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## Guidance note presenting shared goals/priorities for biodiversity monitoring within Biodiversa+

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**biodiversa+**  
European Biodiversity Partnership

EUROPEAN PARTNERSHIP

## Shared goals and priorities for biodiversity monitoring within Biodiversa+



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## What is Biodiversa+

Biodiversa+ is the new European co-funded biodiversity partnership supporting excellent research on biodiversity with an impact for policy and society. It was jointly developed by BiodivERsA and the European Commission (DG Research & Innovation and DG Environment) and was officially launched on 1 October 2021.

Biodiversa+ is part of the EU Biodiversity Strategy for 2030 that aims to put Europe's biodiversity on a path to recovery by 2030.

The Partnership aims to connect science, policy and practice for transformative change. It currently gathers 80 research programmers and funders and environmental policy actors from 40 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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## Acronyms

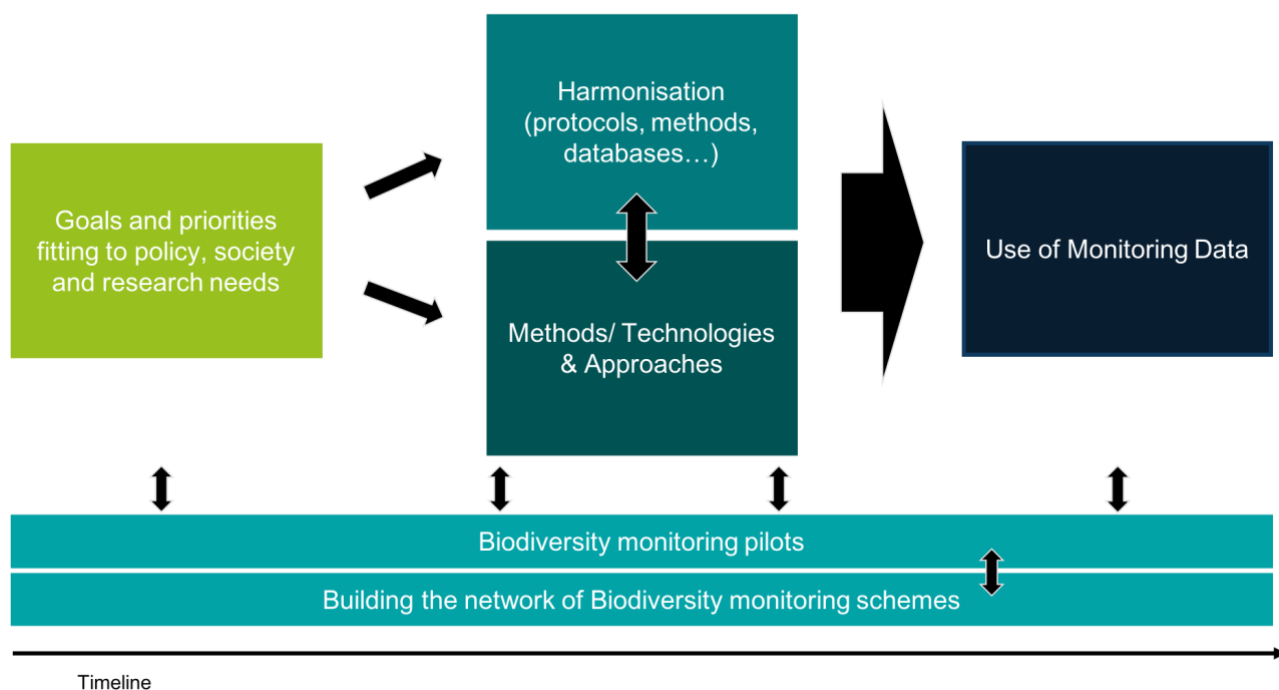
AEWA	African-Eurasian Migratory Waterbird Agreement
ALPARC	Alpine Network of Protected Areas
CBD	Convention on Biological Diversity
CWI	Carpathian Wetland Initiative
DNA	Deoxyribonucleic acid
DPSIR	Driver-Pressure-State-Impact-Response
EBV	Essential Biodiversity Variables
EU	European Union
EUNIS	European Nature Information System
ERGA	European Reference Genome Atlas
G-BIKE	Genomic Biodiversity Knowledge for Resilient Ecosystems
GLORIA	Global Observation Research Initiative in Alpine Environments
iBOL	International Barcode of Life Consortium
MARCO-BOLO	Marine Coastal Biodiversity Long-Term Observations
MedWet	The Mediterranean Initiative on the Ramsar Convention on Wetlands
NGO	Non-Governmental Organisation
T&E species	Threatened and Endangered Species
WP	Work Package

## Executive Summary

This document introduces the revised biodiversity monitoring priorities for the 2023–2025 cycle of Biodiversa+, the European Biodiversity Partnership. Priorities are topics that guide Biodiversa+ activities related to promotion and support of transnational biodiversity monitoring. From an initial number of eight, priorities have been extended to a total of twelve, including seven initial priorities continued from the previous cycle: “Protected Areas”, “Habitats”, “Marine Biodiversity”, “Invasive Alien Species”, “Soil Biodiversity”, “Insects”, and “Wildlife Diseases”. Five new priorities have been identified: “Urban Biodiversity”, “Bats”, “Genomics & Genetics”, “Wetlands”, and “Common Species”. Finally, the last priority from the initial cycle has been converted into a *Special topic*: “Transversal Activities”. Modifications from the initial priorities, rationale for inclusion of new priorities, and other topics considered are also covered in this document. This set of priorities provides the guidelines for biodiversity monitoring activities of Biodiversa+ in the 2023–2025 cycle, and will be re-evaluated at the end of the cycle.

## Introduction and context

One of the objectives of [Biodiversa+](#), the European Biodiversity Partnership, is to identify, refine and address priorities and needs for adequate coverage of biodiversity monitoring to better support research, society and policy. Biodiversa+ partners organise their activities related to shared goals of promotion and support of a transnational network of biodiversity monitoring schemes under a framework of biodiversity monitoring priorities. Priorities, here defined as biodiversity monitoring subjects, are foundational to reach Biodiversa+ shared goals, through coordinated transnational initiatives, such as the Biodiversa+ [biodiversity monitoring pilot programme](#) or other Biodiversa+ activities on biodiversity monitoring (see [Fig. 1](#)). In addition, priorities are also used to guide the use of the European Commission top-up to support national/subnational schemes.



**Fig. 1.** How biodiversity monitoring priorities provide foundations for Biodiversa+ shared goals, from the pilot programme to actual use of monitoring data, through all methodological and governance aspects of biodiversity monitoring.

During the Biodiversa+ initial cycle (2021–2023), eight topics have been selected as priorities (Table 1). Of particular significance, four of these initial priorities are currently tackled in pilot studies launched in 2023: “Invasive Alien Species” and “Pollinators, butterflies and other insects” (by the subpilot *Detection and monitoring of invasive alien species*), “Soil biodiversity” (by the subpilot *Soil biodiversity in protected, near-natural forests*), and “Transversal activities” (by the subpilot *Towards national biodiversity monitoring coordination centres: comparison of governance, data interoperability and standards*).



**Table 1.** Initial biodiversity monitoring priorities for the Biodiversa+ Partnership (2021–2023), together with their associated description when available.

Topic	Description
Terrestrial and marine protected areas (including Natura 2000 sites)	—
Habitats	Remote sensing of habitats/ecosystems, threatened/endangered habitats... also includes coastal macroalgae as part of marine habitats
Offshore marine biodiversity &/or marine megafauna	Including plankton-related aspects
Invasive Alien Species	—
Soil biodiversity	—
Pollinators, butterflies and other insects	—
Wildlife diseases and biodiversity facets linked to health issues	E.g. detection and surveillance of pathogens of wildlife—including relevant aspects for zoonoses, vectors like mosquitoes, ticks, ...
Transversal activities (information systems)	Harmonisation, data management, data analysis... if not already included in the biodiversity facets above

The current document presents the revision process of Biodiversa+ biodiversity monitoring priorities, and its outcome for the second cycle of the Partnership running from October 2023 to September 2025. In particular, dedicated sections describe early and recent inputs and resources, guiding principles for the revision, revised biodiversity monitoring priorities (both existing and new topics), as well as topics considered but not selected as priorities. Concluding remarks pave the way for implementation of biodiversity monitoring priorities during the next Biodiversa+ cycle (2023–2025), and their reassessment after two years.

## Resources for the revision process of priorities

### Genesis of the Biodiversa+ biodiversity monitoring priorities

The selection of the eight initial biodiversity monitoring priorities was the result of months of discussions along the design of Biodiversa+ (September 2020 to May 2021), in relation to scientific and policy relevance. These priorities also aligned with current monitoring efforts across the countries that were valorised through Biodiversa+ as an in-kind budget contribution during the first two years, meaning that such efforts could then also be further reinforced through a European Commission top-up. Other topics that have been discussed and pondered over during this early process are presented in Table 2; topics mentioned but considered subsidiary in preliminary discussions of the Partnership design are presented in Table 3.

**Table 2.** Complementary topics discussed during the design of Biodiversa+ (September 2020 to May 2021), together with the identified pros and cons for each of them.

Topic	Pros	Cons
Common birds	Key indicator used in the European Union	Already well established (added value of the Partnership?)
Chiropterans	Acoustic monitoring	—
Calcareous grassland	Endangered habitat	Narrow
Biodiversity in arable land/farmland	Importance, also for Common Agricultural Policy	Wait for the European partnerships on agroecology + agriculture data
Remote sensing of the state of nature	Developing links with the remote sensing community	Risk of being too far from biodiversity on the ground
Biodiversity and climate-change related processes (including carbon stocks/greenhouse gas emissions)	Highly policy relevant	Complex

**Table 3.** Other topics mentioned in discussions during the design of Biodiversa+ (September 2020 to May 2021), considered subsidiary.

Topic		
Forest vegetation	Sea phytoplankton	Coastal macroalgae and blue mussel communities

Topic		
Amphibians and frogs	Coastal soft bottoms animal communities	Pressure-response measures
Threatened/Endangered vascular plants	Nesting terrestrial birds	Functional diversity traits
Small terrestrial mammals	Biodiversity in Outermost Regions and Overseas Countries and Territories	Spring field weeds
Sea zooplankton	Birds of prey	

## Complementary inputs and resources

The corpus of discussions and topics highlighted above has notably been completed with:

- open exchanges with partners, including at a Biodiversa+ workshop on biodiversity monitoring priorities, needs and governance, held in Madrid (Spain), on September 15<sup>th</sup>, 2022. This workshop gathered 50 participants from Biodiversa+ partners, Biodiversa+ Advisory Board, representatives of the European Commission (DG Environment, DG RTD and JRC), EuropaBON representatives and European Environment Agency representatives. The outcome of the workshop directly fed into the revision process of Biodiversa+ monitoring priorities, by presenting and discussing shared goals/priorities for biodiversity monitoring, identifying gaps, and proposing improvements in the biodiversity monitoring landscape;
- a survey to Biodiversa+ Advisory Board members, and another survey to Biodiversa+ WP2 Task leaders dedicated to evaluate candidate topics and open to suggestion and identification of new topics (November 2022 to January 2023);
- topics emerging from Biodiversa+ Task 2.6 about the pilot programme, and most importantly candidate pilot topics. Discussions occurring in this context were instrumental in suggesting topics as new candidate priorities;
- Biodiversa+ D2.1 “Biodiversity monitoring knowledge gaps and research & innovation priorities” (March 2022)<sup>1</sup>, a joint work of Sub-tasks 2.3.1, 2.3.2, and 2.4.1;
- ad-hoc documentation, including (but not limited to) EuropaBON deliverables such as the “Europa Biodiversity Observation Network: User and Policy Needs Assessment” report (March 2022)<sup>2</sup> and

<sup>1</sup> Hoye T. T., Groom Q., Juslén A., Mandon C., Dinesen L., Rosenberg A., Hendriks R. J. J., Eggermont H. & Vihervaara P. (2022) Report on the knowledge gaps and research & innovation priorities related to biodiversity monitoring. Biodiversa+ report. 41 p. URL: <https://www.biodiversa.eu/wp-content/uploads/2022/12/D2.1-Report-on-biodiversity-knowledge-gaps-VF.pdf>

<sup>2</sup> Moersberger H., Martin J. G. C., Junker J., Georgieva I., Bauer S., Beja P., Breeze T. D., Brotons L., Bruelheide H., Fernández N., Fernandez M., Jandt U., Langer C., Lyche Solheim A. L., Maes J., Moreira F., Pe'er G., Santana J., Shamoun-Baranes J., Smets B., Valdez J., McCallum I., Pereira H. M. & Bonn A. (2022) Europa Biodiversity Observation Network: User and Policy Needs Assessment. EuropaBON/German Centre of Biodiversity Research (iDiv), Leipzig. 228 p. URL: <https://doi.org/10.3897/arphapreprints.e84517>

the “List and specifications of EBVs and EESVs for a European wide biodiversity observation network” (July 2022, revised January 2023)<sup>3</sup>.

### Guiding principles

The revision of Biodiversa+ priorities revolves around a few guiding principles. We can consider three series of those principles, based on the number of priorities (*How many priorities should we/can we manage within the Partnership?*), the deciding criteria (*What makes a good priority?*), and the formalism of the priorities (*How to present and describe a priority?*). The Biodiversa+ monitoring priorities should also be supported by more than only a few countries.

- Number:
  1. **Keep current priorities to the extent possible:** Eight priorities have been selected at the inception of Biodiversa+, and have formed the basis for the Partnership’s activities for the initial 2021–2023 cycle. However, this phase was too short to implement decisive action and consider the topic resolved. Unless there are good reasons for the removal of specific priorities, it has been therefore suggested to keep the list of current priorities—they can however be refined, modified or reworded to match progress and planned activities.
  2. **Keep a manageable number of priorities:** Biodiversity as a whole is under pressure, which provides for an infinite number of topics for biodiversity monitoring. However, available resources are finite, and working under an extensive number of priorities would necessarily weaken the focus and effort on each of them. It has been therefore suggested to limit the number of priorities to a maximum of 12 to 15.
- Deciding criteria:
  3. **Contribute to better decision making:** The ultimate goal of biodiversity monitoring is to contribute to improved evaluation and management of biodiversity in a general sense. In other words, biodiversity monitoring priorities should effectively provide evidence for better decision making, and relate to actual reporting needs at national, european (e.g. EU Directives and Regulations), and global (e.g. CBD Global Biodiversity Framework) levels.
  4. **Focus on actionable priorities:** Following on from the previous principle, it is essential to consider topics in which a path forward can be identified, with effective and impactful actions that can be implemented. It has been therefore suggested that the identification of critical topics for biodiversity is a necessary prerequisite, but that it is equally important to link these topics to clear activities of biodiversity monitoring.
  5. **Fill in monitoring gaps:** The main goal of Biodiversa+ monitoring activities is to fill in gaps in terms of biodiversity monitoring. It has been therefore suggested to identify primary and secondary monitoring gaps, in order to frame activities—primary gaps being knowledge gaps

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<sup>3</sup> Junker J., Beja P., Brotons L., Fernandez M., Fernández N., Kissling W. D., Lumbierres M., Lyche Solheim A., Maes J., Morán-Ordóñez A., Moreira F., Musche M., Santana J., Valdez J. & Pereira H. M. (2023) List and specifications of EBVs and EESVs for a European wide biodiversity observation network. EuropaBON/German Centre of Biodiversity Research (iDiv), Leipzig. 56 p. URL: <https://doi.org/10.3897/arphapreprints.e102530>

in space and time for certain taxa and ecosystems, while secondary gaps are roadblocks related to harmonisation, capacity, policy support and coordination.

6. **Manifest a transnational perspective:** The Partnership is transnational at its core, and should reflect the general principle of European Union law, i.e. subsidiarity. Applied to biodiversity monitoring, subsidiarity means that the scope of action of the Partnership shall be delineated by areas where individual activities from partners at the national or subnational level are not sufficient without transnational coordination or action. It has been therefore suggested to ensure that priorities show a clear transnational perspective to implement decisive action.
  7. **Provide linkages to established initiatives:** The European biodiversity monitoring landscape is already diverse and complex, with many initiatives acting at various levels, from local to transnational scale, on broad or specific topics. Globally coordinated actions are mandatory for the success of the Partnership. It has been therefore suggested to identify, and link to, existing initiatives related to each priority, in order to reduce duplicated efforts, waste of resources and possibly conflicting or contradictory actions.
  8. **Emphasise Biodiversa+ added value:** The strength of Biodiversa+ comes from the diversity of its partners, and its composition mostly based on ministries of environment and environmental protection agencies within WP2 on biodiversity monitoring. However, there are limits to both the scope and field of action of both individual partners and the Partnership, which restrict Biodiversa+'s capacity for action. It has been therefore suggested to focus on topics that are well covered by the extent and scope of partners within the Partnership.
- Formalism:
    9. **Use a short title and a description:** Finally, initial priorities were worded with several inconsistencies, names of different lengths (from 1 to 9 words), sometimes including additional specification within parentheses; some priorities presenting a subtitle serving as a description or an additional specification. It has been therefore suggested to use short names as titles (2 to 5 words with no parentheses), while each priority will come together with a one-sentence description that more precisely delineates their scope.

The rest of this document presents each topic considered, together with the rationale for each of them to be recognised as a priority. The next section lists revised biodiversity monitoring priorities, including initial Biodiversa+ priorities and new priorities for the 2023–2025 cycle; the following section includes other topics that have not been considered a good match following the above criteria.

## Revised biodiversity monitoring priorities (2023–2025)

The full list of Biodiversa+ priorities for the 2023–2025 cycle, together with their descriptions, can be found in Table 4.

**Table 4.** Revised biodiversity monitoring priorities for the Biodiversa+ Partnership (2023–2025), presented in the form of a short name and an associated description. Note that “*Transversal activities*” is now considered a special topic, instead of a thematic priority *per se*.

Topic	Description
Protected Areas	Biodiversity monitoring within protected areas in terrestrial, freshwater and marine realms, including Natura 2000 sites
Habitats	Ecosystem perspective on habitats in terrestrial, freshwater and marine realms, with a particular focus on remote sensing
Marine Biodiversity	Monitoring coastal and offshore marine biodiversity, from plankton to marine megafauna and seabirds
Invasive Alien Species	Detection and monitoring of Invasive Alien Species in terrestrial, freshwater and marine realms, including Non-Indigenous Species in marine realm
Soil Biodiversity	Monitoring micro-, meso- and macrofauna of topsoil and litter, from bacteria to earthworms
Insects	Monitoring insect biodiversity, with a particular focus on butterflies and other pollinators
Wildlife Diseases	Biodiversity facets linked to health issues, from animal and human perspectives
Urban Biodiversity	Monitoring biodiversity in urban, peri-urban and urban-fluvial environments
Bats	Monitoring the status and trends of bats across Europe
Genomic & Genetic Monitoring	Applications of genetic approaches to biodiversity monitoring across levels of biodiversity: harmonisation and gaps
Wetlands	Integrative biodiversity monitoring of European wetlands, including mires and peatlands
Common Species	Standardised multi-taxa approaches for monitoring common biodiversity across Europe
<i>Transversal Activities</i>	Non-specific biodiversity monitoring aspects: governance, information, metrics

## Initial priorities kept or modified

In this section, initial Biodiversa+ priorities (see section “*Introduction and context*” above) are discussed with the prism of inclusion: All initial priorities are kept by default, unless there are strong reasons to remove them. Modifications or clarifications of their title and description are also presented and explained.

### 1. Protected Areas

*Biodiversity monitoring within protected areas in terrestrial, freshwater and marine realms, including Natura 2000 sites*

The initial priority “*Terrestrial and marine protected areas (including Natura 2000 sites)*” had a lengthy title including items of description; it has been simplified to “*Protected Areas*”. The description has been expanded to explicitly include all three realms of biodiversity, while keeping the necessary mention of Natura 2000 sites. Finally, the description is now framed within the context of “biodiversity monitoring”, as to not address other aspects of Protected Areas that are beyond the scope of this priority (e.g. legal aspects, transnational comparison of status, or evaluation of the delineation of protected areas).

### 2. Habitats

*Ecosystem perspective on habitats in terrestrial, freshwater and marine realms, with a particular focus on remote sensing*

The initial priority “*Habitats*” has been kept as is. The description has been clarified to explicitly include all three realms of biodiversity, and highlight the particular use of remote sensing within this priority. Note that remote sensing is not mentioned in an exclusive way, and does not preclude the use of field data and protocols.

### 3. Marine Biodiversity

*Monitoring coastal and offshore marine biodiversity, from plankton to marine megafauna and seabirds*

The initial priority “*Offshore marine biodiversity &/or marine megafauna*” had a lengthy and confusing title; it has been simplified to “*Marine Biodiversity*”. The description kept plankton-related aspects on one extreme, and marine megafauna and seabirds on the other extreme. The description now includes marine biodiversity in coastal areas (not only offshore), as several proposed activities in the pilot programme are focusing on shallow areas and ports/shellfish farms.

### 4. Invasive Alien Species

*Detection and monitoring of Invasive Alien Species in terrestrial, freshwater and marine realms, including Non-Indigenous Species in marine realm*

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The initial priority “*Invasive Alien Species*” has been kept as is. A description has been added to explicitly describe what is meant by Invasive Alien Species, in all three realms of biodiversity, and the near-synonymous term of Non-Indigenous Species in the marine realm (as the adverse effects of alien species necessary to qualify invasiveness are rather difficult to assess in marine environments).

### 5. Soil Biodiversity

*Monitoring micro-, meso- and macrofauna of topsoil and litter, from bacteria to earthworms*

The initial priority “Soil Biodiversity” has been kept as is. A description has been added to explicitly describe what is covered under this priority, from micro– to macrofauna.

### 6. Insects

*Monitoring insect biodiversity, with a particular focus on butterflies and other pollinators*

The initial priority “*Pollinators, butterflies and other insects*” had a confusing title (for instance, pollinators include non-insect fauna, but the title seems to restrict it to insects, which butterflies indeed are), which has been simplified to “*Insects*”. A description has been added to highlight the particular interest of pollinators, including—but not limited to—butterflies.

### 7. Wildlife Diseases

*Biodiversity facets linked to health issues, from animal and human perspectives*

The initial priority “*Wildlife diseases and biodiversity facets linked to health issues*” had an unnecessarily lengthy title, which has been simplified to “*Wildlife Diseases*”. The description further clarifies that the scope of this priority covers all health-related aspects from the points of view of both animals and humans.

### Special topic: Transversal Activities

*Non-specific biodiversity monitoring aspects: governance, information, metrics*

The title of the initial priority “*Transversal activities (Information systems)*” has been simplified to “*Transversal Activities*”. Further clarification of the scope indicates that this topic covers all aspects of biodiversity monitoring that are not related to specific biodiversity monitoring objects, such as governance, information systems (data systems), or biodiversity metrics (e.g. Essential biodiversity variables, aggregative or composite indicators). This topic however still posed a conundrum: as emphasised in the description, transversal activities are not an object of biodiversity monitoring by themselves, that can be the focus of a priority. Instead, they refer to actual activities that are nevertheless crucial for the advancement of biodiversity monitoring at the European scale—so much so that they are indeed the focus of current Biodiversa+ activities, notably through the pilot programme. It has been suggested to demote *Transversal Activities* as a priority, and merely call it a *Special topic*, that remains of high interest for Biodiversa+ activities, notably (but not exclusively) through Biodiversa+ Task 2.5 “*Establish a transnational network of national biodiversity monitoring schemes (for specific domains)*”.

## New priorities



This section introduces newly established biodiversity monitoring priorities for the Biodiversa+ Partnership, describing the rationale behind the selection, existing initiatives and possible activities, and other relevant notes.

### 8. Urban Biodiversity

#### *Monitoring biodiversity in urban, peri-urban and urban-fluvial environments*

**Rationale:** Urban biodiversity is very overlooked, despite the various social and health benefits associated to green spaces in a broad sense (from ecosystem services to well-being and mental health) with increasing evidence that healthy urban ecosystems are more resistant to climate change and are one of key measures for adapting and mitigating climate change impacts in cities. Pressures to urban biodiversity (that encompasses strictly protected taxa) include light, noise, air, water and soil pollution to urban management that does not take into account ecological needs of taxa and urban ecosystems in order to be sustainable. In addition to that, there is limited harmonisation of methods and indicators of urban biodiversity at the European scale. In line with the EU Biodiversity Strategy for 2030, as well as the upcoming EU Nature Restoration Law, it is now critical to monitor the status and trends of urban biodiversity, in order to feed informed conservation measures and development of guidelines for sustainable management of green infrastructure, as well as for other biodiversity important urban areas (roosts in buildings, river banks, etc). In addition to that, 75 % of the European population live in cities, which make them a relevant medium to raise awareness about biodiversity and mobilise citizen science.

**Existing initiatives and possible activities:** A candidate study focusing on monitoring urban biodiversity has been proposed to Biodiversa+'s pilot programme. This work should be conducted hand in hand with the Green City Accord, a movement of European cities (with over 100 signatories) committed to making cities cleaner and healthier, and build on the outcome of BiodiverCities, a pilot project nearing completion with the aim to enhance the biodiversity and green infrastructure of European cities. Potential links with the Driving Urban Transitions Partnership will also need to be explored, such as common approaches to evaluate the degree of biodiversity in European urban areas. Several national or local initiatives also exist, such as the French Capitals of Biodiversity and the newly established centre for research of urban biodiversity "Sciurus" in Zagreb (Croatia), and would also benefit from the monitoring dimension of this priority.

**Note:** This priority should align with Biodiversa+ Sub-task 2.3.2 "*Improved involvement of citizens in the biodiversity monitoring activities*".

### 9. Bats

#### *Monitoring the status and trends of bats across Europe*

**Rationale:** Bats play an essential role in pest control, pollinating plants and dispersing seeds. As long-living, slowly reproducing animals they are sensitive indicators for environmental change and pressures. After a historical massive decline throughout the 20<sup>th</sup> century, some bat populations seem to partially recover, but many species remain endangered and are in unfavourable conservation status in most of European biogeographical regions. Pressures and threats include habitat loss (size and quality), collisions with wind turbines, light pollution, agriculture, road infrastructure, water management and

pollution, inappropriate forest management, and diseases. All bat species are listed in Annex IV of the Habitat Directive (providing strict protection across their entire natural range), and 14 of them are further listed in Annex II (core areas of their habitat are designated as sites of Community importance, included in the Natura 2000 network, and managed in accordance with the ecological needs of bats with specific conservation goals and measures). Collecting harmonised data on status and trends of bats across Europe is a necessary step towards informed conservation actions and regulatory requirements in order to improve their conservation status and/or conservation trend.

**Existing initiatives and possible activities:** A candidate study focusing on the deployment of multi-taxa monitoring stations (targeting nocturnal insects, bats, and birds) has been proposed to Biodiversa+'s pilot programme. This work should be conducted hand in hand with UNEP/EUROBATS Agreement on Conservation of European Bat Populations, an already established network of key bat research and conservation actors in Europe (universities, range states, national and international NGOS) focusing on bat conservation, their migratory status, development of guidelines to mitigate recognized key threats, and working towards the production of population trends. The main barrier towards their success is currently a lack of harmonisation of monitoring protocols, preventing data comparability and large-scale combination. The Bat Monitoring Programme (mostly implemented in Spain but currently expanding in other European countries) currently tries to unlock citizen science in order to fill in this gap.

**Note:** This priority should align with Biodiversa+ Sub-task 2.3.1 *“Test, develop and/or deploy new technologies/approaches”* and Sub-task 2.3.2 *“Improved involvement of citizens in the biodiversity monitoring activities”*.

## 10. Genomic and Genetic Monitoring

*Applications of genetic approaches to biodiversity monitoring across levels of biodiversity: harmonisation and gaps*

**Rationale:** Within just a decade, the cost of genetic tools has dropped to allow for high-throughput ecosystem-wide assessments and monitoring in most environments, most often using non-invasive sampling techniques. Genomics (e.g. DNA barcoding and metabarcoding) and genetics (e.g. reduced representation DNA sequencing) techniques are now mature enough to be deployed at a larger scale towards standard multi-taxa biodiversity monitoring covering vertebrates, plants, fungi, protists and nematodes, and bacteria. Applications target identification at the species level on the one hand (i.e. metagenomics), and estimation of intraspecific parameters such as effective population size, genetic diversity, inbreeding, population structure, and gene flow at large spatio-temporal scales on the other hand (i.e. macrogenetics). For instance, the Kunming-Montreal Global Biodiversity Framework calls for the monitoring and restoration of genetic diversity within populations of wild and domesticated species. However, practical considerations remain, and applications of genetic tools need to be guided and facilitated at the European scale.

**Existing initiatives and possible activities:** Existing initiatives include the International Barcode of Life Consortium (iBOL), a global initiative aiming to support the development of DNA barcoding for species identification (and notably provide reference libraries and protocols), or the Global Life Observatory—Vigilife, another global initiative aiming to foster biodiversity monitoring using standardised environmental DNA methods. Relevant working groups include IUCN's Conservation Genetics Specialist Group, and

the Society for Conservation Biology's Conservation Genetics Working Group. In Europe, it is worth mentioning the European Reference Genome Atlas (ERGA, a consortium involving nearly 50 countries with the aim of generating reference genomes) and the Genomic Biodiversity Knowledge for resilient Ecosystems (G-BiKE, a scientific network from 39 European countries with the aim of establishing the use of genomic data as a standard tool for monitoring and managing wild and ex situ populations of plants and animals). Other initiatives include the MARine Coastal BiODiversity Long-term Observations (MARCO-BOLO) and BIOcean5D (Marine biodiversity assessment and prediction across spatial, temporal and human scales), two Horizon Europe funded projects aiming at addressing this priority in marine environments. Biodiversa+ will need to bring these initiatives together to advance harmonised biodiversity monitoring using genetic tools across Europe.

**Note:** This priority should align with Biodiversa+ Sub-task 2.2.1 “*Harmonise protocols and methods across scales, regions and countries*” and Sub-task 2.3.1 “*Test, develop and/or deploy new technologies/approaches*”.

## 11. Wetlands

*Integrative biodiversity monitoring of European wetlands, including mires and peatlands*

**Rationale:** Wetlands have undergone a strong decline globally in the past century, and are currently under threat from urbanisation and pollution. Despite being a small portion of Europe, they are increasingly recognized as critical ecosystems. With sites present in all European countries from Scandinavia to the Mediterranean Sea, wetlands host a high biodiversity (e.g. up to 40 % of plant species), but existing policy frameworks at the European scale are not enforced or comprehensive. There is thus a need for harmonised monitoring of wetland biodiversity across taxa over Europe.

**Existing initiatives and possible activities:** Several initiatives of importance dealing with wetlands should be mentioned. On a global scale, the Convention on Wetlands (Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat) contributes to the conservation and sustainable use of wetlands. In Europe, work in this priority should also coordinate with the Mediterranean Initiative on the Ramsar Convention on Wetlands (MedWet, 25 countries) and the Carpathian Wetland Initiative (CWI, 7 countries), as well as Wetlands International Europe (11 NGOs from 8 countries) and the WaterLANDS project (6–8 large-scale wetland restoration initiatives or “living labs” in Europe). Local or national initiatives also exist, such as the project Mhéo (*Milieux humides, évaluation, observation—Wetlands, evaluation, observation*) in France, which aims at harmonising biodiversity monitoring protocols in wetlands at a national scale.

**Note:** The work under this priority should not focus on recognizing and delineating wetlands, but instead focus on operational integrative, multi-taxa biodiversity monitoring in established wetlands across Europe (e.g. according to the European Nature Information System, EUNIS).

## 12. Common Species

*Standardised multi-taxa approaches for monitoring common biodiversity across Europe*

**Rationale:** Species abundance and persistence are key components of biodiversity, especially from a functional perspective. A lot of effort has been devoted to rare, threatened and endangered, or

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emblematic species. However, common species play a critical role as they are likely to contribute disproportionately more than rare ones to ecosystem structure, function, and services. Yet, little attention has been given to common species, and no harmonised approach is currently in place to monitor common biodiversity as a whole across Europe. A transnational multi-taxa approach is necessary to overcome national and subnational differences, and provide comparable data on ecosystems' health at the continental scale. There is also a good methodological opportunity to monitor those species that are, by definition, common across Europe, and adequate to be captured using a broad, cost-efficient, harmonizable, sampling scheme.

**Existing initiatives and possible activities:** Existing indicators at the European scale include common farmland and forest birds, common grassland butterflies, and common fishes in the European North-East Atlantic waters. Other common taxa are vastly understudied, and would benefit from a multi-taxa approach. A candidate study focusing on the deployment of multi-taxa monitoring stations (targeting nocturnal insects, bats, and birds) has been proposed to Biodiversa+'s pilot programme.

**Note:** The focus of this priority should specifically be the harmonisation of approaches to monitor common species, particularly including understudied taxa, at the European scale, and should align with Biodiversa+ Sub-task 2.2.1 "*Harmonise protocols and methods across scales, regions and countries*".

## Other topics considered but not selected

### Plants & Fungi

Plants and fungi (including lichens) are large and diverse kingdoms that are visibly absent from biodiversity monitoring priorities. While plants and fungi underpin life on Earth, they are still vastly under-monitored—for instance, only c.30 % of plant species have been assessed for risk of extinction. Fungi are also of particular importance and interest in boreal regions in Northern Europe. It has been estimated that the Partnership does not provide enough identified added value to the topic, and that methodological harmonisation was more advanced, thus not as problematic, than in other domains of biodiversity monitoring.

### Migratory Species

Migration occurs in a broad range of taxa, notably including birds, as well as fishes (both in marine and freshwater realms), insects (including butterflies), sea turtles and cetaceans, some bats, etc. Their transient geographical distribution makes migratory species difficult to address at national or subnational levels only, and calls for a transnational approach at the European level. On the other hand, existing communities regarding migratory species are relatively scattered, with a variety of operational monitoring methods and approaches. As a result, established initiatives are diverse and generally target specific taxa (e.g. the African-Eurasian Migratory Waterbird Agreement, AEWA). It has been estimated that this topic was not mature enough and not directly actionable, while of interest by its nature—elevating the topic as a priority will be reconsidered in the future.

### Mountain and Highland Biodiversity

Mountain ecosystems are biodiversity hotspots, especially for amphibian, bird and mammal species. Mountain biodiversity is critically affected by climate change, and effectively acts as an indicator of climate impacts. It has been estimated that a coordinated action at European level (within the Partnership) might not bring the biggest impact, with initiatives existing at both local/mountain range (e.g. Alpine Network of Protected Areas, ALPARC) and global (e.g. GLobal Observation Research Initiative in Alpine environments, GLORIA) scales.

### Threatened and Endangered Species of European Concern

Threatened and Endangered (T&E) species are at the core of biodiversity conservation. The conservation status of target species is the focus of major efforts at local, national and international levels, such as the IUCN Red List of Threatened Species and its regional adaptations. T&E species often act as umbrella or flagship species, hence covering a larger range of biodiversity and attracting higher support, and are one of the criteria to identify Key Biodiversity Areas (based on population size). However, it has been estimated that the Partnership does not provide enough identified added value to the topic, which is largely addressed through targeted initiatives (e.g. many LIFE projects).

### Managed Species of European Interest

Wildlife management concerns a wide range of species, from game hunting and fishing, to commercial fishing, through population control (e.g. cases of overpopulation causing damage to natural ecosystems, or species causing damage to crops). Adaptive management is frequently used as a flexible and effective approach to assess harvesting of wildlife populations, and requires dedicated monitoring of population abundances and distributions, as well as reproduction rates, life history traits and management pressures. There is currently a very diverse landscape of hunting data in Europe, which prevents comparability and responses at a broad scale. However, adaptive management may often rely on the efficacy of local action rather than transnational cooperation. It has been estimated that this topic does not overlap enough with the partners' scope, as game species and natural resources are generally not in the sphere of activity of ministries of environment and environmental protection agencies that are part of Biodiversa+.

### Indicator Species of European Interest

Indicator species, or bioindicators, are species or groups of species that can be used as a surrogate for an ecosystem's health. Monitoring the status, trends, or functions of indicator species can thus act as a proxy of the state of an ecosystem, instead of a more comprehensive evaluation. In Europe, indicators are available for a small number of ecosystems, such as farmland (birds), forests (birds), grasslands (butterflies) or sea (common fishes). The biggest challenge is to actually validate the proxy, hence the limited set of indicators. This evaluation has been considered outside of the scope of Biodiversa+, while associated monitoring needs still are very relevant. However, indicator species (such as the ones mentioned at the European scale) are generally common species, which would fall under the priority #12 *Common Species* described above.

### Climate-induced Shifts

Climate change is becoming increasingly important as a driver of biodiversity loss. While biodiversity is essential to limit climate change in the first place, climate change can lead to species extinction and habitat loss, favour diseases and affect phenological cycles and geographical distributions. Monitoring these shifts is thus of primary importance to understanding the tight relationship between biodiversity and climate. Focusing on phenological shifts in migration timing (see the *Migratory Species* topic above), and shifts in geographical distributions (latitudinal and altitudinal, see the *Mountain and Highland Biodiversity* topic above) would provide invaluable insights into global changes at the European level. Conversely, climate-induced shifts are a cross-cutting issue that intersects most monitoring priorities, and could thus be addressed indirectly from these lenses—improved monitoring of biodiversity across levels will help detect climate-induced shifts. However, it has been estimated that the topic was not mature enough for immediate action, and that further refinement is required before reassessment, especially in reference to other priorities.

## Conclusions and outlook

This report, and the revised biodiversity monitoring priorities listed therein, provide guidelines for current and future activities of Biodiversa+. As described above, the various topics addressed lie on a continuum of situations, from action-ready fields to less-defined and structured subjects; some topics are already tackled with the Partnership's pilot programme, or are covered by pilot candidates, while others have merely identified critical areas. These priorities are expected to be promoted with the EC top-up funding for biodiversity monitoring activities to improve harmonised transnational biodiversity monitoring across Europe. It is thus essential to invest time and resources for a proper assessment of urgent actions for each priority, as well as the establishment of specific road maps over the course of Biodiversa+. Most importantly, work and activities at the crossroads of priorities have to be encouraged. Priorities are considered perspectives to approach a particular issue, but are certainly not mutually exclusive. Rather, several perspectives—hence several priorities—on the same issue provide multiple benefits, including the possible rallying of different expert communities, as well as pooling of resources and knowledge as a path towards harmonisation.

On a different note, priorities are designed as objects of biodiversity monitoring, focusing on the state of species or ecosystems in order to monitor, study, manage and report biodiversity changes. Essential biodiversity variables (EBVs), defined as basic information about the state of biodiversity, measured or estimated at a given biological level, and within spatial and temporal ranges and resolutions, provide a relevant framework for biodiversity monitoring. EBVs are modular pieces of knowledge that foster harmonisation of monitoring products and provide a standardised information system for informed policy-making about biodiversity. Biodiversity monitoring priorities thus rely on EBVs as a common interoperable language across the Partnership.

Other dimensions of biodiversity notably cover pressures and impacts on biodiversity. The Driver-Pressure-State-Impact-Response (DPSIR) framework provides a complementary tool for a comprehensive management of social-ecological systems. While EBVs only focus on state variables, DPSIR conceptualises a chain of causal links from drivers (driving forces of environmental change, either natural or human), to pressures (stresses that drivers place on the environment), to states (as described by EBVs), to impacts (i.e. biological, economic and social effects of environmental change), to responses (actions by society, targeting all elements of the chain). While not embedded in the design of priorities (which, as explained above, rely on EBVs), DPSIR is a relevant tool to further analyse the products of biodiversity monitoring, and could be considered and used in a comprehensive approach to solving biodiversity problems.

To conclude, this list of revised biodiversity monitoring priorities provides guidelines for action during the 2023–2025 cycle. While further work is required to implement all priorities, it is however essential that activities are actually carried out in the context of each priority—in other words, the current list of revised priorities encourages active contributions from Biodiversa+ partners, and highlights some directly actionable items. At the end of the 2-year cycle, priorities will be reassessed from the prism of ongoing work and implemented activities within the Partnership. Further topics that will be then considered mature for action will also have the potential to be added in the list of biodiversity monitoring priorities.