coordination of national biodiversity monitoring activities. For example, four partners hired coordinators and managers to strengthen cooperation within the national biodiversity monitoring network and to promote transnational cooperation.
- Improving **data management, data cleaning, and data integration** is also of the utmost importance, to ensure that already collected biodiversity data can be reused, by different users for different purposes. Seven Biodiversa+ partners worked on this during the first two years of the Partnership.
- Increasing **sampling efforts and collecting of new data** were also identified as very important ways of covering more sites and providing better visibility on the status and trends of biodiversity. Fourteen partners worked to collect new biodiversity data on the specific topics selected by Biodiversa+, including through already existing schemes.
- Reinforcing **novel technologies and methods** to monitor biodiversity is also crucial. Two partners explored different methods to improve their monitoring capacities, with automated monitoring, eDNA methods and remote sensing being the three main ways Biodiversa+ partners have reinforced national biodiversity monitoring schemes thus far.

The information above reflects the data available at the time of writing, which is based on a very limited number of examples due to the delayed use of co-funds by partners. As the use of co-funding by partners is reported through the Biodiversa+ monitoring and reporting process, a more extensive reporting on the funding used in the first four years of Biodiversa+ is expected in Q1 of 2026 as part of the Biodiversa+ reporting process. The resulting data will enable a more detailed analysis of partners results and will be presented in a future Biodiversa+ publication on the use of co-funding by partners.

4.2. Future funding needs

A comprehensive transnational biodiversity monitoring network across Europe requires appropriate funding. Sustainable biodiversity monitoring requires both investment and commitment to fund the monitoring schemes in the long term (Breeze et al. 2023). Lower income countries will require additional support to address the economic and organizational challenges associated with biodiversity monitoring. In many countries, biodiversity monitoring still lacks continuous and appropriate funding from the state budget. Such funding uncertainties seriously jeopardise the ability of individual national centres to participate equally in EBOCC activities and hinder the utilization of the full benefits of a transnational monitoring approach and a comprehensive European biodiversity monitoring network.

In addition to monitoring itself, the governance solutions proposed in this report require substantial resources. While the proposed funding sources for EBOCC rely mostly on various EU funds (e.g. Research Infrastructures, delegated agreements, European Commission's programmes) (Liquete et al., 2024), national centres' activities should be mostly funded by the countries themselves, as they are intended to serve societal needs and various user groups at national and local levels. In terms of human resources, it has been proposed that an EU Member State's engagement with EBOCC would require at least two full-time staff members (Liquete et al. 2024). However, the necessary resources will ultimately depend on the existing level of implementation of the functions and activities proposed in this report.

Some of the benefits of improving coordination at the national level will be realized at the transnational level. For example, there will be greater opportunities for evidence-based policy within the EU. Therefore, it is proposed that **additional funding, ideally from the European Commission, should be directed to support the transnational activities of National centres**.

This could be achieved. by:

- Directly allocating funding to specified activities, e.g. based on a co-funding model;
- Collecting data handling fees for sharing data with EBOCC and potentially other external users;
- Exploring mechanisms to recover some of the costs of public biodiversity monitoring by offering high-quality, standardised datasets tailored to meet the needs of the private sector —particularly in the context of Corporate Sustainability Reporting requirements, e.g., possibly co-funded via public-private partnerships or other financial models.

As identified by Biodiversa+ in interviews with private companies (Ostermann et al. 2025), the latter often argue that funding biodiversity monitoring is the responsibility of the government, although this cannot be considered feasible. This reflects a broader issue in which the costs of public goods, such as biodiversity data, are expected to be covered by public institutions, while the benefits are shared by all, including by the private sector. Nevertheless, some companies already pay for private biodiversity data, which is often of low quality, leading to frustration about reliability and usability. This indicates a market demand for reliable, standardised, and accessible data, and a potential incentive for companies to pay for higher-quality data. If structured properly, a mechanism whereby companies pay for access to high-quality, verified public data could partially support transnational coordination centres such as EBOCC and NBMCCs. This would shift the paradigm from 'asking for funding' to 'offering a value-based service', which is much more aligned with private sector logic and is therefore likely to face less resistance. By paying for high- quality data private companies could support biodiversity monitoring funding.

The national centres coordinate monitoring activities in a given country, among other functions, and act as a mechanism to connect with transnational structures such as a potential EBOCC. Clearly transnational monitoring, like any other form of cooperation, requires transnational coordination which individual participating countries cannot carry out alone. This applies to all existing and future transnational monitoring communities and Thematic Hubs. Therefore, additional funds would be required for any new Thematic Hubs or transnational monitoring programmes, which would need to be allocated on a case-by-case basis depending on the mandate and coordinating body of the given monitoring activities. As Thematic Hubs benefit transnational European monitoring as a whole and are recognized as an important platform for operational roles within EBOCC, we propose that they should receive financial support from EBOCC itself.

While building a comprehensive European network of transnational monitoring schemes, issues that still need to be resolved in collaboration with affected stakeholders include:

- How should the coordination of new transnational schemes and programmes be funded and by whom?
- How can appropriate, sustained and continuous funding for monitoring be secured in all countries?

5. Conclusions and next steps

With this report, Biodiversa+ sets out strategic recommendations for strengthening European biodiversity monitoring at both the national and transnational levels. Several key conclusions emerge from this work:

1. **Setting up and strengthening solid governance structures that ensure good coordination is essential**

   The successful establishment of transnational and national governance, where needed, is critical for achieving truly transnational biodiversity monitoring and the effective use of biodiversity information in Europe. The proposed European Biodiversity Observation Coordination Centre (EBOCC) and National Biodiversity Monitoring Coordination Centres provide a coherent framework for improved coordination, data integration, and knowledge exchange. Thematic Hubs are an effective way of connecting with monitoring communities across Europe, sharing best practice, standardising methodologies, promoting data sharing, and facilitating data integration.

2. **To set up a functional transnational governance system, a robust mandate and transnational funding are required**

   While the demand for biodiversity monitoring data is growing, the mandate and funding for environmental administration is not necessarily increasing. Improving transnational European governance will require support in the form of a strong mandate from a European body, preferably the European Commission. European countries and sub-national regions are already struggling to allocate adequate funding for their own biodiversity monitoring. Any additional costs arising from a European governance framework and transnational biodiversity monitoring should be co-funded by the countries involved and the EU, given the significant benefits to EU-level policy. Transnational funding should support the transnational aspects of National centres. Opportunities to strengthen public-private partnerships should be further investigated.

3. **Common minimum requirements form a robust foundation for transnational biodiversity monitoring in Europe**

   Common minimum requirements are a crucial step towards harmonisation of biodiversity monitoring protocols. These requirements cover clearly defined and shared monitoring objectives, defined procedures and standardised components, statistical and methodological robustness, and adherence to the FAIR principles. An effective governance model is essential for establishing a shared, flexible, and robust framework for biodiversity monitoring across Europe and beyond.

4. **Long-term sustainability requires robust funding and integration into policy**

   Sustainable biodiversity monitoring depends on secure, long-term funding; a structured approach to collecting and integrating data; and embedding it in existing and emerging policy frameworks. A sustainable transnational biodiversity monitoring network should be designed using a dual approach that ensures that fundamental monitoring activities remain stable and continuously funded, while allowing for flexible, innovative, and adaptive expansion through targeted modules.

5. **Novel technologies hold great potential but their uptake requires more efforts**

Although novel technologies, such as eDNA, bioacoustics, and remote sensing, hold great potential for revolutionising biodiversity monitoring, their widespread deployment still faces significant challenges. These include a lack of awareness among relevant stakeholders, insufficient funding, data management issues, and, for some, a low technology readiness level. Overcoming these barriers through harmonisation, capacity building, and shared infrastructures is essential to realising their full potential.

6. **Monitoring must be aligned with user needs across society**

   Biodiversity monitoring must be designed to align with the needs of all users, including policymakers, researchers, businesses, and the general public, across all scales. A participatory approach to setting monitoring priorities and developing indicators ensures that monitoring efforts are relevant and efficient and support decision-making at all levels.

7. **Enhanced data use and integration will maximise impact**

   Improving the accessibility, usability and integration of biodiversity monitoring data is vital for guiding policy, informing research, and supporting action in the private sector. Better integration of monitoring data with research infrastructures, policy frameworks, and business reporting mechanisms will amplify the impact of biodiversity monitoring efforts.

8. **Transnational coordination mechanisms can help overcome challenges of new transnational monitoring schemes**

   Lessons learned from the Biodiversa+ pilots, combined with the evolving governance structures and technical developments, highlight the challenges and opportunities involved in establishing transnational monitoring programmes. The emerging governance framework of transnational Thematic Hubs and National Biodiversity Monitoring Coordination Centres would facilitate the establishment and operation of new transnational schemes. In the complex European landscape of biodiversity monitoring actors and stakeholders, coordination requires significant resources.

While the work done so far has resulted in some clear recommendations, actual implementation will require a comprehensive consideration of the broader monitoring landscape. Europe already hosts well-established transnational monitoring networks, such as those developed under the Water Framework Directive and Marine Strategy Framework Directive. These networks often operate at the level of transboundary ecosystems, for example within shared river basins or marine regions. However, monitoring systems designed to address transboundary environmental processes are not equivalent to the coordination mechanisms required to achieve a coherent European biodiversity monitoring system. Building on the experience of existing transboundary networks can nonetheless provide valuable governance models and operational lessons, while additional coordination will be necessary to ensure that biodiversity monitoring efforts across Member States collectively support EU-wide assessments and reporting needs. One of the next steps would be to look at those networks, both to see if they can give examples to set up additional new networks or if certain kinds of biodiversity monitoring can be (better) integrated in their ongoing sampling and analysis. The very high cost of monitoring makes it essential to look for synergies and leverage existing infrastructures.

5.1. Next Steps

Building on these conclusions, the next steps for Biodiversa+ in strengthening transnational biodiversity monitoring in Europe are identified as:

- Support the piloting of EBOCC, the establishment and operationalisation of National Biodiversity Monitoring Coordination Centres, and acknowledgement of Thematic Hubs;
- Promote the adoption of common minimum requirements for biodiversity monitoring protocols, in line with policy requirements, by translating identified principles into concrete tools and support structures for practitioners across countries and governance levels;
- Expand capacity-building and networking efforts, particularly around novel technologies and data management, and support the creation of communities of users and experts for different taxa and realms;
- Implement the participatory priority-setting process for biodiversity monitoring at national and transnational levels;
- Identify and promote practices that support the sustainability of long-term biodiversity monitoring schemes;
- Continue supporting the integration of biodiversity monitoring data into research, policy, and private sector decision-making processes;
- Document and share lessons learned from ongoing pilots to design sustainable transnational biodiversity monitoring schemes and associated governance and funding solutions;
- Investigate possible models for the sustainable, long-term funding of biodiversity monitoring.

The final Strategic Phase IV report, scheduled for 2028, will provide a comprehensive overview of progress made during Biodiversa+ and outline final recommendations to ensure Europe's biodiversity monitoring system is fit for purpose, resilient, and capable of supporting the ambitions of the European Biodiversity Strategy for 2030.

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Annex 1: Biodiversa+ survey on national biodiversity monitoring budgets

Introduction

The purpose of this survey is to form a comprehensive picture of existing budgets for biodiversity monitoring in each European country involved in the European Biodiversity Partnership Biodiversa+.

Ideally, the country level figures are meant to include the biodiversity monitoring budgets of all relevant national-level organisations (e.g. Ministries of Environment, Ministries of Agriculture, Environmental Protection Agencies). If this should not be possible, the survey should include the biodiversity monitoring budgets of national-level Biodiversa+ partners.

In this survey, biodiversity monitoring is understood as “a periodic standardised data collection or measurement of a particular set of biodiversity variables in specific sample areas. Biodiversity monitoring aims to highlight changes in the various forms of biodiversity (genes, taxa, ecosystems, etc.)”. * Thus the focus is on periodic monitoring, not one-time mappings, inventories etc. Monitoring counts as periodic even when it is implemented only once, if there is an explicit intention and plan to continue implementation periodically in the form of a long-term monitoring scheme. The survey is meant to cover all realms (terrestrial, freshwater, marine).

Please note that the deadline to send us back your answers is on the 31st of August 2024 (at 10am CEST). Many thanks in advance for your support!

About Biodiversa+: https://www.biodiversa.eu/biodiversity-monitoring/

*Definition from Silva del Pozo, M., Body, G., Rerig, G., Basille, M. (2023). Guide on harmonising biodiversity monitoring protocols across scales. Biodiversa+ report. 60 pp. Available at: https://www.biodiversa.eu/wp-content/uploads/2023/10/Biodiversa_Best-practices_2023_v5_WEB.pdf

1. Privacy notice *

Biodiversa+ conducts this survey to support the harmonisation of national and sub-national biodiversity monitoring schemes for specific domains by looking at costs incurred at national level (and sub-national level when relevant) to monitor biodiversity.

In this questionnaire, we will collect personal data, namely: name, email address, organisation name, country of the respondents. These data will be securely processed and stored, in compliance with the European General Data Protection Regulation 2016/679, and used only for the purposes of this survey. The retention of your personal data will take an end once the Biodiversa+ project ends.

At any time, please keep in mind that you will have the possibility to consult, modify, update or delete your personal data by contacting the Biodiversa Operational Team, processor of your personal data, at the following email address: biodiversa@fondationbiodiversite.fr. Your personal data and all the information contained in this survey will be shared with the Biodiversa+ partners leading this work namely: Ministry of the Environment of Finland and the Finnish Environment Institute Syke its third party, Autonomous Province of Bolzano and Eurac Research its third party, French Foundation for Biodiversity Research (FRB), French Agency for Biodiversity and Executive Environment Agency of Bulgaria.

By ticking the box 'YES', I confirm that I have read and agree with the privacy notice.

Information about the respondents

2. Name of the country *

3. Name(s) of the respondent(s) *

If there are more than one respondent, please separate the email addressess with a semicolon (;)

4. Email address(es) of the respondent(s) *

If there are more than one respondent, please separate the email addressess with a semicolon (;)

5. Please specify, from which organisations biodiversity monitoring budgets are included in your responses *

Ministry of Environment; Ministry of Research; Ministry of Agriculture; Environmental Protection Agency; Regional governmental administration / services; Research performing organisations/ Universities / Institutes; Non-governmental organisations; Other, please specify:

6. Please provide the full (English) names of the organisations whose budgets you have included in this survey

Budget for biodiversity monitoring in your country

7. Terrestrial biodiversity *

Approximately estimate the annual budget for terrestrial biodiversity monitoring activities on the following scale (including coordination costs, salaries with overheads, data gathering, data control, management and data validation, physical and virtual storage, and other budgeted expenses for monitoring, such as potential communication costs).

The budget should consider the overall composition of all funding sources. Estimate the annual average budget over the last 10 years, regardless of the monitoring cycle. If 10 years is a too long period of time for tracking costs for your country, please estimate your costs in the longest period possible so as to avoid cycles effects. 6 years should be the minimum period.

(Please convert your currency to euro using the European Central Bank conversion rate)

Less than 500 000 euros / year

500 000 - 750 000 euros / year

750 000 - 1 000 000 euros / year

1 000 000 - 2 000 000 euros / year

2 000 000 - 3 000 000 euros / year

3 000 000 - 5 000 000 euros / year

5 000 000 - 10 000 000 euros / year

10 000 000 - 30 000 000 euros / year

30 000 000 - 50 000 000 euros / year

More than 50 000 000 euros / year

8. Additional information on terrestrial biodiversity monitoring (e.g. exact budget figure, if available)

9. Freshwater biodiversity *

Approximately estimate the annual budget for freshwater biodiversity monitoring activities on the following scale (including coordination costs, salaries with overheads, data gathering, data control, management and data validation, physical and virtual storage, and other budgeted expenses for monitoring, such as potential communication costs).

The budget should consider the overall composition of all funding sources. Estimate the annual average budget over the last 10 years, regardless of the monitoring cycle. If 10 years is a too long period of time for tracking costs for your country, please estimate your costs in the longest period possible so as to avoid cycles effects. 6 years should be the minimum period.

(Please convert your currency to euro using the European Central Bank conversion rate)

Less than 500 000 euros / year

500 000 - 750 000 euros / year

750 000 - 1 000 000 euros / year

1 000 000 - 2 000 000 euros / year

2 000 000 - 3 000 000 euros / year

3 000 000 - 5 000 000 euros / year

5 000 000 - 10 000 000 euros / year

10 000 000 - 30 000 000 euros / year

30 000 000 - 50 000 000 euros / year

More than 50 000 000 euros / year

10. Additional information on freshwater biodiversity monitoring (e.g. exact budget figure, if available)

11. Marine biodiversity*

Approximately estimate the annual budget for marine biodiversity monitoring activities on the following scale (including coordination costs, salaries with overheads, data gathering, data control, management and data validation, physical and virtual storage, and other budgeted expenses for monitoring, such as potential communication costs).

The budget should consider the overall composition of all funding sources. Estimate the annual average budget over the last 10 years, regardless of the monitoring cycle. If 10 years is a too long period of time for tracking costs for your country, please estimate your costs in the longest period possible so as to avoid cycles effects. 6 years should be the minimum period.

(Please convert your currency to euro using the European Central Bank conversion rate)

Less than 500 000 euros / year

500 000 - 750 000 euros / year

750 000 - 1 000 000 euros / year

1 000 000 - 2 000 000 euros / year

2 000 000 - 3 000 000 euros / year

3 000 000 - 5 000 000 euros / year

5 000 000 - 10 000 000 euros / year

10 000 000 - 30 000 000 euros / year

30 000 000 - 50 000 000 euros / year

More than 50 000 000 euros / year

12. Additional information on marine biodiversity monitoring (e.g. exact budget figure, if available)

13. Please report where the numbers provided in the previous question are from. Please assess their origin in percentages, and make sure that they don't exceed 100% *

Rough estimation (in percentages):

Verified figures from the budgets (%):

From a cost model (%):

Other, please specify:

14. Over the last 10 years, would you say that over time this budget for biodiversity monitoring has

Increased; Decreased; Been stable; Changed a lot each year; Don't know

15. Please assess, how largely biodiversity monitoring relies on project-based funding and on stable funding

Please assess the relative share in percentages, and please make sure that they don't exceed 100%
Project-based funding (%):

Stable funding (%):

16. Which organisations are funding biodiversity monitoring schemes in your country and what other sources are there? *

Funding includes coordination costs, salaries with overheads, data gathering, data management and data validation, physical and virtual storage, and other budgeted expenses for monitoring, such as potential communication costs.

Ministry of the Environment

Other ministries, please specify which ones

Research grants from other national institutions

Research grants from the European Union (e.g. Horizon Europe, LIFE, Interreg)

Research grants from other international instruments

Other sources, please specify which ones and briefly explain how the funding is arranged

17. In an average year, how much do these funding sources contribute to the biodiversity monitoring budget in your country

Funding includes coordination costs, salaries with overheads, data gathering, data management and data validation, physical and virtual storage, and other budgeted expenses for monitoring, such as potential communication costs. Please assess the relative share of the funding sources in percentages, and please make sure that they don't exceed 100%

	0%	1-25%	26-50%	51-75%	76-100%
Ministry of the Environment					
Other ministries					
Research grants from other national institutions					
Research grants from the European Union					
Research grants from other international instruments					
Other sources					

18. Contribution of volunteers *

If possible, please estimate approximately how much time volunteers collectively contribute to biodiversity monitoring work (including for example fieldwork, recording, etc.). Please estimate the annual average number of person months over the last 10 years, regardless of the monitoring cycles.

19. If more detailed information about the biodiversity monitoring budgets is available in your country, please fill out the optional excel sheet that was circulated with this survey and upload it here:

Case studies: monitoring of bats and soil biodiversity

Bat monitoring

20. Are bats monitored in your country? *

No; Yes

21. Budget for bat monitoring

Approximately estimate the annual budget for bat monitoring activities on the following scale (including coordination costs, salaries with overheads, data gathering, data control, management and data validation,

physical and virtual storage, and other budgeted expenses for monitoring, such as potential communication costs).

The budget should consider the overall composition of all funding sources. Estimate the annual average budget over the last 10 years, regardless of the monitoring cycle. If 10 years is a too long period of time for tracking costs for your country, please estimate your costs in the longest period possible so as to avoid cycles effects. 6 years should be the minimum period.

(Please convert your currency to euro using the European Central Bank conversion rate)

Less than 500 000 euros / year

500 000 - 750 000 euros / year

750 000 - 1 000 000 euros / year

1 000 000 - 2 000 000 euros / year

2 000 000 - 3 000 000 euros / year

3 000 000 - 5 000 000 euros / year

5 000 000 - 10 000 000 euros / year

10 000 000 - 30 000 000 euros / year

30 000 000 - 50 000 000 euros / year

More than 50 000 000 euros / year

22. Additional information:

23. Please broadly estimate the budget required to carry on bat monitoring in the following categories

Coordination, administrative work, communications (%)

Fieldwork (%)

Data management and storage (%)

Equipment and maintenance (%)

Service from other sources (sub-contracting) (%)

24. How often is the budget for bats monitoring issued in your country? I.e., for how many years the budget is secured at a time?

Annually
Every two years

Every three years

Every four years

Every five years

Other (please specify):

25. How would you rate the reliability of the budget for bat monitoring in your organisation or country? (i.e., How confident are you that the budget will be renewed or updated in the next period?)

Very reliable (100-80% likelihood)

Pretty reliable (79-60% likelihood)

Somewhat reliable (59-40% likelihood)

Not very reliable (39-0% likelihood)

26. Over the last 10 years, would you say that over time the budget for bat monitoring has

Increased
Decreased
Been stable

Changed a lot each year

27. If the budget was or were to be increased, what would be the main uses of additional funds?

Retain experts (extend contracts, increase wages etc.)

Cover increasing costs (inflation or other causes)

Increase sampling effort in already established programmes

Answer new policy needs

Improve data management and interoperability

Other, please specify

28. Please share the name, organisation and email address of the specialist working with bat monitoring in your country for possible further inquiries

Soil biodiversity monitoring

29. Is soil biodiversity monitored in your country? *

Yes; No

30. Budget for soil biodiversity monitoring

Approximately estimate the annual budget for **soil biodiversity** monitoring activities on the following scale (including coordination costs, salaries with overheads, data gathering, data control, management and data validation, physical and virtual storage, and other budgeted expenses for monitoring, such as potential communication costs).

The budget should consider the overall composition of all funding sources. Estimate the annual average budget over the last 10 years, regardless of the monitoring cycle. If 10 years is a too long period of time for tracking costs for your country, please estimate your costs in the longest period possible so as to avoid cycles effects. 6 years should be the minimum period.

(Please convert your currency to euro using the European Central Bank conversion rate)

Less than 500 000 euros / year

500 000 - 750 000 euros / year

750 000 - 1 000 000 euros / year

1 000 000 - 2 000 000 euros / year

2 000 000 - 3 000 000 euros / year

3 000 000 - 5 000 000 euros / year

5 000 000 - 10 000 000 euros / year

10 000 000 - 30 000 000 euros / year

30 000 000 - 50 000 000 euros / year

More than 50 000 000 euros / year

31. Please broadly estimate the budget required to carry on soil biodiversity monitoring in the following categories

Coordination, administrative work, communications (%)

Fieldwork (%)

Data management and storage (%)

Equipment and maintenance (%)

Service from other sources (sub-contracting) (%)

32. How often is the budget for soil biodiversity monitoring issued in your country? I.e., for how many years the budget is secured at a time?

Annually
Every two years

Every three years

Every four years

Every five years

Other (please specify):

33. How would you rate the reliability of the budget for soil biodiversity monitoring in your organisation or country? (i.e., How confident are you that the budget will be renewed or updated in the next period?)

Very reliable (100-80% likelihood)

Pretty reliable (79-60% likelihood)

Somewhat reliable (59-40% likelihood)

Not very reliable (39-0% likelihood)

34. Over the last 10 years, would you say that over time the budget for soil biodiversity monitoring has

Increased
Decreased
Been stable

Changed a lot each year

35. If the budget was or were to be increased, what would be the main uses of additional funds?

Retain experts (extend contracts, increase wages etc.)

Cover increasing costs (inflation or other causes)

Increase sampling effort in already established programmes

Answer new policy needs

Improve data management and interoperability

Other, please specify

36. Please share the name, organisation and email address of the specialist working with soil biodiversity monitoring in your country for possible further questions