Europa Biodiversity Observation Network:

User and Policy Needs Assessment

EUROPABON

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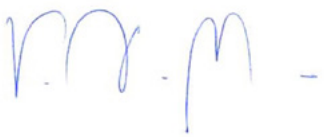
"For the first time in living memory, we can make a real impact on biodiversity in Europe. But if we want a fit-for-future planet, we need a fit-for-purpose framework for biodiversity monitoring. The biodiversity monitoring system we are designing should be like the street lighting of the future planetary citizenship that we are trying to build. The inputs and outputs from EuropaBON will be very relevant for the prioritisation of monitoring gaps and the development of integrated monitoring systems."

John Bell
DG RTD

"Many European countries struggle with similar challenges in biodiversity monitoring: insufficient means to fulfil current monitoring obligations, poor data quality, lack of standardised data collection methods, and the need for better skills, expertise, and increased human resources. Our country is no exception to this reality. We have high hopes to codesign - along with EuropaBON and all relevant stakeholders - a European Monitoring Network that can help us overcome these roadblocks."

Vlatka Dumbovic Mazal
Ministry of Economy and Sustainable Development Croatia



"The capacity of the EU to monitor biodiversity and ecosystems needs to be enhanced. A more performant biodiversity and ecosystem monitoring system is essential, not only to support future legislation on ecosystem restoration but also to help implement existing reporting obligations, and to better inform and connect actions that depend on knowledge of key biodiversity and ecosystem parameters."

Joachim Maes
EC DG REGIO

"Many efforts have already been made to monitor components of European biodiversity, including the set-up of well-established networks to survey populations of common birds and butterflies. However, major knowledge gaps remain and biodiversity monitoring is largely fragmented. Actions implemented by EuropaBON are highly complementary to those of the European Biodiversity Partnership, therefore helping to pave the way towards the establishment of a pan-European network of harmonised monitoring schemes able to efficiently track progress towards the targets of the European Biodiversity Strategy 2030."

Hilde Eggermont
European Biodiversity Partnership/ Biodiversa+

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Expert meeting participating organisations and agencies:

Ministry of Environment and Physical Planning, Republic of North Macedonia; Environmental Protection Agency (SEPA), Serbia; Ministry of Economy and Sustainable Development, Croatia; National Museum of Natural Sciences, Spain; Ministry for Ecological Transition and Demographic Challenge, Spain; Federal Agency for Nature Conservation, BfN, Germany; Finnish Environment Institute (SYKE), Finland; Ministry of the Environment, Finland; Institute of Botany of the Czech Academy of Sciences, Czech Republic; Ministry of Environment Spatial Planning and Infrastructure, Kosovo; Estonian Environment Agency, Estonia; Environment Protection Agency, Lithuania; Agency for Nature and Environment Protection, Montenegro; Institute for Nature Conservation and Forests, Portugal; Research Centre in Biodiversity and Genetic Resources (CIBIO), Portugal; Executive Environment Agency (ExEA), Bulgaria; National Parks & Wildlife Service, Ireland; Research Institute for Nature and Forest (INBO), Belgium; Italian Institute for Environmental Protection and Research (ISPRA), Italy; Danish Environmental Protection Agency, Denmark; Nature Conservation Agency, Latvia; European Biodiversity Partnership: Biodiversa+; Directorate-General for Research and Innovation (DG RTD); Joint Research Centre (JRC); Directorate-General Environment (DG ENV); Directorate-General Agriculture and Rural Development (DG AGRI); European Environment Agency (EEA); Directorate-General Climate Action (DG CLIMA); and the European Research Executive Agency (REA).

Survey participating organisations and agencies:

Ministry of Environment and Physical Planning, Republic of North Macedonia; Environmental Protection Agency (SEPA), Serbia; Ministry of Economy and Sustainable Development, Croatia; Nature Conservation Agency CZ, Czech Republic; National Museum of Natural Sciences, Spain; Ministry for Ecological Transition and Demographic Challenge, Spain; Federal Agency for Nature Conservation, BfN, Germany; Ministry of the Environment, Finland; Institute of Botany of the Czech Academy of Sciences, Czech Republic; Ministry of Environment Spatial Planning and Infrastructure, Kosovo; Estonian Environment Agency, Estonia; Environment Protection Agency, Lithuania; Agency for Nature and Environment Protection, Montenegro; Institute for Nature Conservation and Forests, Portugal; Executive Environment Agency (ExEA), Bulgaria; National Parks & Wildlife Service, Ireland; Ministry of Climate and Environment, Poland; Italian Institute for Environmental Protection and Research (ISPRA), Italy; Danish Environmental Protection Agency, Denmark; Nature Conservation Agency, Latvia; Ministry of Agriculture, Hungary; PBL Netherlands Environmental Assessment Agency, the Netherlands; Slovak Environment Agency (SEA), Slovak Republic; Institute of the Republic of Slovenia for Nature Conservation (ZRSVN), Slovenia; Swiss Academy of Sciences SCNAT, Switzerland; European Biodiversity Partnership: Biodiversa+; Joint Research Centre (JRC); Directorate-General Agriculture and Rural Development (DG AGRI); and the European Environment Agency (EEA).

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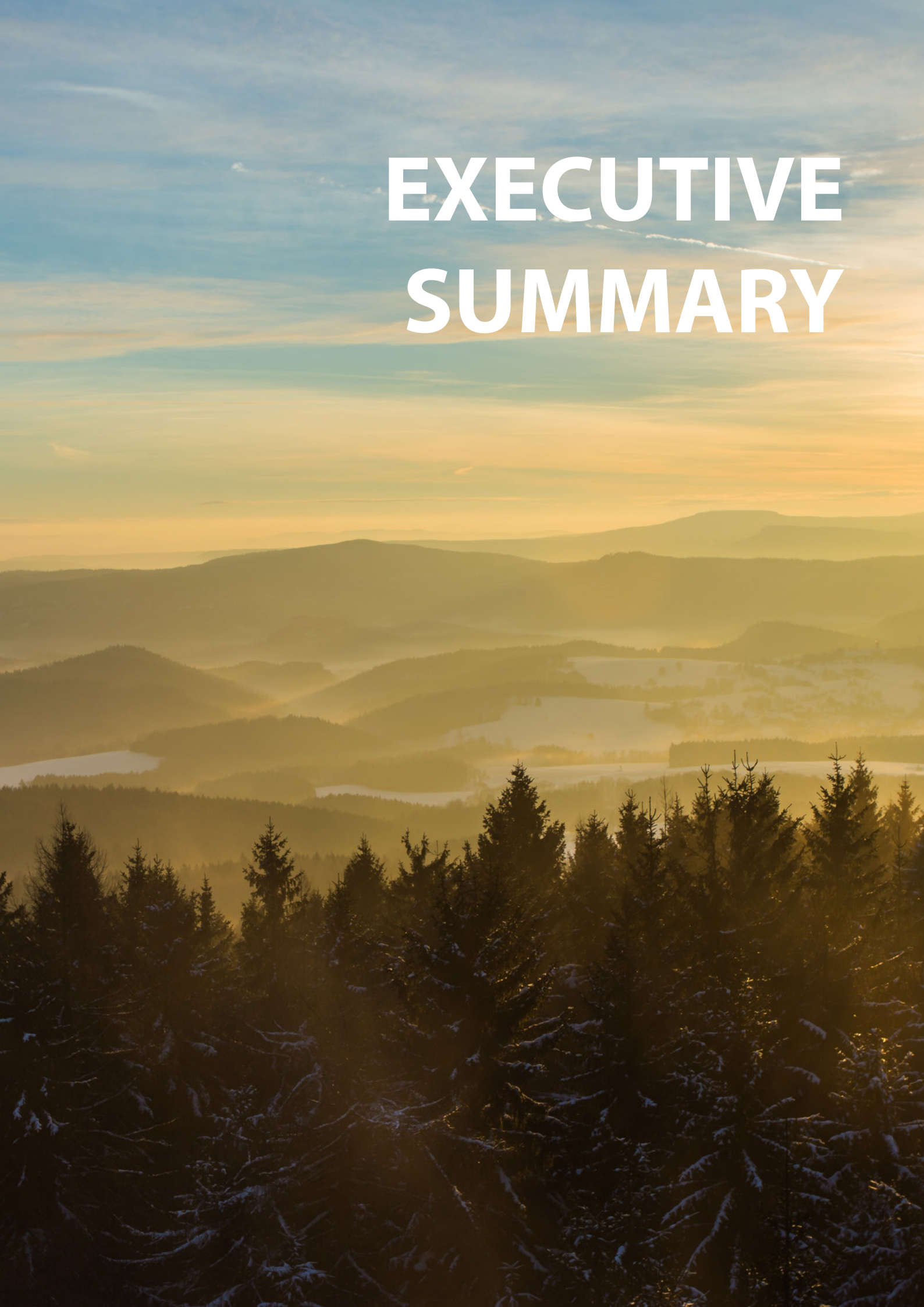
LIST OF ABBREVIATIONS

BMCC	Biodiversity Monitoring Coordination Centre
CAP	Common Agricultural Policy
CFP	Common Fisheries Policy
DG	Directorate-General
DG AGRI	Directorate-General for Agriculture and Rural Development
DG CLIMA	Directorate-General for Climate Action
DG ENV	Directorate-General for the Environment
DG MARE	Directorate-General for Maritime Affairs and Fisheries
DG REGIO	Directorate-General for Regional and Urban Policy
DG RTD	Directorate-General for Research and Innovation
EBKC	European Biodiversity Knowledge Centre
EBV	Essential Biodiversity Variable
EE	Eastern Europe
EEA	European Environment Agency
EESV	Essential Ecosystem Services Variable
EIA	Environmental Impact Assessment
Eionet	European Environment Information and Observation Network
ETC/BD	European Topic Centre on Biodiversity
EU	European Union
EuropaBON	Europa Biodiversity Observation Network
FAIR	Findability, Accessibility, Interoperability, and Reusability
GBIF	Global Biodiversity Information Facility
IAS Regulation	Invasive Alien Species Regulation
IUCN	International Union for Conservation of Nature
JRC	Joint Research Centre
MAES	Mapping and Assessment of Ecosystem Services
MSFD	Marine Strategy Framework Directive
NE	Northern Europe
NGO	Non-governmental organisation
PPP	Public-Private Partnership
REA	European Research Executive Agency
SCB	Society for Conservation Biology
SE	Southern Europe
SDG	Sustainable Development Goal
SEA	Strategic Environmental Assessment
SIA	Social Impact Assessment
UNSD	United Nations Statistical Division
WE	Western Europe
WFD	Water Framework Directive
WP	Work package



EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

EuropaBON aims to design an EU-wide monitoring framework for biodiversity and ecosystem services.

Building the EuropaBON framework requires engaging stakeholders at all stages of the design process. This continuous process starts with identifying user and policy needs for biodiversity monitoring, as laid out in this report. The next step in the EuropaBON design process will consist of assessing current monitoring efforts to identify gaps, as well as data and workflow bottlenecks. The process will conclude with co-designing a new monitoring system that integrates existing data streams with models to produce relevant biodiversity indicators tailored to policy and management.

This report reflects the needs and opinions expressed by the stakeholders who were able to participate in the various engagement events described below. The results of this initial assessment of the biodiversity data and policy landscape in Europe will serve to guide and inform the further work that EuropaBON will undertake over the next two years and should not be regarded as final results of any upcoming EuropaBON tasks. While this report provides information on user data needs for addressing open policy questions, EuropaBON is currently investigating which user-identified policy questions can be addressed with existing data, and how modelled biodiversity variables can help to fill remaining data gaps. These and other tasks form part of the Work Packages (WP) on assessing existing monitoring capability in Europe (WP3) and co-designing the proposed European monitoring system (WP4), the results of which will be released to the EuropaBON community for open review at a later stage of the project.

To define the various user needs, we engaged stakeholders in four key steps. We held an initial public stakeholder workshop attended by 246 participants from policy, practice, and research. After the workshop, we collected information through a survey on biodiversity data use and policy needs addressed to experts from all European countries and EU agencies. This was followed by an expert meeting with national focal points of the European Environment Information and Observation Network (Eionet), representatives of eight relevant EU agencies and experts involved in national/regional biodiversity monitoring from 18 European member and non-member states. We also conducted semi-structured interviews with selected stakeholders to complement the survey responses. A majority of the stakeholders represented the agencies dealing with the Nature Directives, while there were few stakeholders representing agencies working on freshwater and marine issues. Therefore, the results of this report focus mainly on terrestrial biodiversity monitoring, while freshwater and marine monitoring are equally important.

The results of this assessment show a fragmented biodiversity data landscape that cannot easily answer all relevant policy questions. The quantity and quality of baseline biodiversity datasets differ across countries, ranging from non-existent biodiversity monitoring due to capacity issues, to intermittent and regular monitoring of ecosystem state and processes.

Monitoring schemes focus mainly on species and protected areas. Habitats and ecosystems are covered to a lesser extent, and genetic diversity is even more rarely monitored. The most intensively monitored taxonomic groups by European countries are birds, mammals, and plants. More than two-thirds of biodiversity datasets listed by survey respondents are currently used to report to the Habitats and Birds Directives, while less than one-third were reported to be used to inform other EU Directives (e.g., Water Framework Directive WFD, Marine Strategy Framework Directive MSFD) and policies (e.g., Common Agriculture Policy, Common Fisheries Policy, Invasive Alien Species Regulation), pointing to potential data bottlenecks. For the WFD, the monitoring is conducted for all major taxonomic groups (biological quality elements) in a large number of rivers, lakes, transitional and coastal waters. Several countries indicated their struggle to fulfil monitoring obligations for EU Directives, which is due in part to limited resources as well as differing taxonomies and habitat classifications. EuropaBON is mapping monitoring efforts and how successful they are in task 3.1 (WP3), which will give a more accurate picture.

With exceptions such as some bird species and some priority habitat types, **monitoring schemes do not cover the full range of genetic, taxonomic and ecosystem diversity** within the respective countries. The coverage of different species and ecosystems is biased, as many of the national monitoring activities are mainly influenced by the reporting obligations of the Birds and Habitats Directives, and therefore focus on species listed in the Directives and endangered species. Similar biases exist in taxa monitored by non-governmental organisations (NGOs) and citizen scientists. These well-monitored taxa, however, may not always address urgent national and European policy needs, and many unknowns remain.

Countries across different regions of Europe ranked biodiversity monitoring challenges differently. For example, the lack of long-term policies is seen as a major challenge in southern and western Europe, while limited financial resources were ranked as a more important constraint in southern and eastern Europe.

Roadblocks to monitoring by national agencies include lack of support to establish coordinated monitoring programs and insufficient technical capacity. They also include lack of guidance in identifying monitoring priorities; lack of authoritative and standardised monitoring protocols; hesitation to change existing monitoring prac-

tises; unavailability of data from sectors such as agriculture, fisheries, and energy; and limited in-house knowledge and technical infrastructure to adequately mobilise and access biodiversity data. A positive example is the Water Framework Directive (WFD), for which all countries have established both surveillance and operational monitoring programmes following the WFD article 8 and using the WFD monitoring guidance and the standardised sampling and analysis methods.

The lack of detailed geo-referenced information is severely hampering assessments of biodiversity and ecosystem trends, as well as infrastructure planning. Often, agencies only have access to regionally aggregated assessments of species or ecosystems and the underlying specific (raw) data are not traceable or easily accessible.

Although most countries responded that they use biodiversity monitoring data for some modelling, lack of capacity and funding currently prevents some countries from exploiting the full potential of biodiversity modelling.

The following solutions are proposed as potential avenues to address the challenges and to build a European Biodiversity Observation Network (figure ES1).

- **Enhanced overall coordination, cooperation and synchronisation** of monitoring efforts are key to synthesise Europe's fragmented biodiversity data landscape. Coordinated monitoring programmes need to provide guidance for identifying monitoring priorities and standardised, efficient, and agreed upon monitoring protocols, similar to WFD monitoring practises. Better spatial, temporal, and taxonomic synchronisation of data collection, along with improved cross-country monitoring coordination (ideally through a European coordination platform) would improve effectiveness and impact of current monitoring efforts. Reporting obligations need to be coordinated, and they need to provide clearly defined **indicators for each (new) policy target**, so that cross-country comparison is possible.

- **Enhanced data standardisation, coupled with increased data gathering and mobilisation, and dedicated data sharing mechanisms** will be key to harnessing Europe's rich, yet fragmented data landscape to answer urgent questions by policy, practice and research. Strengthening the principles of open and FAIR (findable, accessible, interoperable and re-usable) data, creating public databases and new statistical tools for integrating heterogeneous data will make data more accessible to both researchers and policymakers. **Data collected by private companies for environmental impact assessments could be made available through online open access.** The same applies for raw data at species level collected under the Water Framework Directive and other EU obligations. Overall, open access should always acknowledge the data providers, and donor institutions should be evaluated by the impact of the monitoring they are funding.

- **Increased modelling efforts and the use of new technologies** will serve as important solutions to address monitoring design, methods and data analysis tackling complex biodiversity monitoring challenges. New technologies include Artificial Intelligence, 24/7 monitoring, remote sensing, and eDNA coupled with metabarcoding, genomic sequencing or other laboratory methods. They have a great potential to standardise biodiversity monitoring in Europe.

- **Adequate substantial financial resources** are needed to address both the lack of capacities in member states and to foster integration of data and monitoring schemes. More and better long-term, cross-country, cross-institutional, and cross-sectoral coordination of funding, along with private sector investments, can help unlock and mobilise financial resources needed to maintain existing initiatives and increase and improve monitoring efforts.

- **Capacity building** is needed to harness and develop a network of skills, knowledge and people. Key solutions include training experts across all disciplines, working with existing and creating new biodiversity fora in collaboration with the Knowledge Centre for Biodiversity, fostering extensive networks and virtual platforms for experts and stakeholders

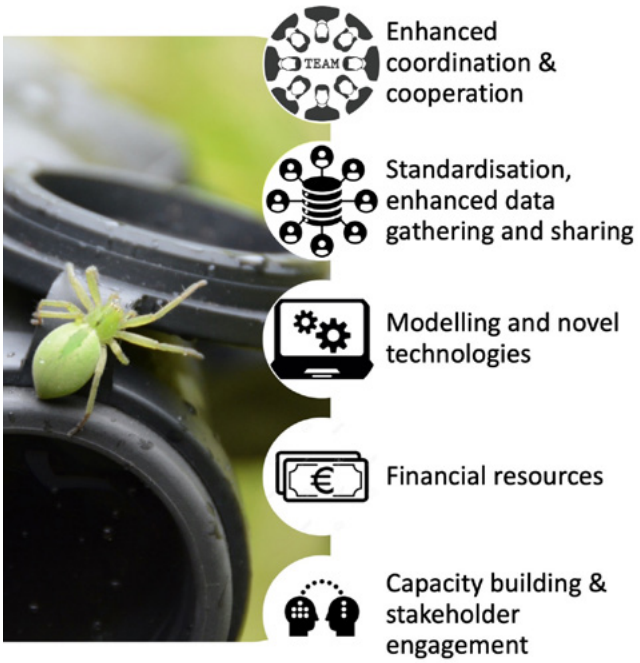


Figure ES1: Solutions identified by stakeholders to biodiversity data challenges - Building of a European Biodiversity Observation Network, EuropaBON.

to share ideas and exchange knowledge, and embracing citizen science as a means of involving volunteers in monitoring and in designing an effective and user-driven monitoring scheme for Europe.

Two clusters of user and policy needs are of key importance in Europe over the next 5-10 years (figure ES2):

- **Biodiversity data are needed to ensure integrated cross-sectoral policies:** biodiversity data can provide evidence for policies for agriculture, climate change, infrastructure, freshwater, marine spatial planning, fisheries, nature-health linkages, green investments, and financial accounting.

- **Biodiversity data are needed to increase policy impact and effectiveness to fulfil goals of the EU Biodiversity Strategy:** enhanced biodiversity monitoring can inform and guide policy targets on conservation, marine biodiversity, restoration, ecosystem services, telecoupling (ecological footprint in other countries), and societal engagment.

Essential biodiversity variables (EBVs) and essential ecosystem service variables (EESVs) were ranked by stakeholders for their relevance to policy needs. The fifteen highest ranked variables included species abundances of rare/priority birds, common birds, selected mammals (carnivora; artiodactyla; bats) and harvested marine fish species; species distributions of priority plants/all vascular plants, freshwater fish, all mammals and invasive taxa; ecosystem distribution of habitats in Habitats Directive; land use/land cover change; community abundance of pollinator insects; and water quality regulation. Other important EESVs included belowground carbon content, fish harvest, economic value of pollination and seed dispersals, and harmful algal blooms.

The highly-ranked EBVs address a wide variety of policy questions that feed into three major EU-policy missions: 1) how to monitor biodiversity trends and assess that populations are on a path towards recovery; 2) how to monitor trends in key regulating and cultural ecosystem services to ensure that they continue to deliver in the long-term; and 3) how to monitor ecosystem restoration to effectively restore degraded ecosystems by 2050. All EBVs/EESVs can be used to address multiple policy questions. Likewise, some of the policy questions cannot be answered sufficiently by monitoring only one EBV/EESV.

The majority of highly ranked EBVs/EESVs are currently not, or insufficiently, monitored across Europe (figure ES3). However, most countries monitor all of them partially and only a few countries indicate that one or more of the desired EBVs/EESVs are not yet monitored at all. In any case, clear monitoring gaps exist, even for variables rated as very important to monitor by the users, with none of the variables being adequately monitored in the majority of countries.

Stakeholders require high spatial and temporal resolutions. For the top fifteen-ranked EBVs/EESVs, the preferred temporal frequency is between one and five years and a spatial resolution of 1km^2 to 50km^2. Satisfying these demands would require combining existing in situ schemes with targeted novel in situ monitoring and remote sensing data using models. In a next step, jointly with thematic experts, EuropaBON will refine and complement this list and identify which policy-relevant aspects of biodiversity (and related key ecosystems) can be feasibly and cost-efficiently monitored. EuropaBON's showcases will be a case in point of this EBV/EESV development process with specific focus on the Habitats, Birds and Water Framework Directives, Soil Restoration and Climate Policies, and the Bioeconomy Strategy.

The highly ranked set of EBVs/EESVs is not yet a balanced representative set of variables to be monitored. The identification of essential variables to be monitored across Europe will be done at a later stage of the EuropaBON project, based on the analysis of this report as well as further expert input by stakeholders and scientific expertise of the consortium and colleagues. This identification of EBVs and EESVs needs to consider a balanced set of variables across different EBV and EESV classes (i.e., different levels of biological organisation and types of ecosystem services), different realms (marine, terrestrial, freshwater), and different taxonomic groups.

With this user and policy needs assessment, we lay the foundation for co-designing a user-oriented European Biodiversity Observation Network. In this process, EuropaBON stakeholders have identified a number of challenges and pointed out some potential solutions. This report articulates how biodiversity data is currently being used

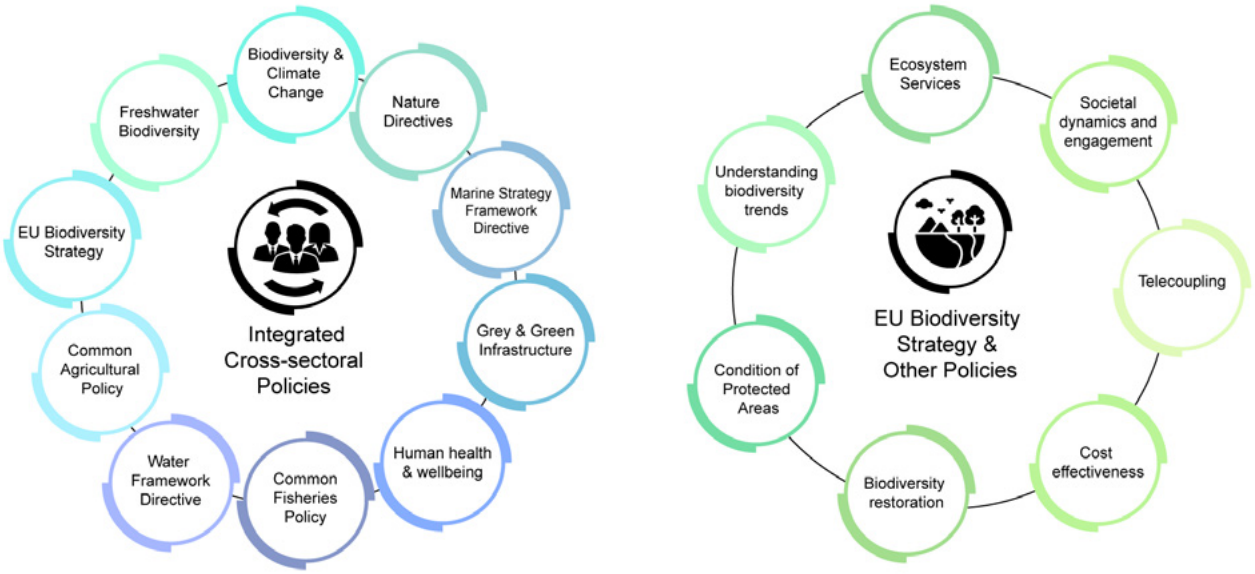


Figure ES2: The two clusters and their subcategories of policy needs identified by stakeholders.

by policy and what the biodiversity monitoring requirements for addressing the main policy questions and goals are.

The findings from this report will support EuropaBON in the future tasks of selecting a consolidated list of essential biodiversity and ecosystem service variables, identifying monitoring gaps on existing monitoring, co-designing workflows from observations to knowledge products that address bottlenecks and considering novel technologies, maximising benefits to users and society at large.

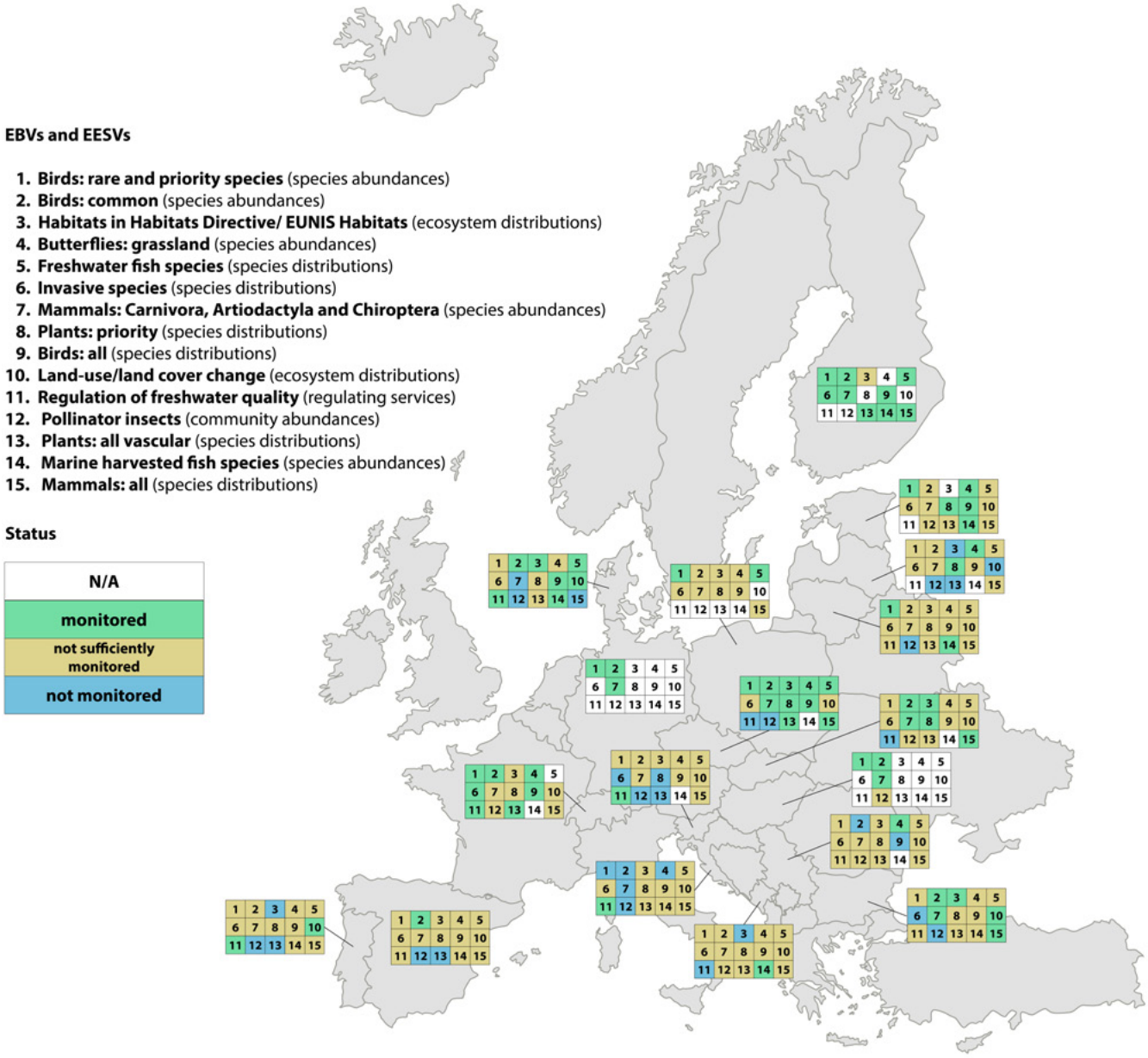


Figure ES3: Monitoring status of the 15 most highly ranked Essential Biodiversity Variables (EBVs) and Essential Ecosystem Services Variables (EESVs) in Europe, as selected by countries and agencies. For each respondent country the monitoring status is given for each essential variable.

1 INTRODUCTION & STAKEHOLDER ENGAGEMENT PROCESS

1 INTRODUCTION & STAKEHOLDER ENGAGEMENT PROCESS

Biodiversity monitoring is crucial to assess both biodiversity trends and the impact of related policies. In Europe, however, biodiversity monitoring remains spatially and temporally fragmented across ecosystems and habitats, as in many other regions around the world[1]. There is a widening gap between the biodiversity data needs of policymakers and what those authorities responsible for policy implementation can deliver using existing data sources and reporting streams.

The EuropaBON project is tasked by the European Commission Directorate-General for Environment to bridge this gap by designing a European Biodiversity Observation Network. The project adopts the approach for the development of coordinated Biodiversity Observation Networks (BONs) from the Group on Earth Observations Biodiversity Observation Network (GEO BON)[2]. This approach emphasises co-design with stakeholders at all stages of the BON development, from assessment of current monitoring to implementation of a new design including new information streams. The overall aim is to integrate data streams with models to produce relevant biodiversity indicators for policy and management. Although EuropaBON follows the GEO BON approach in the design of the monitoring system, this does not imply that such a system will be a distributed and bottom-up network (as many of other BONs are), or a more centrally controlled system with top-down organisation of monitoring protocols and workflows. The decision on the governance and mode of operation of the system will be agreed upon at a later stage in the project.

Assessments and scenarios should draw upon the concepts of Essential Biodiversity Variables (EBVs) and Essential Ecosystem Service Variables (EESVs) developed in GEO BON[3]. EBVs/EESVs are a comprehensive set of biodiversity indicator variables that can be used to standardise and coordinate biodiversity data collection and monitoring. This approach allows users to integrate biodiversity data derived from different methods to rapidly quantify biodiversity change across space and time. Adopting EBVs/EESVs as the language of the EU Directives and other monitoring programmes can help uncover gaps in the current monitoring of European biodiversity and prioritise data mobilisation and modelling efforts in Europe. At the same time, EBVs/EESVs need to be adapted to existing policy needs and indicators to maximise support of policy implementation through research and innovation.

Over the course of three years (2020-2023), EuropaBON is building the architecture for a European biodiversity monitoring system that will be aligned with the needs of European policy and key strategic objectives. These include the European Green Deal, the Post-2020 Global Biodiversity Framework, the EU Biodiversity Strategy for 2030, the Horizon 2020 and Horizon Europe work programmes and the Sustainable Development Goals 2030. EuropaBON brings together a community of practitioners working on different aspects of biodiversity and ecosystem service monitoring in Europe, including experts working with different monitoring techniques for different taxa of flora and fauna and their respective habitats across terrestrial, freshwater and marine ecosystems.

This *User and Policy Needs Assessment* is one of the key first steps of EuropaBON and represents an initial scoping exercise of the uses, needs and challenges of EU Member States and key EU agencies regarding biodiversity monitoring. This assessment constitutes the foundation for the design of a cost-efficient, user-oriented, and policy-relevant European biodiversity monitoring network. In this report, we present the analysis of the different available biodiversity data streams at the EU and national level, both baseline biodiversity data and monitoring data. This report assesses how these biodiversity data inform and trigger policy action and identifies the related challenges the different European countries and relevant EU agencies face and the solutions to overcome them. The assessment draws upon a wide range of stakeholder expert knowledge and is based on four key data sources (figure 1):

- Public stakeholder workshop with 246 participants (362 registrants) from 48 countries across the globe representing ~170 organisations on 26-28 May 2021
- Standardised surveys filled in by national experts from 26 European countries/agencies
- Semi-structured interviews with 17 experts from 13 European countries and 2 EC directorates/agencies in September-December 2021
- Expert meeting with 27 European representatives, experts and colleagues from 18 countries and eight EC directorates/agencies on 29 September 2021.

Stakeholder engagement process

EuropaBON initiated its stakeholder engagement process with the official launch of EuropaBON at the kick-off meeting on 1st December, 2020. Attendees of this meeting in-

1 Proença, V., Martin, L. J., Pereira, H. M., et al. (2017). Global biodiversity monitoring: from data sources to essential biodiversity variables. Biological Conservation, 213, 256-263.

2 Navarro, L. M., Fernández, N., Guerra, C., et al. (2017). Monitoring biodiversity change through effective global coordination. Current opinion in environmental sustainability, 29, 158-169.

3 GEO BON (2021). What are EBVs? [Online]. Available from: https://geobon.org/ebvs/what-are-ebvs

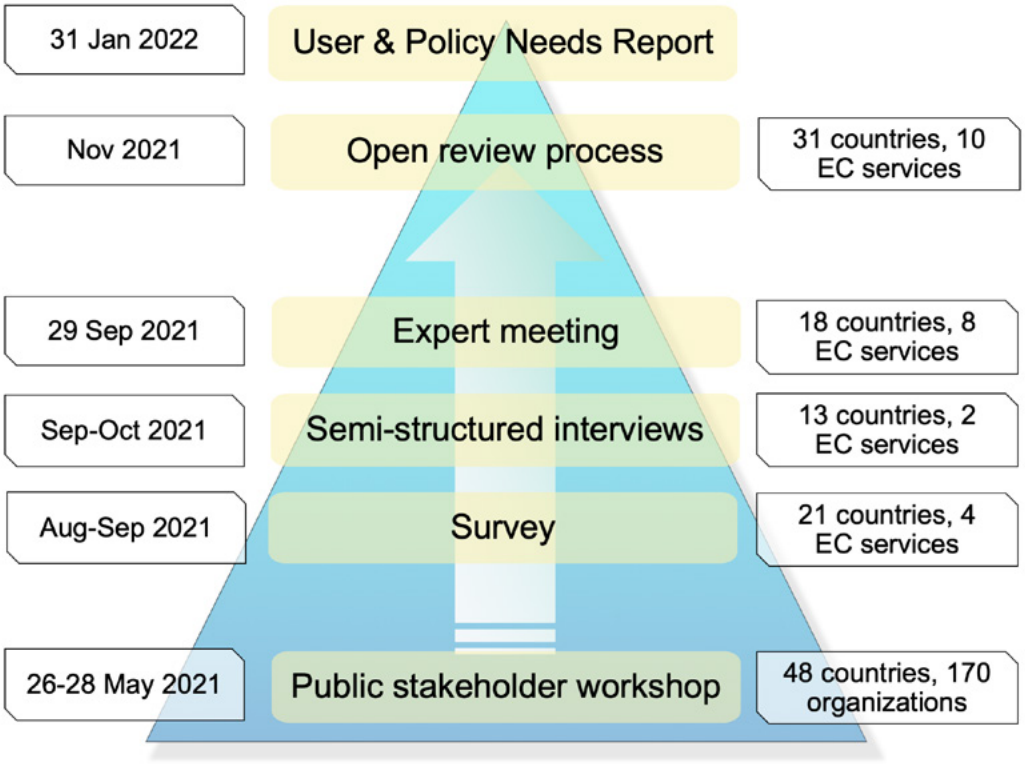


Figure 1: The stepwise methodology of EuropaBON's stakeholder engagement process.

cluded all 64 EuropaBON partners as well as representatives of organisations that had provided Letters of Support during the application process. Following the meeting, we publicly launched an open call via EuropaBON's website and social media channels for interested individuals/institutions to become members and or stakeholders of the EuropaBON network by signing up via our members portal. We currently have 380 members in EuropaBON representing 240 organisations and 45 countries from around the globe.

Public stakeholder workshop

The first open (virtual) stakeholder workshop took place on 26-28 May, 2021. We invited all interested stakeholders to jointly identify and discuss user and policy needs for biodiversity monitoring in Europe. The workshop attracted 362 registrants from 48 countries across the globe and was attended by 246 participants from policy, academia and non-profit organisations. The majority of attendants were from south-western and central Europe (in particular Germany, Portugal and Spain) and had academic backgrounds. Therefore, we followed this up with national expert consultations to also include expertise from policy and practice (see below). The public stakeholder workshop featured a high-level policy event with speakers and roundtables from the European Commission's directorate level, including the Commission's Directorate-General for Research and Innovation (DG RTD), the Directorate-General for the Environment (DG ENV), the Directorate-General for Agriculture and Rural Development (DG AGRI), the Joint Research Centre (JRC), the European Environment Agency (EEA) and Eurostat. More information on the programme can be found here.

During the workshop, stakeholders actively engaged in targeted interactive sessions with small break-out groups of approximately ten participants each. Within a two-hour period, participants went through a rapid brainstorming process on policy needs, challenges, and solutions related to biodiversity monitoring. Over 80 participants added 240 entries into an online database, which were clustered and ranked by priority through a voting process (see Appendix 3 for the list of challenges and solutions identified). This allowed us to obtain a broad overview of the monitoring data needs, challenges to biodiversity monitoring, and potential solutions to overcome these challenges. We then complemented these lists when experts identified critical gaps during the public consultation period.

During further break-out groups, participants were also asked to list and rank pre-defined (from a rapid survey circulated before the workshop) EBVs/EESVs to be monitored in EuropaBON to address open policy questions in their country/agency. Here, we asked respondents to indicate desired spatial and temporal resolutions for these EBVs/EESVs and taxonomic representation. The respondents in each break-out group were then asked to rank the priority of each EBV/EESV from low to high. The results from the breakout groups were combined and EBVs/

EESVs further condensed by similar or redundant characteristics (i.e., spatial, temporal and biological entity scope and resolution). A final refined set of the highest priority EBVs/EESVs was created using the highest average rank scores by respondents.

We also invited all registered workshop participants and consortium members to contribute to a rapid survey on data and monitoring needs to support future policies prior to the workshop. The survey registered 81 entries, which were sorted into ten thematic clusters by eleven experts in the EuropaBON consortium.

National European expert survey

On behalf of the European Commission (DG ENV), EuropaBON invited national and European experts to participate in an extensive survey. The survey inquired about policy needs, data flows, a ranking of current challenges to biodiversity monitoring and the importance of EBVs/EESVs to national policymaking. Respondents also listed potential solutions to overcome current challenges. The standardised survey was disseminated in July-September 2021 to all national focal points of the European Environment Information and Observation Network (Eionet) and other relevant experts in 37 European countries. We also sent the survey to nine European Commission services (comprising Directorate-Generals and agencies): DG ENV, DG CLIMA, DG AGRI, DG RTD, the EEA, Eurostat, the EBKC, REA, and the European Biodiversity Partnership. We received responses from 21 countries and four Commission services (figure 2, table 1).

The survey was answered by national experts from both research and policy. In this report, we refer to responses from national experts as "countries" and from experts working for the European Commission as "EC services" to make a clear distinction between the national and European level.

The survey template and the submitted raw data can be found in Appendix 1 and Appendix 6, respectively. For any specific questions about other parts of the data, please contact us at info@europabon.org

Semi-structured interviews

Building on the survey responses, we conducted 15 semi-structured interviews with experts from 13 countries and two Commission services in September 2021 (figure 2, table 1). The interviews allowed for clarification and in-depth discussion of the respective survey responses. A second round of interviews is scheduled for early 2022, the results of which will be used for further synthesis publications.

Expert meeting

The invite-only, half-day virtual expert meeting brought together selected experts from multiple European countries and EC directorates and agencies on 29 September 2021. The event was mainly tailored to respondents of the EuropaBON survey and/or participants of the interviews. The meeting was attended by 40 expert stakeholders from 18 European countries and eight European agencies (figure 2, table 1) and 17 EuropaBON partners. The meeting facilitated in-depth discussions on biodiversity monitoring data needs at national and regional levels in Europe, including current policy roadblocks and potential solutions.

Open review process

This report has undergone a public consultation process during which it was shared with all survey respondents, expert meeting participants, EuropaBON consortium members. The invitation for consultation was also publicly shared on the EuropaBON website. The draft report has been formally reviewed by dozens of experts from 31 countries and 10 EC services, in November 2021. Limitations are listed in box 1.

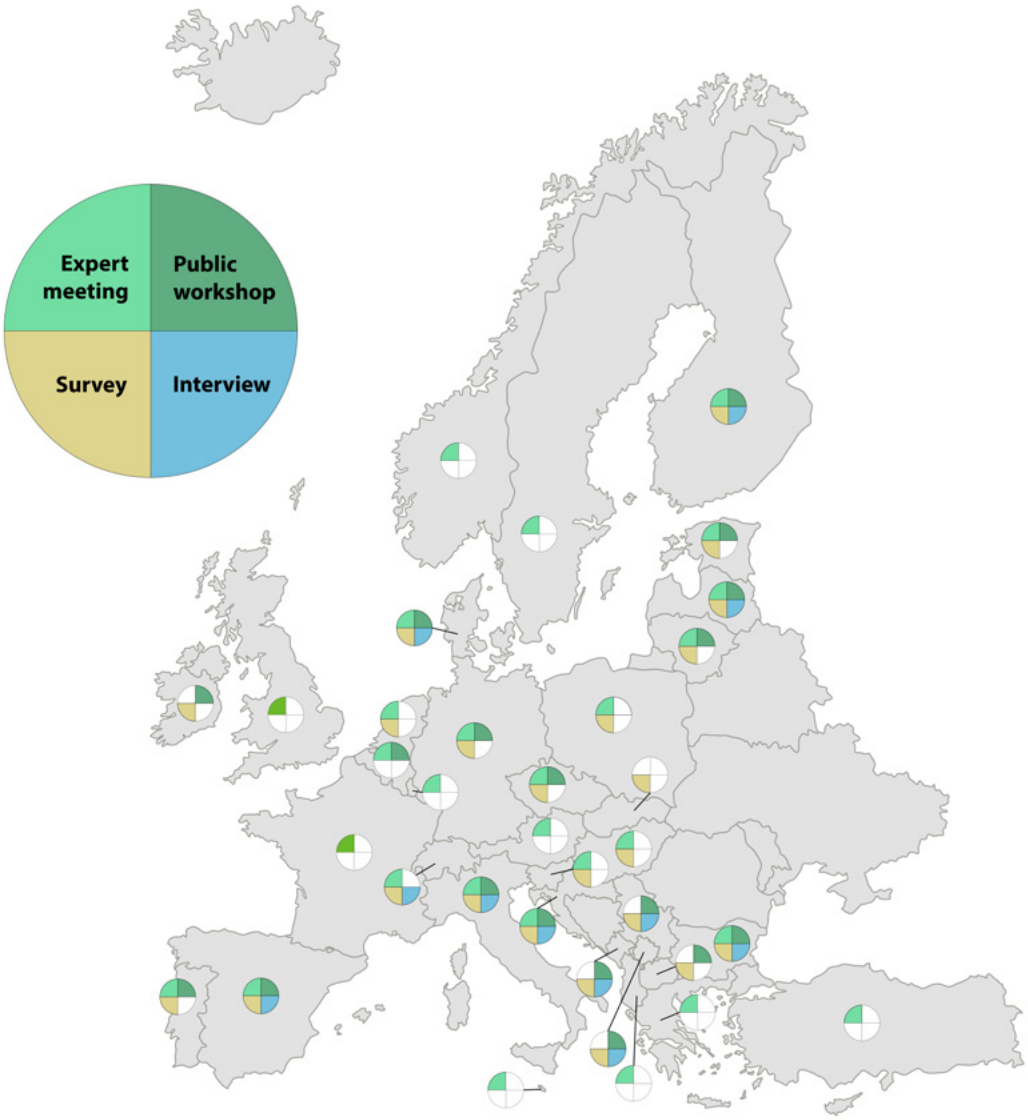


Figure 2: Geographic distribution of participants to the workshops, surveys, and interviews.

Table 1: European Commission services represented in the workshops, surveys, and interviews that fed into this analysis

	Public stakeholder workshop	Survey	Interview	Expert meeting
Directorate General for Environment	✓			✓
Directorate General for Agriculture and Rural Development	✓	✓		✓
Directorate General for Climate Action			✓	✓
Directorate General for Research and Innovation	✓			
Eurostat	✓			✓
European Environment Agency	✓	✓	✓	✓
European Research Executive Agency	✓			✓
European Biodiversity Partnership	✓	✓		✓
Joint Resource Centre	✓	✓		✓

Box 1: Limitations of the information presented in this report

This report presents novel insights into current biodiversity monitoring data flows on both country and EU levels. It is the first attempt to collect and analyse information on these flows as well as EBVs/EESVs in Europe by consulting with relevant experts in data provision and policymaking on national and regional levels. The EuropaBON project team facilitated an in-depth stakeholder consultation process within the allocated timeline, while it was not possible to capture the views of all relevant stakeholders (e.g., all European countries or EC services). Future EuropaBON work will build and expand on this. We are aware that by focusing first on experts of the Habitats and Birds Directive, this may have biased the number and nature of respondents, as detailed below.

The participation of key stakeholders from countries and Commission services varied in the four steps of the stakeholder engagement process (figure 1) and may cause some biases. Furthermore, not all respondents could answer all questions. Participants were also mainly working on terrestrial biodiversity, both at national and at EU level, while aquatic biodiversity (freshwater and marine) was less well represented. EuropaBON partners have therefore added several aquatic EBVs used in the Water Framework Directive.

For much of the data analysed, double counting was inevitable. For example, if a country or organisation carries out a monitoring scheme on priority habitats, these might fall under several biomes or be relevant to several reporting obligations. Given the complexity of biodiversity monitoring at the national and institutional levels in Europe, certain parts of the surveys might not always have been answered by the appropriate respondents, as they do not always carry out monitoring themselves. Therefore, answers may not always represent entire countries' or agencies' biodiversity monitoring situations.

In terms of how biodiversity monitoring data lead to policy action, it was often difficult to identify and differentiate between different data uses and purposes. Monitoring often overlapped to inform species and habitat action plans, management plans, as well as conservation status appraisals. For example, in Estonia, wolves are monitored annually under Article 9 of the Birds Directive and Article 16 of the Habitats Directive. Based on the results from these monitoring schemes and suggestions by the Environment Agency, the Environmental Board decides every year how many hunting permits will be issued to regulate the number of wolves. Here, monitoring informs not only species' conservation status, action plans, and management plans - it also leads to the regulation of hunting permits.

Overall, we are very grateful for the very timely and in-depth engagement of many stakeholders from policy, practice and science to share their expertise on user and policy needs. Further EuropaBON workshops will build on the results and focus on selected aspects to develop more specific solutions.

2 BIODIVERSITY DATA USE & UPTAKE IN POLICY-MAKING

Key messages

- The biodiversity data landscape is rich but highly fragmented. Many different programmes exist in different countries that lack collaboration, standardisation and interoperability. This impedes joint analysis of biodiversity trends and drivers as well as successful assessment of impact of policies.
- Birds are monitored most intensively through the national monitoring schemes, followed by mammals and plants. In contrast, soil biota, ecosystem services and microorganisms are rarely monitored.[4]
- Large geographical differences exist in the quantity and quality of biodiversity datasets. Several countries struggle with fulfilling monitoring obligations under European Directives, in particular from southern and south-eastern Europe.
- The majority of monitoring schemes feed into European or national reporting, particularly for the Habitats and Bird Directives, and few into global reporting (e.g., Convention on Biological Diversity). However, there is little cross-sector use of biodiversity data monitoring e.g., for climate and agriculture policies.
- Countries have expressed interest in using modelling to harmonise and leverage biodiversity monitoring data and some are already doing so; other countries mention lack of capacity and funding as the key barriers to undertake modelling.
- Biodiversity data are mostly used to inform conservation action at the species level (with a taxonomic focus on birds) and protected area level for species management and action plans.

4 Note: the survey covers marine and coastal environments in a less comprehensive manner than terrestrial and freshwater environments.

2 BIODIVERSITY DATA USE & UPTAKE IN POLICY-MAKING

Biodiversity monitoring data are key to understanding trends in and threats to biodiversity in Europe. Robust and high-quality data, however, are not the only prerequisite to be able to have a meaningful impact. Data need to be fit-for-purpose to inform the development, design, and formulation of policies and strategies in Europe.

Besides informing policy formulation, monitoring data are also needed to evaluate the effectiveness of policies and track progress towards policy goals and targets. Thus, biodiversity monitoring data can be used at various stages of the policymaking cycle (figure 3). The survey we sent to EU country and agency representatives was structured around these different policy cycle stages and aimed to identify the uses and data workflows at each of these stages.

This section briefly describes some of Europe's key biodiversity monitoring data users and providers. We then explore the different biodiversity monitoring schemes that current (and future) EU countries and key EU services are engaged in, as elicited from stakeholder interviews and surveys.

This represents a first step in informing and shaping future work carried out by EuropaBON, in particular, the inventory of the current European monitoring network (CREAF 2021[5]).

2.1 Key biodiversity data users, providers and policy stakeholders in Europe

The landscape of European biodiversity data users represents a rich mosaic of policy stakeholders who regularly require and consume biodiversity data to inform, design, report, or trigger policy decisions, and of many experts from a variety of organisations who both provide and ingest biodiversity data.

Agencies such as DG ENV, DG AGRI, DG CLIMA and DG RTD along with the EEA and the ETC/BD are directly supported by numerous key data providers in Europe which include the Eionet, Eurostat, the JRC, and Biodiversa+, the new European Partnership on Biodiversity[6]. The Partnership builds on previous initiatives and results, such as the BiodivERsA network and the Mapping and Assessment of Ecosystem Services (MAES).

Another extensive source of biodiversity data and information is provided by a host of non-governmental and intergovernmental organisations including GBIF, Dryad, BirdLife International, the World Conservation Monitoring Centre and the European Landowners' Association, among many others. Databases and datasets associated with published papers provide another major source of biodiversity data and information that might be used to respond to policy priorities. Funded by the EC, most recently through the Horizon Europe program, numerous projects also contribute to addressing various policy needs through data provision and modelling, including EUMON, EU BON, and ECOPotential. For more information on these various bodies and others, please refer to Appendix 5.

2.2 Current biodiversity monitoring efforts in Europe

The biodiversity policy landscape in Europe is complex, with countries often being parties to a number of national and regional instruments (e.g., European Union Directives) as well as global agreements (e.g., Convention on Biological Diversity, Regional Seas Conventions, Ramsar Convention), with specific and often overlapping reporting needs. In addition, biodiversity monitoring data are used for protected area management, environmental impact assessment and other management and policy needs. As a result, the current stakeholder landscape is rich, and data flows are not always clear. Here, we briefly describe the different monitoring efforts undertaken by current and potential future EU Member States, as based on interview and survey results. A more detailed inventory and analysis of biodiversity monitoring initiatives in Europe providing extensive information on current workflows to the European level will be produced later by EuropaBON, as described below. A total of 274 biodiversity monitoring schemes were extracted from the survey and classified according to different criteria:

- reporting scale
- taxonomic group and biome focus
- corresponding EU directives
- main purpose (e.g., management plans, conservation area designations)

European countries and agencies are engaged in a plethora of diverse monitoring schemes. We found that two-thirds (63%) of the monitoring schemes used by the

5 Morán-Ordóñez, A., Martí Pino, D., Brotons, L., (2021): Inventory of current European network for monitoring. Web-based database. EuropaBON/ The Centre for Ecological Research and Forestry Applications (CREAF), Barcelona. Unpublished report.

6 Biodiversa+, the new co-funded biodiversity partnership – jointly developed by BiodivERsA and the European Commission (DG Environment and DG Research & Innovation) started on the 1st of October 2021.

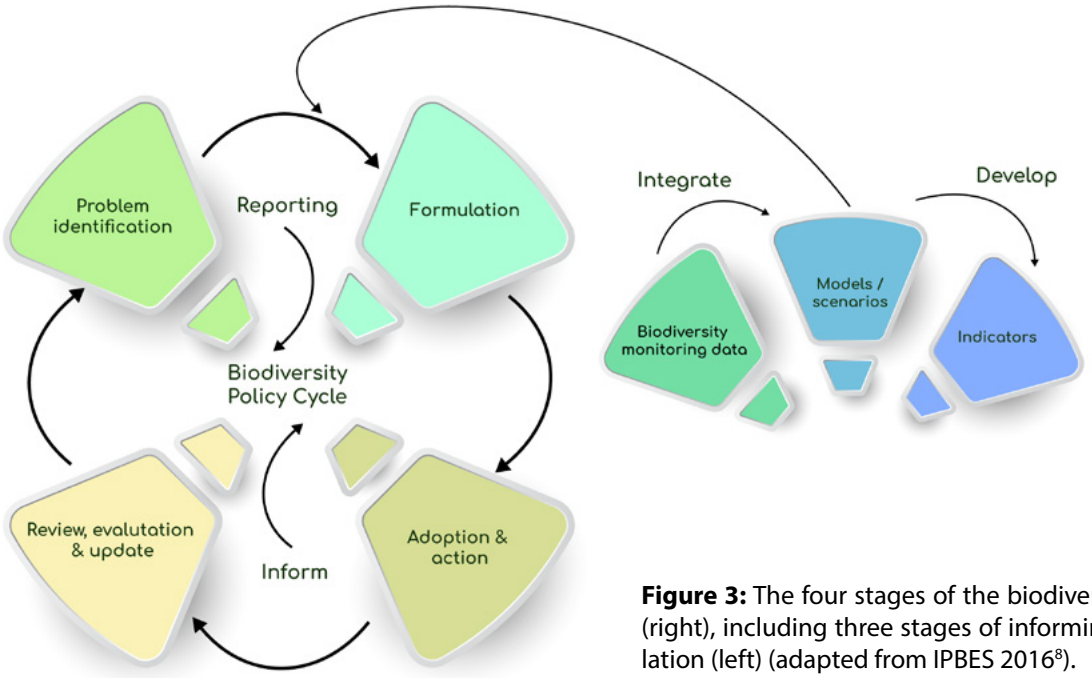


Figure 3: The four stages of the biodiversity policy cycle (right), including three stages of informing policy formulation (left) (adapted from IPBES 2016[8]).

Habitats Directive are focused on mammals (20%), including bats (13%), followed by birds (10%), insects (10%), and amphibians (10%) (figure 4). Plants represented 10% of listed schemes when describing vegetation parameters of specific sites. Bacteria, fungi and microorganisms were virtually absent. The Birds Directive includes mostly (79%) data on birds, but also on mammals (10%), as well as some data on pollinators, insects, bats, and fish (10% in total). Most schemes that were listed in the stakeholder survey focused on terrestrial biodiversity (66%). Freshwater, marine and coastal biodiversity together covered 44% of schemes. There is therefore a visible **bias in the taxonomic groups and ecosystem types** that are monitored. Genetic diversity is rarely monitored; examples exist in few countries on small scales, such as Sweden, Switzerland, and Scotland.[7]

Our survey revealed that the majority of monitoring schemes feed into European reporting (62%) and national reporting (58%). Only 16% of schemes were used for international reporting, which included reporting to Regional Seas Conventions, the Ramsar Convention or informing the IUCN red list. When asked which EU or national policy or management action biodiversity monitoring data inform, most respondents (73%) indicated that the **data are mainly used to report to the Habitats Directive (46%) and the Birds Directive (27%)**. Only few datasets are used to inform other policies, directives, and strategies such as the Common Agriculture Policy (CAP) and Common Fisheries Policy or the Water Framework Directive (WFD), the Marine Strategy Framework Directive or Invasive Alien Species Regulation (figure 4). Nevertheless, an important caveat to note here is the complexity of the biodiversity data reporting landscape, meaning that some of the data reporting processes might be invisible to the survey respondents.

Large differences also became apparent in countries' biodiversity monitoring activities. Some governments seem to not conduct any nationally organised biodiversity monitoring while other countries monitor biodiversity through a multitude of schemes. Despite often mandatory reporting schemes, our survey and interviews responses highlight that many smaller countries currently struggle with fulfilling monitoring obligations for European Directives. Many countries expressed the wish to learn from their neighbours on how to enhance their national biodiversity monitoring. Therefore, promoting maximum coordination and cooperation between the various data providers and users is key to developing an effective biodiversity monitoring system for Europe and thus a top priority for EuropaBON.

Building on these results, and to facilitate efficient use of data from existing monitoring schemes by policy, EuropaBON's WP3 is currently preparing an **extensive inventory of ongoing monitoring programmes and their characteristics at the EU and national level**, including information collected by previous inventories (final version of this deliverable to be published in the RIO EuropaBON collection soon). This inventory is particularly novel in that it surveys data workflows across Europe and puts emphasis on identifying data aggregators at different spatial scales.

7 Switzerland: gendiv.ethz.ch
Scotland: Hollingsworth et al. (2021) Scotland's Biodiversity Progress to 2020 Aichi Targets, https://www.nature.scot/doc/scotlands-biodiversity-progress-2020-aichi-targets-final-report
Sweden: https://www.naturvardsverket.se/om-oss/publikationer/6900/mapping-and-monitoring-genetic-diversity-in-sweden-a-proposal-for-species-methods-and-costs

8 IPBES (2016): The methodological assessment report on scenarios and models of biodiversity and ecosystem services. S. Ferrier, et al. (eds.). Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany.

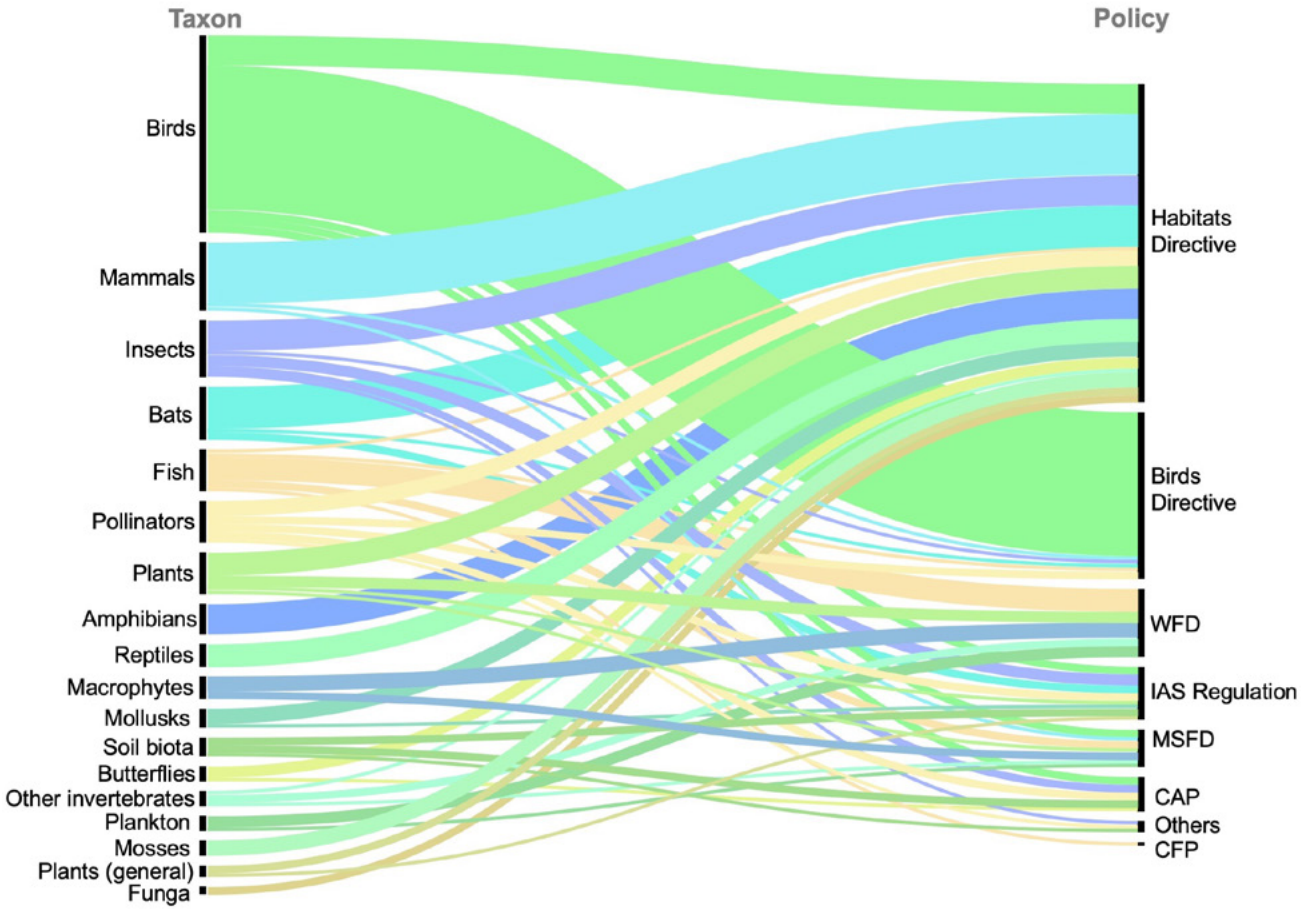


Figure 4: Alluvial diagram showing the flow of monitoring data collected for different taxonomic groups to the various policy directives. Taxon and policy groupings are indicated by black bars on both sides of the figure. Please note that some smaller taxonomic groupings may also be included in larger taxonomic groupings identified by the users during the assessment process, which the groupings in this figure are based on.

These data will be stored in a web-based accessible database to ensure that these data are used efficiently to decrease costs and to increase policy impact of the different Directives. Maximising the policy uptake of biodiversity data by identifying data and workflow bottlenecks will be one of the main tasks of EuropaBON in Work Package 3.

2.3 Relevance and uptake of monitoring data by policy and practice

Biodiversity data are mostly used to inform conservation action at the species and protected area level (67%, figure 5). Monitoring schemes mainly focus on collecting species records for species management and action plans, with a taxonomic focus on birds. Ecosystem information is less often collected except for forests, where respondents frequently answered that biodiversity data informed forest policy formulation and conservation action on the ground. Fewer schemes address ecosystem state assessments, land-use management, invasive alien species management, and hunting management assessments, as well as a few ecosystem service assessments. Water management was absent from the list of schemes to which data contributed, probably due to the lack of water agencies among the respondents.

Uptake of biodiversity data in policymaking depends on various factors, such as the timing of the publication of monitoring results, the strength of data and their interpretation, the interest and personal values of decision-makers, as well as wider policy trade-offs. A word frequency analysis of answers to questions 2 and 3 of the survey ("How are biodiversity data used to identify biodiversity problems and trigger policy formulation" and "How have biodiversity data informed national and local action", respectively) confirmed these results by revealing that 'protected', 'species', 'protected area' and 'forest' were mentioned the most frequently by respondents (figure 6).

While surveys and interviews have highlighted some of the barriers to effective biodiversity monitoring, they also draw attention to numerous cases of successful biodiversity data uptake in policy workflows (boxes 2 & 3) and in bioeconomy, using the example of aviation management (box 4).

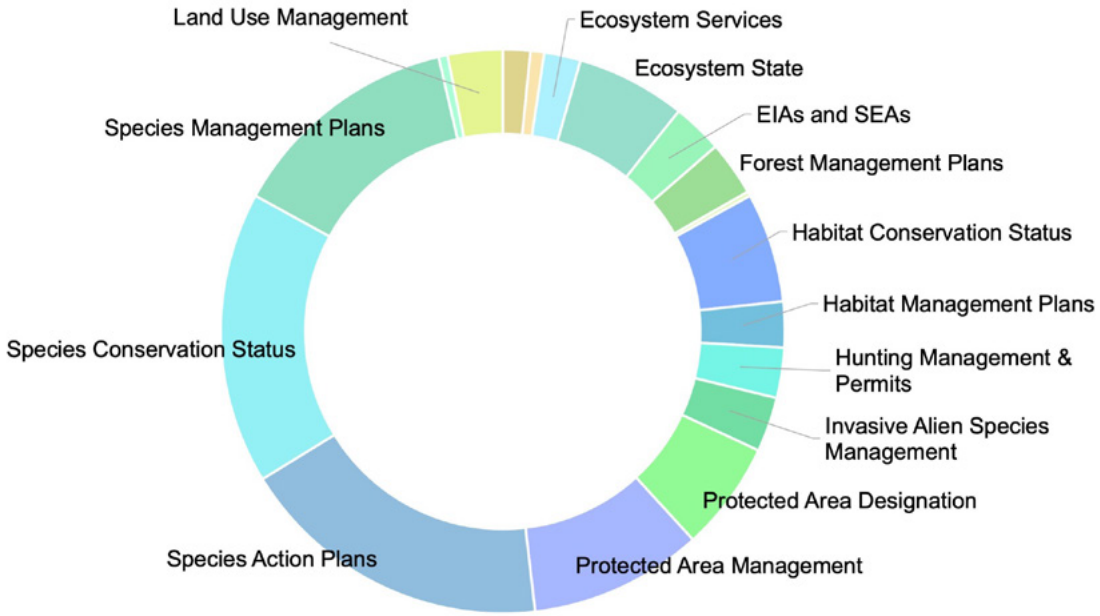


Figure 5: Use of data collected by the various monitoring schemes listed in the surveys. The data often contribute to multiple schemes, and as such the graph gives an impression on the proportional magnitude of schemes to which data contribute. The list also reflects the priorities of the experts whose focus is mainly on the EC Nature Directives (not example on freshwater or marine management).

Box 2: Species conservation management informed by data

Hungary hosts over 66,1% of the Saker Falcon (*Falco cherrug*) population in the European Union. Using satellite tracking data, the risks to raptor populations as well as their home range were identified. Modelling of the home range needs of Saker Falcon will help target conservation efforts for this species.[9]

Left: Saker Falcon (*Falco cherrug*).

9 Prommer, M., János, B., Fehérvári, P. et al. (2018). Home Range Size and Habitat Use of Adult Saker Falcons Falco cherrug in the Breeding Season in Hungary. [Online]. Available from: doi:10.13140/RG.2.2.19501.95204

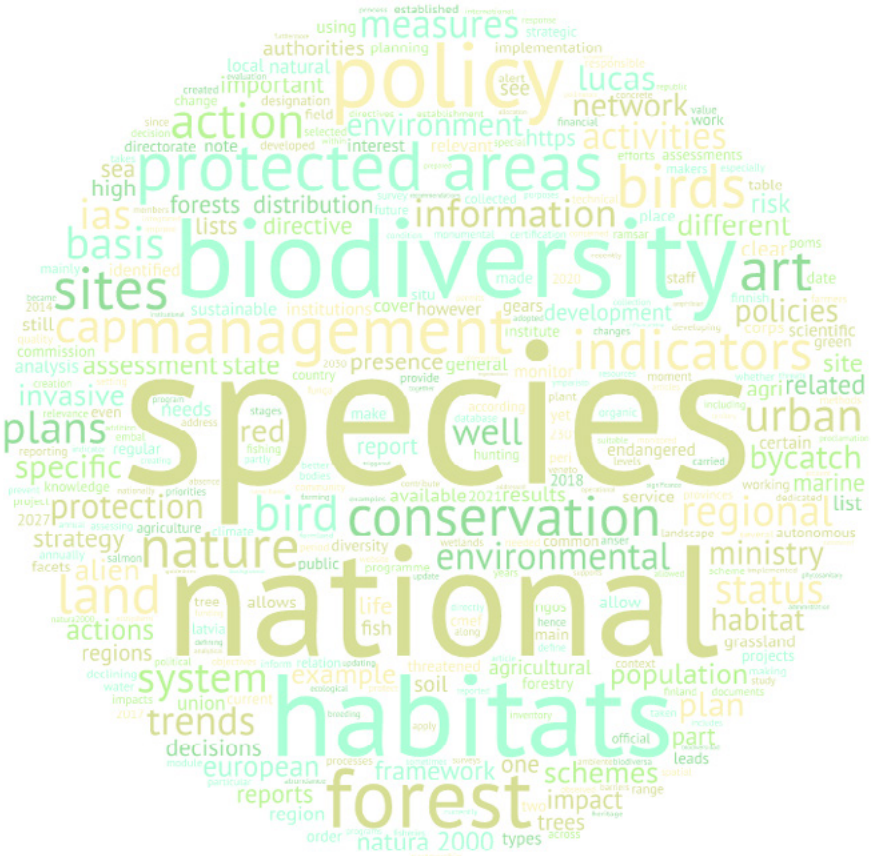


Figure 6: Word cloud derived from stakeholder interviews and surveys of how biodiversity data are currently used to identify biodiversity problems, to trigger policy formulation and to inform national and local action at national and EU level (NVivo coding and clustering of keywords in answers by participants).

Box 3: Successful biodiversity data uptake and policy workflows for designation of protected areas and forest management

In Denmark, data on distribution of marine migratory birds recently triggered the designation of 6 new marine bird protection areas (approx. 1 million ha).

In Serbia, monitoring data of strictly protected species, e.g., Autumn Lilly (Scilla autumnalis), Eastern Imperial Eagle (*Aquila heliaca*) and Long-nosed Locust (*Acrida ungarica*) were used in defining borders of recently established protected areas in the Pannonian part of Serbia.

The Swiss National Forest Inventory is a major project as about a third of the country is covered by forest. It was started already in 1981 and thereby provides 40 years of data to inform sustainable use and protection of the forests to politicians, foresters, the timber industry, as well as science. The scheme covers 6600 forest sample plots and records the current state and the changes of the Swiss forest in all its functions. The Swiss National Forest inventory is unique in that it is embedded in national law, namely the 921.0 Swiss Federal Act on Forest and the Forest Ordinance.

Left: Autumn Lilly (*Scilla autumnalis*).
P18 bottom: Eastern Imperial Eagle (*Aquila heliaca*).

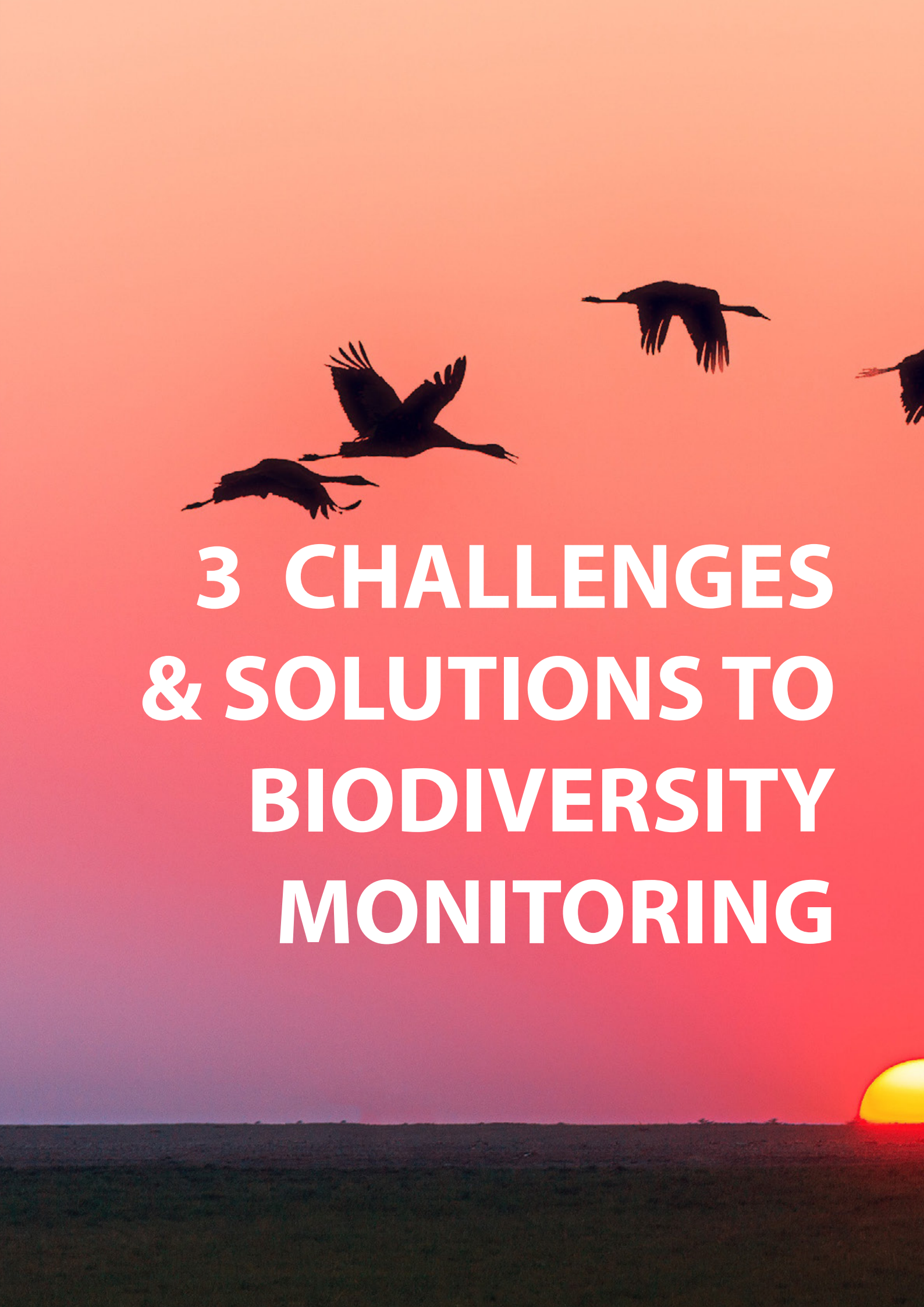
Box 4: Relevance of biodiversity data for bioeconomy

Biodiversity data can be applied to many aspects of bioeconomy. One of these is the mitigation of collision risk between birds, aircraft and wind turbines

Real time warnings and migration forecasts of birds are used to alter flight planning and reduce the risk of collisions between birds and aircraft during periods of peak migration, reducing last minute cancellation of training, potential damage to aircraft, aircraft downtime due to subsequent repairs and in the severest cases the loss of human life. For this, radar monitoring of the aerial density of migratory birds is utilised by military aviation in several countries in Europe to monitor migration in near-real time. Migration models have been developed based on aerial abundance of migratory birds retrieved from radar and weather conditions to provide a forecast of migration for military aviation.

Similar approaches are now under development for wind energy in which forecast models will be used to provide an early warning for the temporary shutdown of wind parks. Forecasts are essential to provide the energy transmission operators enough time to stabilise the energy market. Early warnings should thus contribute to the conservation of migratory species (reducing the risk of collisions between birds and wind turbines) and facilitate a stable energy market, reducing the risk of energy instability that may otherwise result from abrupt shut down of wind parks[10].

10 Bauer S., Chapman J. W., Reynolds D. R., et al. (2017). From agricultural benefits to aviation safety: Realizing the potential of continent-wide radar networks. BioScience 67:912-918.



3 CHALLENGES & SOLUTIONS TO BIODIVERSITY MONITORING

Key messages

- Funding limitations were ranked as one of the main constraints to biodiversity monitoring. Much of the funding for monitoring is short-term or project-based and not permanent funding. Funding relates to data collection, harmonisation as well as to analyses to derive policy and management advice.
- Countries ranked biodiversity monitoring challenges differently. For example, the lack of long-term policies is seen as a major challenge in southern and western Europe, while eastern and northern Europe ranked this as less critical.
- Other identified roadblocks for monitoring by national agencies include lack of support to establish coordinated monitoring programs, lack of guidance for identifying monitoring priorities, lack of standardised monitoring protocols, and limited in-house technical and infrastructure capacity.
- On the positive side, for aquatic biodiversity, a lot of improvement has been gained through the WFD, providing standardised protocols for monitoring and assessment of ecological status for single biological quality elements based on inter-calibrated methods and harmonised taxa lists between many countries. Nevertheless, there is still a need for better implementation of these directives and for strengthening the monitoring capacity and methods, including small water bodies.
- The lack of available, detailed, geo-referenced information is severely hampering assessments of biodiversity and ecosystem trends, as well as infrastructure planning. Often, agencies only have access to regionally aggregated assessments of species or ecosystems and the underlying specific (raw) data are not traceable or easily accessible.
- Many of the current challenges can be addressed by five clusters of solutions, namely: enhanced coordination, cooperation; and standardisation, enhanced data gathering and sharing; modelling and novel technologies; financial resources; and capacity building and stakeholder engagement. EBVs and EESVs are a powerful solution to help overcome some of the current road blocks.
- Better spatial, temporal, and taxonomic synchronisation of data collection, along with improved cross-country monitoring coordination, ideally through a European coordination platform, would improve effectiveness and impact of current monitoring efforts.
- Reporting obligations need to provide clearly defined indicators for each (new) policy target, so that comparison between countries is possible.
- The application of open and FAIR data principles, creation of public databases, new statistical tools for heterogeneous data, and data integration will make data more accessible to both researchers and policymakers.
- New technologies such as Artificial Intelligence, 24/7 monitoring, metabarcoding, eDNA or genomic sequencing have a large potential to standardise biodiversity monitoring in Europe. This potential can only be fully exploited if it is accompanied by investments to develop taxonomic skills of experts in laboratories, and if it is linked to current coordinated monitoring efforts.
- More and better long-term, cross-country, cross-institutional, and cross-sectoral coordination of funding, along with private sector investments, can help unlock and mobilise financial resources needed to increase and improve monitoring efforts. To address this challenge, EuropaBON will develop a draft proposal of a cost-efficient, integrated biodiversity observation network as part of work package 4.
- Training of experts and citizen scientists, knowledge exchange, and stakeholder engagement are key solutions to overcome current gaps in capacity and skills.

3 CHALLENGES & SOLUTIONS TO BIODIVERSITY MONITORING

Understanding the current challenges that European countries and EU agencies face in monitoring biodiversity is critical to be able to co-design a European Biodiversity Observation Network that meets all stakeholders' needs.

The compilation of these challenges started with the first stakeholder workshop held in May 2021, where participants were asked to list and prioritise challenges. These challenges were subsequently grouped into clusters (see Appendix 3 for the full results). All survey respondents then ranked the identified challenges by relevance. We also present solutions identified by workshop participants and survey respondents and how they relate to the different challenges.

3.1 Challenges and roadblocks in biodiversity monitoring

Article 17 of the Habitats Directive requires Member States to submit a report on the conservation status of habitat types and species to the European Commission every six years. **The majority of European states regularly signal challenges related to poor data quality and completeness when drafting these reports.**

- Currently, more than 60% of countries struggle with high levels of missing or unknown information.
- When it comes to the methods used for reporting, the situation is even more daunting. Here, 11% of all Member States base more than half their reporting on expert opinion or do not have any information on the methods used. The majority (82%) need to rely on combinations of methods, and only 7% state that more than half of their methods are actually based on complete surveys (EEA 2020[11]).
- This lack of available data (or access to it) and performance reliance on weak methods implies that reporting results have a high level of uncertainty and are not very robust.

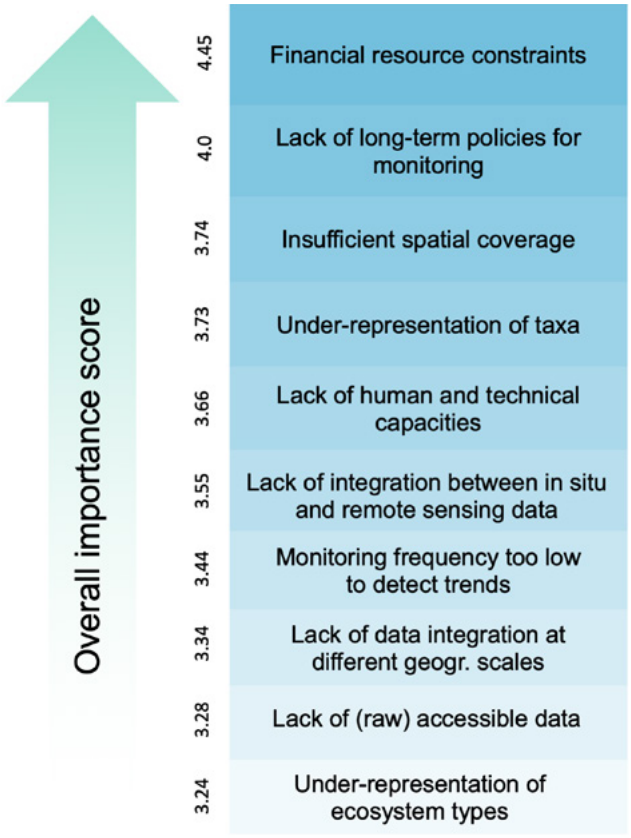


Figure 7a: Overall importance of the ten most highly ranked challenges to biodiversity monitoring. Individual importance scores are listed on the left-hand side of each challenge.

These challenges were mirrored and complemented by the EuropaBON survey. Extracting the **top ten challenges listed as most important by countries** in the different regions across Europe (figure 7a), it is apparent that some obstacles to biodiversity monitoring are common across the EU, while significant regional differences exist (figure 7b).

Challenges faced by countries across the various regions of Europe are quite different (figure 7b). Southern and western European countries ranked the lack of long-term policies for monitoring as very important in contrast to other countries. Both southern and eastern European countries ranked limited financial resources as an important constraint, while western and northern European countries considered this less relevant. Countries in western Europe ranked low monitoring frequency as not very important, but countries in southern Europe did. Insufficient spatial coverage was ranked as not very important in eastern Europe, but as an important challenge in southern Europe. In conclusion, challenges differ regionally and these differences need to be considered when designing the EuropaBON.

11 EEA (2020). Data quality and completeness scoring in Article 17. Available online: https://tableau.discomap.eea.europa.eu/t/Natureonline/views/DataqualitycompletenessforArticle17/Article17Dataqualitycompleteness?:showAppBanner=false&:display_count=n&:showVizHome=n&:origin=viz_share_link&:isGuestRedirectFromVizportal=y&:embed=y

3.1.1 Lack of data integration

Currently, Europe has a **highly fragmented data landscape at different geographic scales.** In some European countries, this is partly due to the lack of European level bodies ensuring transnational coordination and integration and by an apparent disconnect between national monitoring authorities, local non-governmental organisations (NGOs), and natural history societies, which are often important biodiversity data providers. Stakeholders mentioned that NGOs frequently collect monitoring data that do not necessarily correspond to national or European policy needs. Broadly speaking, a lack of integration between **in situ and remote sensing data** was noted as an impediment across all regions.

Successful data integration requires that the data to be combined are aligned in terms of definition, temporal and spatial resolution, data formats, etc. and that metadata is fully available to judge these factors. The fact that these pre-conditions are often not met may explain why more data integration has not happened despite the common understanding. While resources for data integration will always be a bottleneck, the key factor may actually be the incompatibility of data as such. One caveat to be considered is that where data integration happens, for example across spatial scales, there is often a need to settle for the lower common denominator which then leads to a loss of information, compared to what would be expected from the promise of data integration.

3.1.2 Insufficient spatial coverage

Importantly, the spatial scale and resolution or detail of reporting, as well as methodologies, quantity and quality of records differs, even for joint European monitoring and reporting schemes such as the Water Framework Directive.

Often, only aggregated data are reported, i.e., whether habitats are in favourable conservation status or not (traffic light system of the Habitats Directive), and detailed spatial information, i.e., **raw data or georeferenced data are seldom available** and traceable in workflows.

3.1.3 Lack of (raw) accessible data

The lack of availability of cost-free and open (FAIR) raw geo-referenced monitoring data hampers the development of more detailed spatial-temporal assessments of species and ecosystem trends that could inform the management of ecosystem units (such as river basins or certain habitat types) and support more targeted implementation and monitoring of policy actions (such as

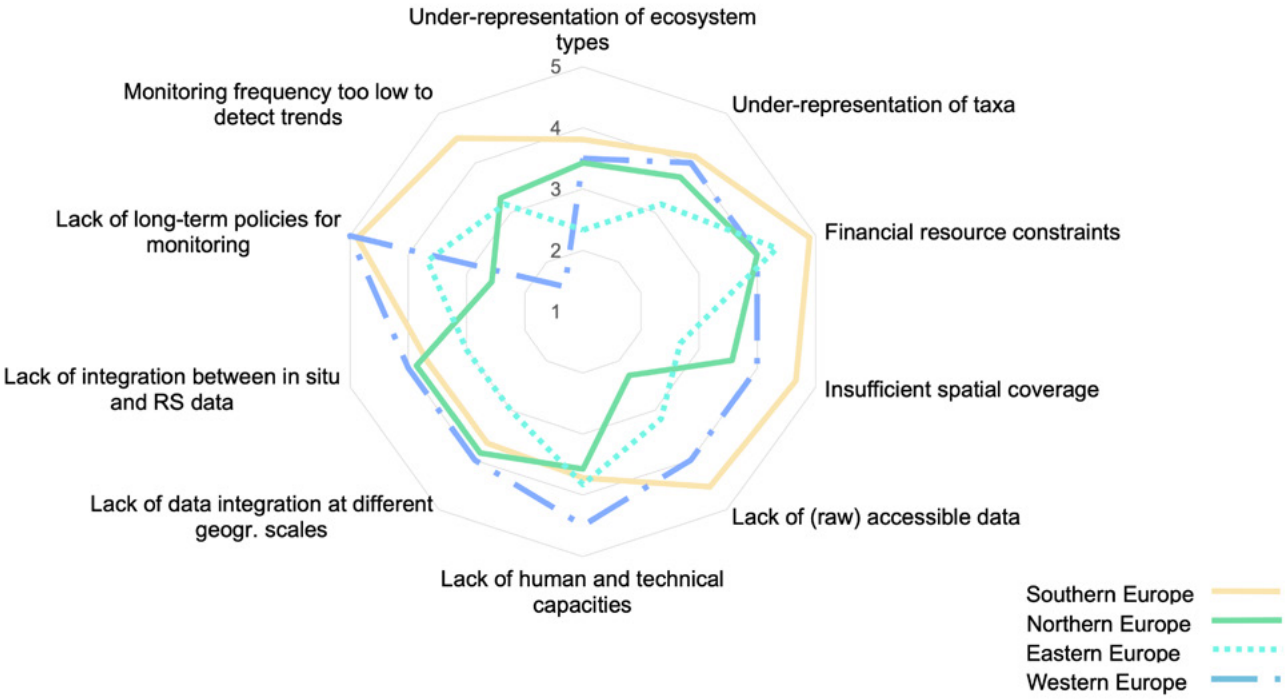


Figure 7b: The ten most important challenges to biodiversity monitoring differ across the four European regions (information derived from surveys and interviews).[12] Importance is ranked on a scale of 1 (least important) to 5 (most important). Importance ranks are averaged across countries in the four regions.

12 Countries were grouped into different regions using the categorization developed by the World Atlas. SE = southern Europe, NE = northern Europe, EE = eastern Europe, WE = western Europe

renewable energy infrastructure or under the EU Biodiversity Strategy for 2030). For example, it is also essential to have spatially referenced biodiversity and ecosystem data to facilitate validation and interpretation of satellite observation data for biodiversity monitoring purposes.

3.1.4 Taxonomic bias and underrepresentation of taxa and ecosystems

National monitoring activities in the EU are largely underpinned by the reporting obligations for the Directives, which are already overwhelming for many countries. In addition, due to the taxonomic biases of the Directives, **there is a lack of monitoring data on the taxa that are not addressed in the Directives**. Examples of species not addressed by the Directives include many insects e.g., *Andrena fulva* or *Tettigonia longispina* and plants e.g., *Drosera anglica*. Fungi are also missing from the directives (e.g., Boletus regius although it might be listed on some regional lists by countries) along with many soil organisms. Between-country differences in taxonomic and ecosystem diversity, in-country monitoring and policy needs as well as related investment needs, should be considered when designing the European biodiversity monitoring system.

> *"Due to the lack of a biodiversity information system at national level, different and unstandardised formats of data storage, data processing and analysis have been identified as obstacles in most of the institutions dealing with biodiversity information in Europe."*
> *(N. Macedonia, from survey)*

There is also an **underrepresentation of ecosystems, such as marine habitats**, whose monitoring is necessary to support the Marine Strategy Framework Directive. Significant monitoring does, however, occur for coastal and transitional habitats for phytoplankton, macroalgae, seagrasses, benthic invertebrates and fish (fish only in transitional waters). There is often a tendency to focus on terrestrial biodiversity when considering biodiversity monitoring. On several occasions during the EuropaBON stakeholder workshop, participants emphasised the need to include marine biodiversity in current debates. As opposed to terrestrial biodiversity, marine biodiversity is often susceptible to different pressures which span entire exclusive economic zones (EEZ) and areas beyond national jurisdiction.

3.1.5 Lack of human and technical capacities

Several national experts reported that they lack **human resources, knowledge and skills, including lack of technical capacity, and lack of technical infrastructure** for mobilising and accessing biodiversity data. Some countries also mentioned that they are hampered by a lack of support for establishing coordinated monitoring programs, lack of guidance for identifying monitoring priorities, and a lack of authoritative, standardised monitoring protocols. However, other national experts noted that mandatory top-down protocols could cause tension on various levels. In the case of the WFD these issues are somewhat addressed. Nonetheless, biodiversity monitoring is often labour intensive and requires substantial human resources. A lot of expert time, skills and knowledge are needed to conceptualise, develop and maintain current monitoring and observation schemes, and these experts are costly and require a lot of training and education. Furthermore, a lot of expert time is spent on repetitive tasks such as gathering and identifying instead of on interpretation.

There is a shared **concern about the declining number of taxonomists in Europe** due to insufficient resources dedicated to developing the skills and technology needed for better monitoring. On top of that, monitoring programmes are often not appealing as a scientific career, nor for the private sector, as they are restricted to very particular applications. **Unclear and untransparent respon-**

sibilities concerning data and workflows pose further problems. Long workflows with many people involved dilute motivation and lead to significant lags between data collection and reporting. This **lack of timely data reporting** hinders its relevance for and uptake by policymakers. One exception is the WFD where data are reported to the national databases one year after sampling and to the EEA annually (EQR-values), based on sampling from 2 years earlier.

A **lack of expert knowledge and skills** has been identified as hampering improvements in monitoring across many countries. Data management and analysis capacities are very heterogeneous, and there is often a lack of competence in specific methods, data analysis, new technologies and their benefits. There is also insufficient knowledge on innovative methods and how they relate to conventional methods. **Insufficient awareness of the full potential of available tools and resistance to the uptake of novel technologies** pose a significant challenge. However, applying these technologies through integrating conventional data with new datasets coming online such as the rapidly evolving satellite-based Copernicus services and related products could contribute to increased spatial coverage and continuous monitoring. Differences in 'language' between ecologists and the developers of monitoring frameworks continue to be a challenge, as well as **limited integration and exchange of knowledge** among different monitoring frameworks, e.g., for different taxa. One example is the current monitoring of emerging diseases, which is presently decoupled from biodiversity monitoring.

EuropaBON can play an important role in addressing the above-mentioned roadblocks, by coordinating efforts across countries and relevant EU agencies to make better use of existing data and targeting monitoring efforts at important data gaps.

3.1.6 Insufficient financial resources

Funding limitations continue to be a major constraint to biodiversity monitoring, according to many respondents across Europe. However, the budgetary amount allocated to biodiversity data collection in the countries is often difficult to assess, since monitoring is split between multiple administrations and programmes that lack coordination. Financial constraints were mentioned by nearly all interviewees as having moderate to significant impact on the scale, resolution and application of data that they were able to generate. The most common of these constraints was a simple lack of funds relative to the ambition of the monitoring activity. Sixteen national agencies provided an estimate of their monitoring budget, which ranges from €17.7M per year to no funding at all (median €650,000/year). Several respondents noted, however, that this only represented part of their spending on monitoring, much of which was drawn from external funds or other work streams. However, with few exceptions (i.e., western Europe), all countries noted the critical impact that financial constraints had upon monitoring. Additionally, two of the countries with the largest budgets noted that their budgets were subject to significant pressure to reduce their spending. EC services also indicated that costs remained a constraint on their activities.

Limited funds lead to taxonomic biases, limited spatial and temporal coverage and, even in the case of countries with larger available funds, an inability to invest in novel monitoring technologies. Several interviewees reported that they were not able to make adequate preparation or investment in long-term monitoring efforts as many of the funds for monitoring were project related and not structural or permanent funds.

3.1.7 Lack of policy support and coordination

For more harmonised and standardised monitoring efforts, better policy coordination and support are needed. Coordination at subnational, national and EU levels is currently insufficient in terms of protocols, scalability, harmonisation and sharing of data and information. To improve this, it is key to involve public administrations in institutionalising coordination and sharing of data and knowledge, recognizing that they face in many cases funding and capacity limitations. The workflows from data to policy are long and efforts get dispersed along the way. There is a need for Europe-wide coordination, and communication is a key aspect in this challenging process across countries. In addition, there is a clearly expressed lack of policy support for better funded, integrated, coordinated and harmonised biodiversity monitoring. This includes a lack of long-term policies on biodiversity monitoring in several countries, which was ranked as one of the

top 10 challenges by survey respondents.

3.2 Potential solutions to biodiversity monitoring

It is apparent that many of the challenges identified above can be addressed by a relatively concise set of solutions (figure 8), as reported by stakeholders during the EuropaBON public stakeholder workshop, the related survey, interviews, and the follow-up expert meeting. While financial resources are listed as a separate solution, all solutions require targeted and, in most cases, additional financial resources for their implementation. Importantly, some solutions address several challenges simultaneously. These include improving overall coordination, synchronisation and standardisation of monitoring efforts along with capacity building, as well as increasing funding dedicated to data sharing mechanisms, data analysis and management, and increasing modelling efforts and the use of new technologies represent important solutions to many of the aforementioned stumbling blocks. These solutions are aligned with previous studies[13][14], confirming both their importance and the urgency now required to transition to implementation. Focussing efforts on strategies to overcome the identified challenges will help us in designing an effective and user-targeted monitoring scheme for Europe. These solutions are further elaborated below.

3.2.1 Enhanced coordination and cooperation

Better coordination and synchronisation of monitoring efforts are key to move towards improved monitoring and close current monitoring gaps[15]. International collaboration and knowledge transfer are of key importance, as well as having comparable monitoring approaches across countries.

Alternatively, adopting a **common coherent approach across Europe** could be a solution, albeit a very ambitious one. Some respondents suggested a more realistic alternative: creating a program to challenge scientists to develop **statistical methods** which integrate and align different data types and sources. There are, however, good examples of multinational cooperation e.g., shared laboratory protocols, genetic markers and datasets in order to track population sizes, effective population sizes, migration, and change in genetic diversity for large mammals which often cross international borders[16].

There is also a strong interest in a **common platform** for Europe, e.g., a biodiversity monitoring coordination centre, which can integrate data at national and EU levels, and which can provide monitoring protocols and guidelines where needed, and facilitate data flows from various sources, while safeguarding those programmes which function well. Data collection efforts need to be better **synchronised temporally, spatially, ecologically, and taxonomically.** Themes across geographic borders, such as ecoregions, rivers or marine subregions, could help harmonise methods and share best practises. Several efforts to improve monitoring coordination are already underway, e.g., the ocean observation initiative developed by DG MARE.

Another potential solution could be to strengthen and promote **consortium networks** similar to that implemented for birds, allowing for better integration and reduced redundancy of data collection and sharing. Creating opportunities for greater collaboration between organisations monitoring different taxa would help advance coordination and synchronisation (e.g., plant monitoring transects could do some observational pollinator monitoring as well). It could also be important to harmonise indicators and thresholds at the EU level, at least within specific policies such as the Habitats Directive or the MSFD which is developing threshold values for non-BHD marine species and habitats.

13 Schmidt, A. M. & Van der Sluis, T. (2021). E-BIND Handbook (Part A): Improving the availability of data and information on species, habitats and sites. Wageningen Environmental Research/ Ecologic Institute /Milieu Ltd. Wageningen, The Netherlands.

14 Peer G., Birkenstock M., Lakner S., et al. (2021). The Common Agricultural Policy post-2020: Views and recommendations from scientists to improve performance for biodiversity. Volume 3 – Policy Brief.

15 Kühl, H. S., Bowler, D. E., Bösch, L., et al. (2020). Effective biodiversity monitoring needs a culture of integration. One Earth, 3(4), 462-474.

16 de Groot, G. A., Nowak, C., Skrbinšek, T., et al. (2016), Harmonization of genetic markers in wolves. Mammal Review, 46: 44-59.

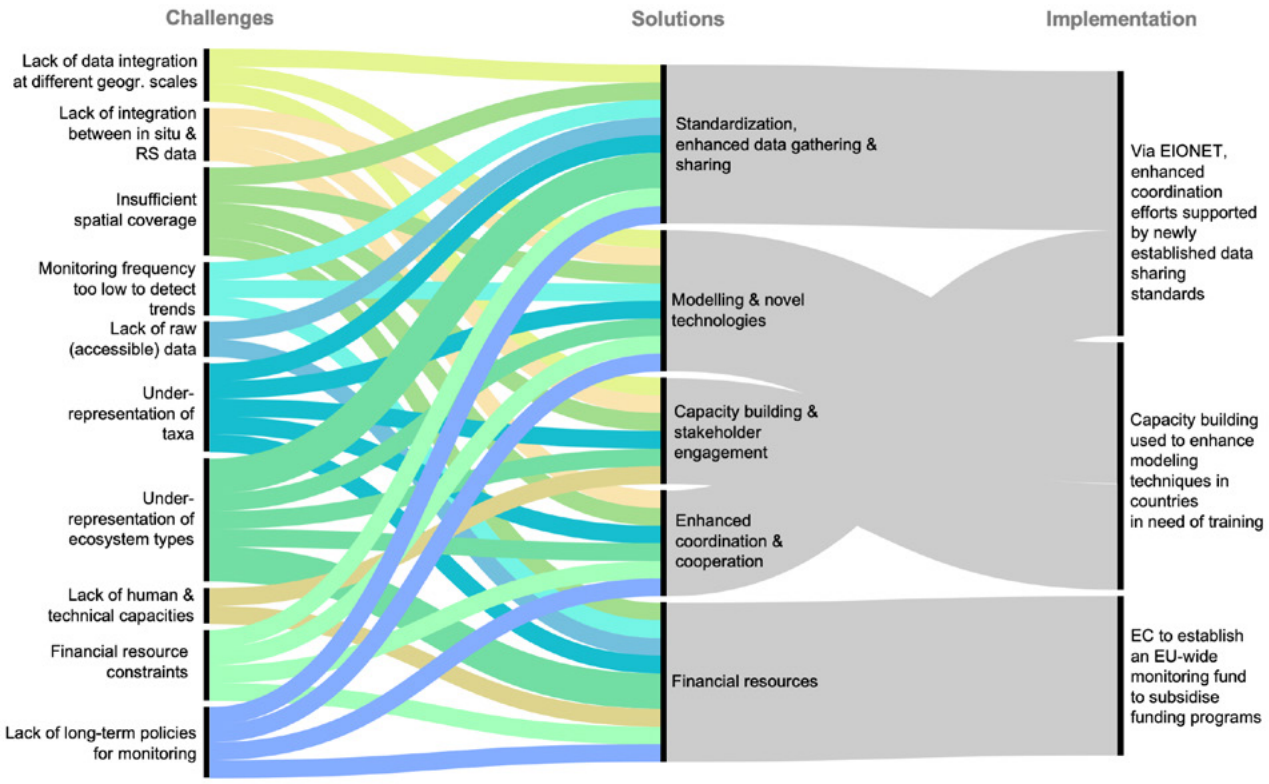


Figure 8: The ten most important challenges to biodiversity monitoring in Europe to be addressed by five aggregated solutions proposed by EuropaBON stakeholders along with potential avenues for implementation. The thematic clusters of challenges and solutions (and their importance scores) were derived from the stakeholder engagement workshops, surveys and interviews.

Reporting obligations need to provide clearly defined indicators for each (new) policy target, so that comparison between countries is possible. For example, Germany developed a successful monitoring workflow for the High Nature Value Farming indicator, but since this is neither monitored by all member states nor accomplished in the same way, data are not comparable, although it would be possible to do so[17].

To make monitoring more impactful and efficient, a **new monitoring framework** could help to observe variables at large spatial scales and over long time periods, along with clear **measurement protocols**, similar to how it is done in meteorology for supporting climate modelling. In general, the research and policy related to climate can often serve as an inspiration and provide helpful lessons learned for biodiversity. Here, for example, having a resource **similar to the Copernicus climate service** or the Copernicus land service, which turn monitoring products into regularly updated maps or data, would be valuable.

Establishing a **monitoring baseline before launching biodiversity-friendly interventions** in cities would help create more effective and meaningful (urban) management.

3.2.2 Standardization, enhanced data gathering and sharing

Essential biodiversity variables (EBVs) and essential ecosystem services variables (EESVs) are a promising attempt to standardise and coordinate biodiversity data collection and monitoring, addressing many of the challenges raised in chapter 3.1. Essential variables facilitate data integration by providing an intermediate abstraction layer between primary observations and indicators. Adopting EBVs and EESVs as the language of the EU Directives and other monitoring programmes is an important aspect towards the design of a European biodiversity monitoring system. Since EBVs and EESVs are estimated parameters (determined from primary observations), outcomes should focus on the estimated confidence levels and uncertainties and create products rather than rely on essential variables as raw data (see chapter 4 for more details).

The promotion of open data and various derivatives emerged as key contributions to future policymaking in biodiversity. All stakeholders, ranging from high-level governmental agencies to nature conservationists on the ground, require **simple, reliable open access to bio-**

17 Pe'er, G., Birkenstock, M., Lakner, S., et al. (2021). The Common Agricultural Policy post-2020: Views and recommendations from scientists to improve performance for biodiversity. Volume 3 – Policy Brief.

diversity data. Stakeholders from policy, research and practice need standardised maps for species ranges, species richness, functional properties of assemblages, genetic diversity and phylogenetic information. Workflows from the emerging field of 'macrogenetics' could be models for creating standardised maps of genetic diversity. Data must be easily accessible online and able to be downloaded for further use. These data need to be integrated, cleaned, interoperable and follow an accepted taxonomy. To facilitate such principles of open science and FAIR data (findable, accessible, interoperable, reusable), joint interfaces and interoperability between national, supranational, regional and EU platforms is of key importance. Several potential solutions to overcome the challenges related to data sharing and availability exist.

Better data sharing policies: data sharing should be enabled, both through encouragement of FAIR data practises, as well funding or enforcements. For this, legal obstacles such as intellectual property rights need to be addressed[18]. For example, open data and FAIR data principles could be mandated by all funders and governments, and the culture of open data should be expanded to science, agencies, non-governmental organisations (NGOs), and others. The requirement on data sharing should also apply for data on policy implementation, not only monitoring data (e.g., CAP related). As a default, data that have been collected with public money should be made publicly available. Potentially, a European-level central organisation could coordinate the data collation, harmonisation and interoperability.

Data collected by private companies for environmental impact assessments could be made available through online open access. The same applies for raw data at species level collected under the Water Framework Directive, which should be made available through open access (currently, the data are presented at EU-level as EQR-values on a numerical scale from 0-1 and as five status classes for each of the biological quality elements (high / good / moderate / poor / bad). Such data are already publicly available in many countries from the national databases, but are structured differently and are not easy to extract and compare by external experts. Overall, open access should always acknowledge the data providers, and donor institutions should be evaluated by the impact of the monitoring they are funding.

A public database for researchers and practitioners could also ensure data quality and metadata standards. An efficient directory of existing data could help users find their way through the "maze" and improve data flows. Information flows could be homogenised and standardised through an intermediary layer between observation and data. Ensuring quantification of uncertainties of each data product could facilitate aligning different data products and thus, potentially creating more impact. Even though datasets are more and more published with their associated scientific papers in the last years, there is a need to redesign the academic reward system so that data contribution to policy is seen as a benefit for scientists (currently important 'data holders'), and not as a loss of data property.

Standardisation of methods and data integration: Data flows and potential for analyses need to be improved through data standardisation, harmonisation and interoperability of data. Methods and data reporting, management and archiving need to be standardised. Taxonomies need to be harmonised through continuously updated, universal reference lists, as already done for many of the WFD Biological Quality Elements as a basis for the intercalibration process of national metrics. There is a need to equally consider marine and terrestrial biodiversity in monitoring approaches and methodologies. For example, the European Marine Observation and Data Network (EMODnet) provides a useful tool for the synthesis of marine monitoring data. Newly developed tools and methodologies need to be harmonised with those used in previous monitoring schemes in order to understand and interpret long-term trends. It will be important to avoid causing additional workload for nature conservation agencies due to data standardisation, but rather facilitate streamlined reporting as is done for WFD data reporting for Ecological Quality Ratios and status class. A reliable data infrastructure is needed to support standardised data collection and reporting.

Statistical tool development for dealing with heterogeneous data: Discontinuities in effort and methods can be overcome if there is enough data for rarefaction at the study level (i.e., determination of the number of species as a function of the number of samples). Furthermore, new statistical tools are becoming available for data integration of heterogeneous data in space, time and quality[19].

3.2.3 Modelling, novel technologies, genetic diversity

Most countries (86%) responded that they use biodiversity monitoring data for modelling. However, this result has to be interpreted with care, as in interviews and discussions it became apparent that in most cases this meant that the monitoring data were being used in models for scientific purposes. Still, the interest in increasing the use of modelling in processing biodiversity monitoring data to develop policy support tools was generally very high across countries and stakeholders. Barriers to an increase in the use of models mentioned by stakeholders were a lack of capacity, expertise and funding.

Taking advantage of **digitalization and new technologies** can be of vital importance to advance biodiversity monitoring and thus help implement and enforce relevant policies, as well as meet biodiversity targets. New

18 Egloff, W., Donat, A., Patterson, D. J. et al. (2016). Data Policy Recommendations for Biodiversity Data. EU BON Project Report. Research Ideas and Outcomes 2: n.pag

19 Isaac, N. J. B., Jarzyna, M. A., Keil P., et al. (2020). Data Integration for Large-Scale Models of Species Distributions, Trends in Ecology & Evolution, Vol 35, Issue 1, 56-67.

technologies like Artificial Intelligence (AI), 24/7 monitoring such as biomass flows with radar (e.g. migratory birds), low cost sensors, eDNA, genomic sequencing, bioacoustics or metagenomics offer opportunities for measures and actions that were not possible 5-10 years ago. They are an important tool for better spatial and temporal coverage, along with clear frameworks to better integrate observations from local, national to European levels. Another essential tool are novel data types such as (i) images, e.g., through phenocams, (ii) citizen science-based imagery, (iii) audio-visual content (audiologs, videos), and (iv) spatiotemporal data in addition to integrated sensor networks capturing climate, phenological, and biological observations. Here, data can be collected via automated biodiversity monitoring stations and complemented by machine learning approaches. In aquatic ecosystems, sensors are used to measure abiotic data, e.g., turbidity, oxygen, nitrate, pH, salinity/conductivity, but can also measure chlorophyll fluorescence and maybe fish migration, but not species composition. Being open-minded and adaptable to these new approaches and technologies was mentioned as an important prerequisite for their wider application. Widely available digital solutions, such as mobile apps, websites, or partner ecosystem building could be used by a wide range of researchers and citizens. Ideally, biodiversity monitoring experts should be involved in such product and platform developments early on.

> *"The obligation to report biodiversity monitoring data to the EU can provide good stimulation for nature conservation in our country. There is not enough awareness of the human-nature connection in society and the urgency of considering nature conservation in policy. The added value of biodiversity data in policymaking is not clear and applied enough."*
>
> *(Slovenia, from interview)*

Multi-scale earth observation data from satellites and drones are key to support e.g., the Birds, Habitats, and Marine Strategy Framework Directives and contribute with EBVs to assess the status and trends across biodiversity levels. The Copernicus Program has several services in operation that provide timely EU-wide data relevant for biodiversity monitoring. Radar remote sensing to monitor aerial abundance of birds is a recent earth observation application that generates new monitoring possibilities for the entire EU. Some stakeholders also suggested that essential variables should cover not only the state of biodiversity but also pressures and impacts/costs on society (e.g., wolf attacks) and societal/management responses.

Genetic diversity is a largely overlooked aspect in policies related to biodiversity protection and management, yet it is of crucial importance for assessing species and population survival (Santamaria & Méndez 2021; Laikre 2010[20]). There is an urgent need to map and monitor genetic diversity within species, and the development of indicators and other monitoring means are at its core (Hoban et al. 2020; Hoban et al. 2021[21]). Intra-species genetic diversity can now be extensively investigated through new genetic and genomic approaches, able to generate huge amounts of data: These data need to be stored and retrieved in online repositories, with explicit quality check policies. This will promote better collaboration and interoperability across repositories throughout Europe. One example of standardisation in storage of genomic data is The Genomic Observatories MetaDatabase (GEOME, https://geome-db.org/). Other DNA-based techniques such as eDNA-metabarcoding and metagenomics provide novel avenues for rapid monitoring and detection of species when traditional monitoring or taxonomic expertise is not available or best-suited.

3.2.4 Financial resources

More funding for biodiversity monitoring efforts in Europe is needed. In addition, more and better **cross-country, cross-institutional, and cross-sectoral coordination of existing funding** is a key requirement to ensure biodiversity monitoring, particularly with a focus on long-term stable funding instead of short-term project budgets. This requires a long-term vision and the identification of long-term monitoring priorities by funders and policymakers, which is often impaired by rapidly changing priorities. Historically, most research activities and funding schemes

20 Santamaría, L. and Méndez, P. F. (2012), Evolution in biodiversity policy – current gaps and future needs. Evolutionary Applications, 5: 202-218.
Laikre, L. (2010), Genetic diversity is overlooked in international conservation policy implementation. Conserv Genet 11, 349–354.

21 Hoban, S., Bruford, M., D'Urban Jackson, J. et al. (2020): Genetic diversity targets and indicators in the CBD post-2020 Global Biodiversity Framework must be improved. Biological Conservation, Vol. 248.
Hoban, S., Bruford, M. W., Funk, C. W., et al. (2021): Global Commitments to Conserving and Monitoring Genetic Diversity Are Now Necessary and Feasible. BioScience, Vol. 71, Issue 9, 964–976.

have considered long-term environmental monitoring as beyond their remit. In addition, environmental policies usually do not have specific EU funds to be implemented, even though the current context in Europe seems to give hope for change. Long-term funding of extensive biodiversity monitoring networks should include **financial support of citizen science and especially natural history societies.** Cooperation agreements and financial compensation of NGOs currently collecting these data are another potential solution. Of equal importance are **private sector investments** which can help unlock public funds, and long-term public-private partnerships (PPPs) can help mobilise more financial resources. There are several opportunities for the private sector to invest into biodiversity monitoring, such as the development of new technologies, use of biodiversity forecasts (e.g., outbreaks of pest species or nuisance species, bird migrations [see box 4], agricultural forecasting), environmental consulting to support governments or companies with impact assessments, natural capital accounting, and ecosystem restoration.

Subsequent work in EuropaBON (task 3.4 in WP3) will examine these financial constraints in greater detail as part of a survey of both agencies and monitoring organisations. This survey will identify the main costs experienced by monitoring (e.g., staff, materials etc.) and how these costs scale relative to the scale of the monitoring activities undertaken. Through this survey and as part of a later workshop we will examine means to make monitoring more cost-efficient through collaborations between monitoring organisations and between other public/private bodies, and how financial constraints could be overcome, and new support implemented in an efficient manner.

> *Biodiversity data are used in models and scenarios, but only partially – their use could be significantly improved.* (Estonia, from survey)

In the interviews and workshops, less wealthy countries expressed concern that they lacked the necessary expertise or infrastructure to support citizen science, while other countries embraced the citizen science approach to keep costs down. Coordinated funding efforts, simplified administration, and **highlighting the consequences of inadequate monitoring data** (e.g., weaker decision-making tools or repercussions for failing to meet EU biodiversity targets) were all proposed as means to increase funding available for monitoring.

3.2.5 Capacity building and stakeholder engagement

Capacity building and the increase of human resources are one of the main proposed solutions to the challenges related to the lack of experts, skills, and knowledge. More training of experts across all disciplines is needed, and this capacity building needs to be supported by increased funding for both human resources. The collaboration with existing and the creation of new **biodiversity fora**, in collaboration with the Knowledge Centre for Biodiversity, is another important avenue. Experts should also be supported by the creation of **extensive networks and virtual platforms** to share ideas and exchange knowledge. In addition to scientific experts, **volunteer training**, particularly in the context of citizen science, can support monitoring.

Citizen Science has been and continues to be one of the most **important avenues of data collection in terrestrial and coastal biodiversity monitoring.** A long tradition of working with taxonomy and species experts in natural history societies has ensured that a majority of species records have actually been reported outside academia and through volunteers. The additional benefits of citizen science and volunteer engagement are also important; it increases public awareness and engagement in biodiversity protection and conservation while allowing for a spatial and temporal coverage of data collection that would otherwise not be possible. In the future, citizens could also help to collect more data on biodiversity drivers, such as groundwater and rainfall levels or land management or conservation measure implementation. To make current workflows more efficient, citizen science data could be better aligned with policy indicators to inform policies. Also, targeted communities could be formed, and reward systems could be established. Overall, web apps for collecting data need to be harmonised, strengthened, amplified, and the quality of their performance needs to be assessed.

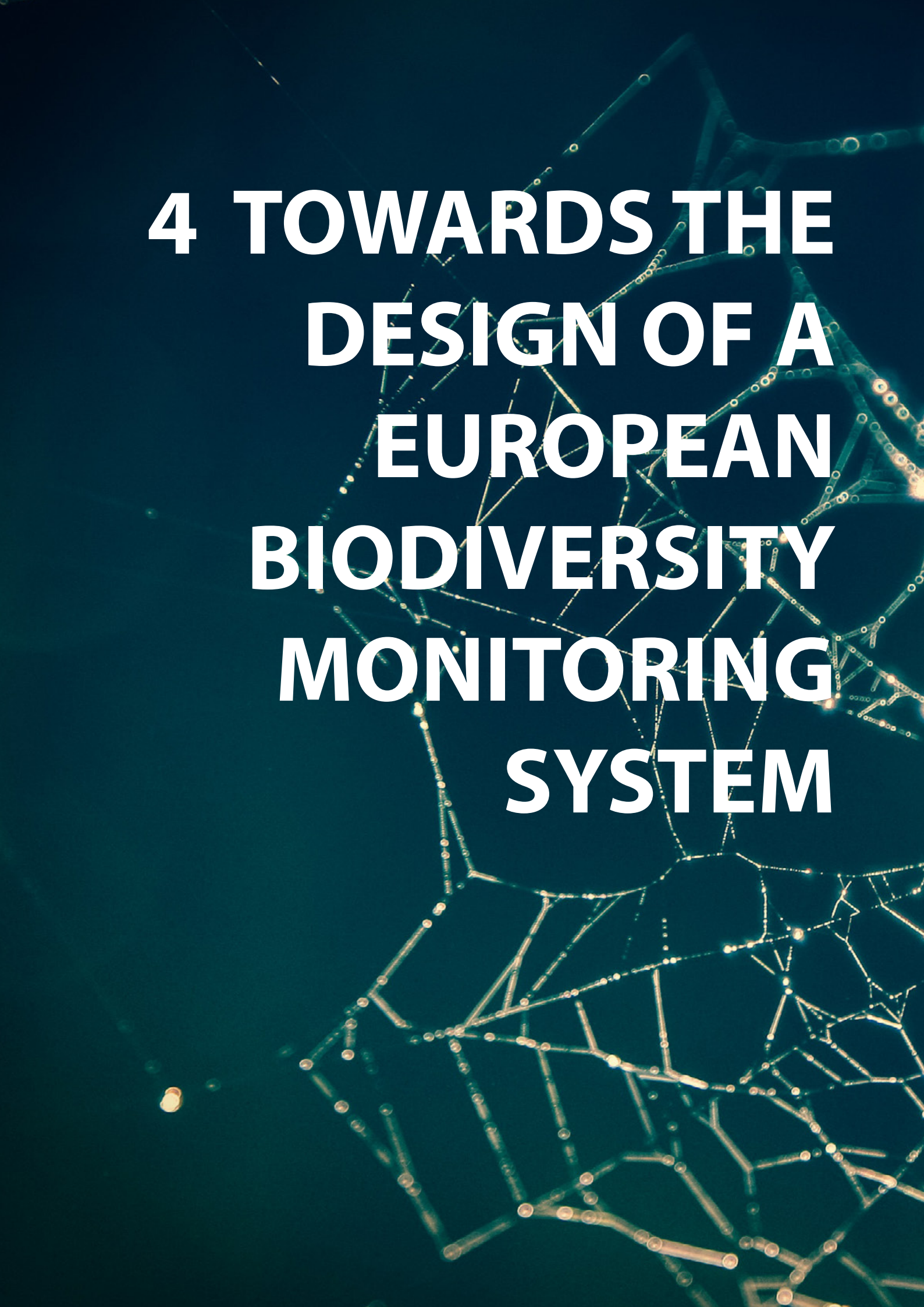
Including, consulting, and working with stakeholders at crucial stages of the process, from monitoring to policy formulation, is of key importance. Here, addressing the needs of the various stakeholders involved can help overcome their hesitations, concerns, and even resistance. Better dialogue with sectors of high relevance for potential biodiversity deterioration, such as agriculture and energy, is particularly useful. This goes hand in hand with increased cooperation between regions and communities of people studying different taxa. Much of the long-term data for many taxa have been collected by volunteers. This is particularly true for small natural history societies where unpaid staff often generated the majority of data, and coordination among those stakeholder nodes was mostly non-existent. In general, citizen science is undoubtedly of crucial importance for terrestrial biodiversity monitoring and their role needs to be better acknowledged, supported, coordinated, and funded. Making better use of the information collected in large citizen science platforms like e-Bird or iNaturalist is another im-

portant solution. Deepening links with stakeholders, in particular with business, and improving the "policy relevance of conservation science by addressing real-world, practical problems instead of focusing on novel academic publishing" were listed as two solutions to overcome barriers for data mobilisation and use in conservation policy by the EU BON project.[22] This also helps overcome the challenge of stakeholders not feeling valued, considered, or being opposed by interventions.[23]

Practice and communication: Biodiversity monitoring data will only be effective when integrated into practice. Embedding it into **Environmental Impact Assessments (EIA) processes** is of key importance here. This should include open databases, knowledge transfer on the existence and use of them, and user input from EIA results. Another key challenge remains in explaining and integrating cultural ecosystem values into policy formulation, and to help them contribute to building an evidence-base for biodiversity. However, putting biodiversity data to practice can only be successful if it is accompanied by robust and systematic communication efforts to circulate information transversally. We also need to capture what is going on 'in the field' and inform science about practical approaches, including open questions that need to be addressed.

22 Rose, D. C., Sutherland, W. J., Mukherjee, N., et al. (2016). Policy paper on strategies to overcome barriers for data mobilization and use in conservation policy. EU BON deliverable 6.2

23 Rose, D. C., Sutherland, W. J., Amano, T., et al. (2018). The major barriers to evidence-informed conservation policy and possible solutions. Conservation Letters; 11:e12564.



4 TOWARDS THE DESIGN OF A EUROPEAN BIODIVERSITY MONITORING SYSTEM

Key messages

- Two clusters of user and policy data needs are of key importance in Europe over the next 5-10 years:
    - **Biodiversity data to ensure integrated cross-sectoral policies**, linking biodiversity data with policies for agriculture, climate change, infrastructure, freshwater, maritime spatial planning, fisheries, and nature-health linkages.
    - **Biodiversity data to increase policy impact and effectiveness** to fulfil goals of the EU Biodiversity Strategy and other policies, including policy targets on conservation, restoration, ecosystem services, telecoupling, and societal dynamics & engagement.
- Essential biodiversity variables (EBVs) and essential ecosystem service variables (EESVs) were ranked by stakeholders for their relevance to policy needs. The fifteen highest ranked variables included species abundances of rare/priority birds, common birds, selected mammals (carnivora; artiodactyla; bats) and harvested marine fish species; species distributions of priority plants/all vascular plants, freshwater fish, all mammals and invasive taxa; ecosystem distribution of habitats in Habitats Directive; land use/land cover change; community abundance of pollinator insects; and water quality regulation. Other important EESVs included belowground carbon content, fish harvest, economic value of pollination and seed dispersals, and harmful algal blooms.
- The majority of highly ranked EBVs/EESVs are currently not sufficiently monitored across Europe. However, most countries monitor all of these variables partially and only a few countries indicate that one or more of the desired EBVs are not yet monitored at all. In any case, clear monitoring gaps exist, even for variables rated as very important to monitor by the users, with none of the variables being adequately monitored across a majority of countries.
- Stakeholders desire high spatial and temporal resolutions for the highest ranked EBVs, often yearly to 5-year intervals and 1x1km^2 to 50x50km^2. This will require combining existing in situ schemes with targeted novel in situ monitoring and with remote sensing data using models.
- The highly ranked set of EBVs is not yet a balanced representative set of variables to be monitored. The identification of essential variables to be monitored across Europe will be done at a later stage of the EuropaBON project, based on the analysis of this report as well as further expert input by stakeholders and scientific expertise of the consortium and colleagues. This identification of EBVs and EESVs needs to consider a balanced set of variables across different EBV and EESV classes (i.e., different levels of biological organisation and types of ecosystem services), different realms (marine, terrestrial, freshwater), and different taxonomic groups.

4 TOWARDS THE DESIGN OF A EUROPEAN BIODIVERSITY MONITORING SYSTEM

In order to design a European Biodiversity Monitoring System, it is important to identify key policy questions and what types of biodiversity data may be used to address those questions.

First, we discuss the policy questions that stakeholders have identified and relate them to the EU Biodiversity Strategy for 2030. Next, we assess the ranking of the variables that stakeholders would like to monitor to address those policy questions. This assessment is made using the EBVs and EESVs framework (box 5), using a standard typology of variables and spatial, temporal, and biological entities specifications. A system using such a framework can leverage the power of models to integrate remote sensing and different types of in situ observations addressing some of the challenges identified in the previous section.

4.1 Policy questions requiring improved biodiversity monitoring

During EuropaBON's first stakeholder workshop in May 2021, expert stakeholders identified two clusters of policy needs and questions (figure 9) that need improved biodiversity monitoring over the next 5-10 years (tables 2 and 3):

- **Biodiversity data to increase policy impact and effectiveness to fulfil goals of the EU Biodiversity Strategy and other policies:** Biodiversity data are needed for improved policy operationalisation and evaluation to ensure reaching targets on conservation and protection including marine biodiversity, restoration, ecosystem services and telecoupling as well as considerations of cost effectiveness and societal engagement
- **Biodiversity data to ensure integrated cross-sectoral policies:** Linking biodiversity data from the EU Biodiversity Strategy to other EU policies and Directives will enable better policy integration, e.g., on sustainable development, agriculture, climate change, water, maritime spatial planning, fisheries, infrastructure and biodiversity-health linkages.

The specific needs covered in each of these two clusters are represented in figure 9.

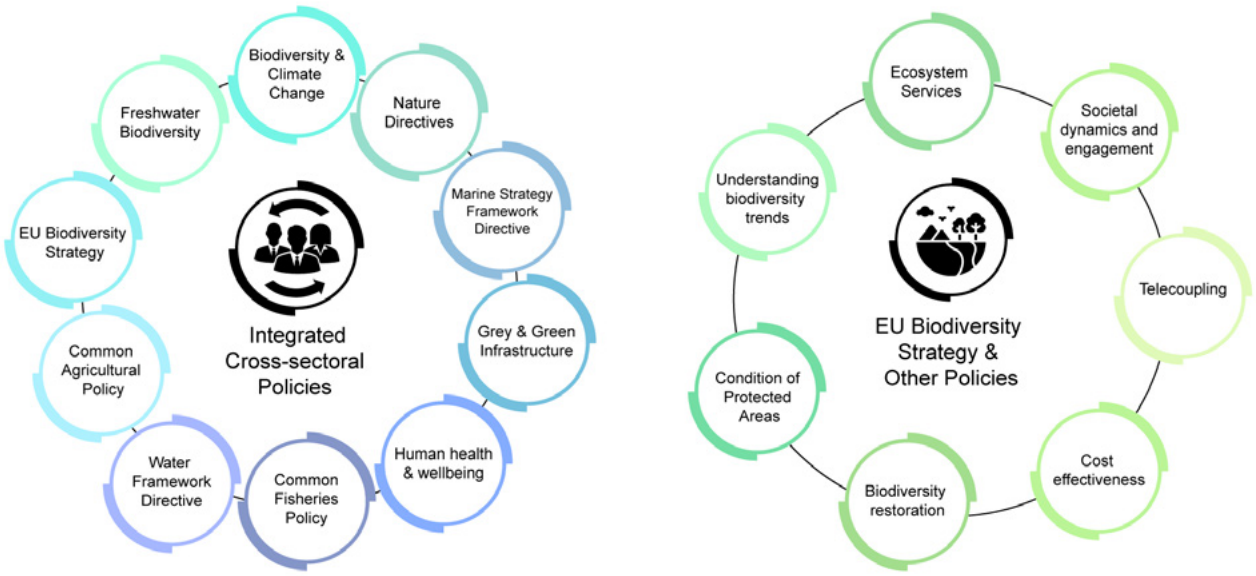


Figure 9: The two clusters and their subcategories of policy needs identified by stakeholders.

4.1.1 Biodiversity data to inform the EU Biodiversity Strategy and other policies

The goal of the EU Biodiversity Strategy is to halt biodiversity decline and to put biodiversity on the path towards recovery by 2030. For this, a substantial part of degraded ecosystems needs to be restored, so that they can deliver multiple ecosystem services in the long-term (provisioning as well as regulating and cultural services). The European Biodiversity Monitoring Network needs to be able to provide key evidence to these policy goals and to evaluate their effectiveness and impact over space and time.

Determining the effectiveness and impact of biodiversity policies is also crucial to evaluating the success of the EU WFD, MSF and Nature Directives. The key here is to analyse which policy instruments and which practical land and sea management measures were and are effective in halting or slowing biodiversity loss. For example, we need to identify how the Habitats and Birds Directives effectively contribute to biodiversity conservation in Europe, or how effectively the restoration targets of the EU Biodiversity Strategy are implemented, and what difference they make to enhance biodiversity. Several relevant clusters of impactful and effective biodiversity policies were identified (table 2).

Halting biodiversity decline: The EU Biodiversity Strategy for 2030 sets the target of ensuring that "at least 30% of habitats and species are in a favourable conservation status". For its successful implementation, managers and **decision-makers need to know which measures will help them achieve this ambitious goal on the European and national level**. When conceptualising management action for biodiversity protection, decision-makers need more knowledge and support in determining how exactly to stop, or even reverse, ecosystem degradation and loss (table 2). The best measures for preserving, protecting and increasing natural areas are often context-dependent and unclear, as well as the level of biodiversity protection needed to maintain a certain level of ecosystem services.

Understanding biodiversity and its trends: Better and more integrated data on species distribution and trends is needed to inform the Habitats, Birds, Water Framework and Marine Strategy Framework Directives. In particular, population dynamics, **population status of rare and threatened taxa**, species abundance and distribution trends, within species genetic diversity, and species distribution data are needed across terrestrial, marine, freshwater and aerial realms. Designing and implementing a cross-sectional monitoring methodology at the European level to robustly assess the population status of rare and threatened taxa (e.g., from the IUCN Red List) in terrestrial, marine and aquatic environments would contribute to assessing the impacts of the EU Nature Directives, as well as related policies on agriculture, climate and energy. In addition, an **EU-wide invasive and alien species monitoring** is needed to determine if and where they pose threats to red list species. To monitor 'genetic erosion' - a significant part of the EU Biodiversity Strategy - more and better data on within-species genetic diversity is indispensable. For marine biodiversity, also more global policies are needed to protect marine populations, including a framework for international enforcement.

Condition of protected areas: Protected area monitoring needs improved measurement and spatial resolution of monitoring. While Europe has a growing network of protected areas, there is little to no scientifically robust joined-up monitoring of their condition or integrity across networks and borders. Apart from Natura2000 sites, there is a general lack of common metrics, indicators, and frameworks, which does not allow to judge site performance.

Ecosystem Restoration: Determining where and how to restore biodiversity and ecosystems is another important step towards more impactful policy measures. Several important steps have been taken recently. For the first time in the history of European policy, the EU Biodiversity Strategy requires improving the status of (that is, restoring) species and habitats. It also requires the creation of specific legally-binding restoration targets. The Nature Restoration Law is currently under negotiation and expected to be adopted in early 2022. These are important steps toward monitoring biodiversity and ecosystems that are not covered by EU Directives (e.g., farmlands, deep seas and urban areas) which will need to be further pursued and strengthened. Overall, there is a need for better monitoring data in order to prioritise ecosystem restoration. But we also need to consider if and how management action to restore biodiversity can result in improved outcomes for society and the economy. This includes, but goes beyond, ecosystem services.

Ecosystem Services and Human Well-Being: Maintaining a healthy and sustainable level of ecosystem services, i.e., nature's contributions to people, is a priority for many policymakers and decision-makers as their benefits are of vital importance for their citizens. Biodiversity represents the foundation of human health and wellbeing, and ultimately the economy. However, there is still some uncertainty on how to use ecosystems and their services in sustainable ways, and to what extent biodiversity needs to be preserved to keep ecosystem services. More specifically, policy advisors need to know to what extent insect diversity and biomass are declining in agricultural, urban, and natural habitats – or recovering – and how does this affect ecosystem services like pollination, pest control, and ultimately human well-being? Overall, the value of biodiversity is little understood, and few socio-economic data exist on the benefits of biodiversity for humans.

Telecoupled effects of European policy on biodiversity abroad: In an increasingly globalised and connected world, it is not sufficient anymore to only look at the effects of policy measures on a national level. Instead, Europe and its member countries need to reduce their footprint beyond their borders, thus revealing and avoiding effects of telecoupling. Important questions include: How can we ensure that Europe's policies don't undermine bio-

Table 2: Key policy questions requiring biodiversity monitoring for the next 5-10 years to inform the EU Biodiversity Strategy and other policies.

Cluster	Policy Question
Effectiveness & impact of policies and measures	What is the effectiveness of major biodiversity policies in Europe, incl. Natura 2000, species protection in the Habitats, Birds and Marine Strategy Framework Directives, and the EU Biodiversity Strategy?
	How can policy decisions better be linked to biodiversity indicators?
Understanding biodiversity trends	How can we stop or reverse biodiversity loss, how can we address the main drivers? How can we use clear indicators that are clearly correlated to pressures and the underlying driver?
	Which is the impact of biodiversity on human beings and how can this be measured?
	How can we better integrate underrepresented groups (e.g., invertebrates, macrophytes/macroalgae, soil organisms, marine habitats and species) in biodiversity monitoring? Are birds and butterflies sufficient indicators? Or do we need to include ecosystem composition - covering a broader taxonomic group in order to create effective policy interventions?
	How do we measure and create indicators for the quality of habitats? How do we standardise monitoring schemes across the EU to inform biodiversity policies?
	How do we know if biodiversity and abundance of organisms are increasing (e.g., invasives) or decreasing (loss of species), based on frequent monitoring?
	How do we measure and create indicators for within species genetic diversity? What is the impact of new species on the environment and genetic composition of native species?
	How to develop effective policies for marine biodiversity, which is susceptible to different patterns than terrestrial biodiversity, spanning entire countries' exclusive economic zones (EEZ) and also areas beyond national jurisdiction (ABNJ)?
	How do we successfully and seamlessly integrate monitoring, data flow, data products and policy across realms (marine, freshwater, terrestrial, aerial)?
Condition of protected areas	How can we more effectively preserve, protect, and increase natural areas?
	How do we ensure at least 30% of habitat and species have a favourable conservation status?
Restoration of biodiversity and ecosystems	How can we monitor and restore terrestrial and marine biodiversity and ecosystems outside of the Habitats directive (mainly farmland, forest and urban areas)?
	How can we better assess where and how to restore biodiversity in Europe?
	How does biodiversity restoration action result in improved outcomes for the economy and society?
	Is the money for monitoring and observation spent just to observe biodiversity loss or also on actions to halt and restore biodiversity? Actions to halt/restore biodiversity (= mitigation or adaptation measures) can be costly. Investing in a good monitoring programme will provide the best foundation for planning effective mitigation or adaptation measures.
Ecosystem services	How can we preserve biodiversity to maintain ecosystem services?
	To what extent is insect diversity and biomass in agricultural, urban, and natural habitats declining (or recovering) and how does this affect ecosystem services (e.g., pollination, pest control)?
	How can we use ecosystems and their services in a sustainable way?
Telecoupling	How are European societies exporting negative externalities outside of Europe, i.e., negative environmental impacts, and how is this impacting biodiversity IN Europe?
	How can we ensure that Europe's policies do not undermine biodiversity elsewhere?
	How can the EU mitigate the impacts of their ecological footprint, arising from trade with the rest of the world? How can impact on tropical and other biodiversity-rich ecosystems in other countries be monitored and mitigated?

Table 2 continued.

Cluster	Policy Question
Cost effectiveness	What is the effectiveness of EU budgets, e.g., what are the outcomes of expenditures on nature conservation and restoration?
	How can we produce reliable data-based risk and impact assessments?
	What is the most effective way to distribute government subsidies to ensure they deliver biodiversity outcomes (e.g., via CAP)?
	How can we identify "perverse" funding, e.g., through subsidies?
	How can we make land and sea monitoring on species and habitats economically viable?
	How can we better match funding with biodiversity hotspot preservation?
	How can corporate reporting (e.g., through EIA, LCA) improve biodiversity protection and restoration?
Societal dynamics & engagement	How do we deal with a dynamic society that changes priorities for land management every generation?
	How to motivate a broader range of people to participate in bending the biodiversity curve by making them able to meaningfully contribute?

diversity elsewhere? What are the "domestic" and remote footprints of the EU on biodiversity in other countries, and how is this evolving? How can the EU mitigate the impact of its trade with the rest of the world, particularly regarding raw materials from tropical and other biodiversity-rich countries? Adding a layer of complexity to these reflections, we need to know what the impacts of Europe exporting negative externalities to other countries on biodiversity within Europe are.

Clarity on the costs and benefits of biodiversity conservation and monitoring is needed. Also, the effective distribution of government subsidies on biodiversity goals, e.g., via CAP, needs to be understood, and how they help to ensure they help deliver positive biodiversity outcomes or to identify "perverse subsidy" funding with (unintended) negative effects on biodiversity. For example, the impact of biodiversity measures or nature-based solutions targeted at mitigating and adapting to climate change is needed, including potential negative impacts (e.g., converting species-rich grasslands to forests for carbon sequestration). Here, Environmental Impact Assessments can play a central role in determining the effects of policy and corporate measures on biodiversity. Reliable data-based risk and impact assessments are needed, along with evaluations of the effectiveness of conservation measures such as protected areas or environmental schemes, and where their flaws are. It would also be of interest to know how biodiversity relates to job availability. In order to design and implement effective and impactful biodiversity policies and measures in the future, decision-makers and scientists need to have sufficient financial means. It will also be important to establish possibilities to make monitoring of species and habitats economically viable.

Societal dynamics & engagement: Naturally, society and societal dynamics play a major role in policymaking and to ensure implementation. We need to know the best way to factor in dynamic societies whose priorities change with every generation. In parallel, we need to know how a broader range of people can be motivated to participate in and meaningfully contribute to bending the biodiversity curve. At the same time, human activities are not always to the detriment of biodiversity. Many habitats actually depend on human activity, and a big challenge lies in understanding what happens to cultural landscapes and semi-natural habitats in the event of human depopulation and migration, as it is occurring across Europe, and how this can also provide opportunities for biodiversity restoration.
Building on lessons learned from developing effective and impactful policies, scientists and policymakers could work together to produce guidelines on the impact of current and future policies.

4.1.2 Biodiversity data to ensure integrated cross-sectoral policies

Biodiversity data are needed to support integrated EU and national policies. Linking up biodiversity policies with interconnected sectors is key for maintaining – and improving – ecosystem health and human health, and for reaching the integrated policy goals. Data are needed to integrate nexus challenges into policy creation, and to support future-proofing biodiversity policies.

This cluster focuses on policy questions that relate to integrating biodiversity monitoring better across different sectors and policies at EU level in the immediate future of the next 5-10 years. Within the large field of developing integrated biodiversity policies, six areas of specific importance emerged: climate change, agriculture and the Common Agricultural Policy (CAP), infrastructure, freshwater, anthropogenic influence, and marine biodiversity (table 3).

Biodiversity monitoring data must serve - and be tailored to - relevant European and global frameworks and policies. Of utmost importance are the EU Biodiversity Strategy for 2030, the Post-2020 Global Biodiversity Framework currently being established by the Convention on Biological Diversity (CBD), the Sustainable Development Goals (SDGs) and the new treaty on Biodiversity Beyond National Jurisdiction. Genetic diversity within species and populations, which is essential to species survival and ecosystem resilience, should be at the core of the EU Biodiversity Strategy's as well as the Post-2020 Global Biodiversity Framework indicators and other monitoring means. The interdisciplinary and cross-cutting nature of the SDGs requires awareness and inclusion of other goals when formulating biodiversity policies, such as on gender, equality, peace and justice, partnerships, clean water, and more.

To develop more integrated and effective policies, better understanding the status, trends and interconnections of different landscapes, land use types, and habitats in Europe is imperative. Near real-time monitoring of sea and land use and land cover change through remote sensing and application of artificial intelligence and machine learning could inform a range of policies on marine and terrestrial biodiversity, agriculture, climate, water, and health. In order to better analyse data collected, a centrally organised raw data collection hub and analysis pipeline would be key. To measure trends of decrease in functionality and biodiversity, we should set up a pan-European geo-dataset of habitat degradation. The same system could also collect data on forest vitality, indicating events of defoliation and leaf discoloration. This links to climate change, e.g., through drought indices. More data on grassland types and farming systems would, e.g., allow better analysis of their implications for the CAP and other Nature Directives. Policy integration also requires qualitative and quantitative scenarios and models analysing potential future developments, which are then incorporated into the process of policy formulation.

The links between climate policies and biodiversity policies need strengthening. The climate dependency of many goals and targets set by the **Nature Directives, Water Framework Directive, and Marine Strategy Framework Directive as well as the Common Agricultural Policy (CAP)** requires more knowledge on what additional actions are needed to take climate change impacts into account. Data are needed for better understanding the interactions between climate change and land use change. This includes, for example, the effectiveness of

nature-based solution measures within climate policies, such as evaluating ecosystem restoration for climate mitigation and adaptation. To create stronger links between biodiversity and climate policies, we also need more information on climate regulation services, such as mapped CO^2 sequestration capacity and, therefore, the mitigation potential as well as adaptation potential offered by different vegetation types and habitats. Standardised methodologies for databases, mapping, and modelling of ecosystem services would allow embedding it into EU and national spatial planning. In this way, monitoring data could inform EU climate policies and climate goals of the Nature Directives and other EU sector policies.

For supporting integrated agricultural policies and assessing the impact of the Common Agricultural Policy (CAP), more data on farmland and biodiversity and in particular pollinator and soil biodiversity as well as High Nature Value farmland are needed. The link between the CAP and biodiversity is not clear. Neither is the impact of biodiversity change on agricultural soils, and hence its impact on sustainable farming targets. For example, if the CAP was to integrate pollinators and pollination services, what would be the key pollinators and crops to target across the EU, and how could this help enhance conser-

Table 3: Key policy questions requiring biodiversity monitoring for the next 5-10 years to ensure better integrated policies

Cluster	Policy Question
Cross-sectoral policies	How do we better integrate biodiversity policies with interconnected sectors - e.g., food, farming, diets, energy, water management, pollution, climate, poverty, equity?
	How do we measure the effects of forest practices on the status of forest biodiversity?
	How to balance the various policy needs and decisions (and hence subsidiaries) for the benefit of ecosystem health?
	How can we 'future proof' biodiversity policy?
Agriculture	What are the key pollinators of different crops in the EU that should be integrated by the CAP?
	How is biodiversity change driving changes in agricultural soils and how will this impact sustainable farming targets?
	How well is the CAP conserving/restoring biodiversity and how can agri-environment schemes be improved to enhance positive effects on biodiversity?
	How does the Farm to Fork strategy contribute to biodiversity, e.g., through pesticide reduction, organic farming etc.?
Climate change	What is needed to take climate change impacts on biodiversity into account?
	How can we restore ecosystems in a climate change perspective?
	What are the costs and benefits of climate change mitigation policies targets for biodiversity, including eventual negative impacts (e.g., converting species-rich grasslands to forests for carbon sequestration)?
	What is the climate dependency of goals/targets set by Nature Directives, WFD, and MSFD?
	How can we improve the links between climate policies and biodiversity policies?
Grey & Green Infrastructure	What is the effect of infrastructure projects on biodiversity (e.g., roads, wind farms, power lines)?
	How can we measure and work towards better green infrastructure (connectivity for species)?
Freshwater biodiversity	What is the best approach to distribute water allocations between agricultural and natural areas during droughts, weighting economic benefits, vulnerabilities and sustainable use?
	How can we better link policy on Agriculture and WFD with Natura 2000?
	How can we achieve 25,000km of free-flowing rivers by 2030?
	What is the contribution of the Water Framework Directive to the conservation of biodiversity and ecosystem services?
	How best to establish groundwater biodiversity assessment/monitoring schemes related to the WFD and Groundwater Directives?
Biodiversity and human health & well-being	How can we operationalise access to nature as a basic necessity for people in the EU and the world?
	How to manage and protect wildlife biodiversity despite human activities?
Marine biodiversity	How can major policies help improve monitoring of marine biodiversity, and how can this data help track progress, e.g. via the Common Fisheries Policy, MSFD, EU Maritime Spatial Planning Directive, or the "new approach for a sustainable blue economy in the EU"?

vation efforts? There is a need for monitoring spatial and temporal patterns of pollinators to answer these questions (see Potts et al. 2021[24]). The Farm to Fork Strategy addresses some of these challenges, although it still needs to be fully implemented and monitored.

Pollinators are key to sustainable farming practises in Europe, while we know very little about which species are important in which parts of the EU, what their population trends are and how to tailor management to declining occurrences. Monitoring pollinators and pollinator-friendly plants of interest, including their location, expansion, numbers, temporal flowering patterns and their relationship with environmental variables will support the Farm-2Fork Strategy, the EU Biodiversity Strategy, and the Habitats Directive. The CAP evaluation would also be strongly supported by the creation of a pan-European indicator of the biodiversity value of farmland. More crop pest monitoring, particularly on the population trends of key pests would support sustainable agricultural practises.

Agroecosystems depend on healthy soils. Soils and soil biodiversity, however, are usually underrepresented in biodiversity monitoring, as there is no EU Directive on soils to push for more monitoring. Monitoring of soil health could contribute to more sustainable soil management in the future. Currently, little is known on the extent to which biodiversity and wider environmental factors can affect soil health. These data are crucial for ensuring that essential ecosystems and their services are preserved and enhanced, and for evaluating the effectiveness of the CAP.

Grey, blue and green infrastructure: Infrastructure projects like roads, wind farms, and power lines, by their very nature, cut across sectors, landscapes, and ecosystems. The impact of growing linear infrastructure such as roads and power lines on biodiversity needs to be considered. In addition, we need to understand how to achieve better connectivity for species through blue and green infrastructure. Blue-green infrastructure mapping through GIS could address the challenge that green infrastructure elements can currently not be identified, especially in terms of functionality. Evaluations are often made on-the-spot, even though very detailed remote sensing possibilities exist. Blue and green infrastructure mapping also misses links between modelling, spatial planning, and biologists.

Urban biodiversity is an often-neglected facet of smart city planning, even though it is closely connected to good quality of life of citizens, water and air quality, and certain ecosystem services. Here, standard indicators for urban biodiversity and urban forests are needed.

Freshwater biodiversity and management are another central piece in the puzzle. Policymakers need more clarity on how to achieve ambitious goals such as creating "at least 25,000km of free-flowing rivers by 2030" as set in the EU Biodiversity Strategy for 2030[25]. Another missing piece is the contribution of the Water Framework Directive to the conservation of biodiversity and ecosystem services. With extreme events happening more frequently across Europe, questions on the distribution of water allocations between agricultural and natural areas during droughts become more urgent and challenging. Here, policymakers need to weigh economic benefits, social conditions, vulnerabilities, and sustainable water use, among others.

Biodiversity and human health & wellbeing: Monitoring should make clearer links between biodiversity and human well-being in the future. A healthy and productive status of biodiversity, as well as the connection to and accessibility to nature are considered a basic necessity for people everywhere in the EU. Biodiverse environments are important for delivering ecosystem services and have also been linked to life satisfaction and mental wellbeing. Here it will be important to establish how biodiversity links to public health and also recreation and tourism.

Marine biodiversity is an often underrepresented yet central aspect of biodiversity monitoring. Several major policies and instruments in Europe would benefit from improved monitoring of marine biodiversity and, in turn, the collected data could help track progress toward the associated policy targets. This includes the Marine Strategy Framework Directive, the Common Fisheries Policy, the EU Maritime Spatial Planning Directive, and the "new approach for a sustainable blue economy in the EU".

4.2 Identifying Essential Biodiversity and Ecosystem Services Variables

In this report, we start the process of identifying the priority EBVs/EESVs for EuropaBON based on the policy questions that need to be addressed (figure 10) and the ranking of their importance by stakeholders (Table 4, Appendix 2). At the first stakeholder workshop, we identified 45 EBVs and EESVs that could potentially be a priority to monitor across Europe. This list was constructed by asking participants what kind of variables and data are needed to address policy questions for different frameworks in Europe (e.g., Birds Directive, Habitats Directive, Restoration, etc) and then aggregating the variables to eliminate redundancies across policy topics. In the survey, we asked respondents to rank each of these potential EBVs and EESVs by degree of importance and calculated the average ranks for each variable (Table 4, Appendix 2).

We found that **the fifteen highest ranked EBVs/EESVs** (top one third) were in the **species populations class** including species abundances of rare/priority birds, common birds, selected mammals (carnivora; artiodactyla; bats) and marine harvested fish species, and species distributions of priority plants (yearly and 1km^2 resolution) all vascular plants (every 5 years in 10km^2 resolution),

24 Potts, S., Dauber, J., Hochkirch, A. et al. (2021). Proposal for an EU Pollinator Monitoring Scheme, EUR 30416 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-23859-1.

25 Biodiversity Strategy for 2030, target 2.2.7

Box 5: What are Essential Biodiversity Variables (EBVs) and Essential Ecosystem Services Variables (EESVs)?

Essential Biodiversity Variables (EBVs) and Essential Ecosystem Service Variables (EESVs) are frameworks to standardise and coordinate biodiversity data collection and monitoring. EBVs/EESVs are a small and comprehensive set of variables, ranging from genes to ecosystems, which allow for the integration of biodiversity data to rapidly quantify the magnitude of biodiversity change or ecosystem service delivery. The framework has two components: the **identification of priority variables** from a set of classes of biodiversity and ecosystem service variables (along with a generic set of variables)[26]; and the **harmonisation and integration of observations** using data infrastructures and models to provide EBV/EESV datasets and indicators. Such a framework addresses several of the challenges identified in section 3.1 such as lack of data integration and harmonisation and limited funding and uses some of the solutions proposed in section 3.2 such as use of models and remote sensing and standardisation of data.

The identification of which variables are essential to monitor, through consultations with different stakeholders and the subsequent mapping of those specific variables to the generic variables defined in the framework, is crucial. This identification needs to include details on the spatial, temporal and taxonomic/biological entity resolution and scope of the variables in order to fully specify them. The prioritisation of the most important variables for monitoring needs to address issues such as the policy and scientific relevance[27], and the feasibility of the monitoring.

An EBV or EESV dataset is initially generated by a sparse collection of observations and progressively filled by different levels of data integration and modelling. The dataset is characterised as a hypercube with the value of the variable at each position in space, time, and for different biological entities. Such spatially- and time-explicit EBV and EESV modelled datasets can be aggregated at different spatial scales and combined with ancillary datasets on pressures (e.g., threats to biodiversity) and responses (such as policies) to produce biodiversity indicators that can simultaneously meet policy and management needs at multiple levels. For more information, please visit the GEO BON website.

26 Pereira, H. M., Ferrier, S., Walters, M. et al. (2013). Essential Biodiversity Variables. Science, 339, 277–278.
27 Guerra, C. A., Pendleton, L., Drakou, E. G., et al. (2019). Finding the essential: Improving conservation monitoring across scales. Global Ecology and Conservation, 18, e00601.

freshwater fish, all mammals and invasive taxa; in the **ecosystem structure class**, including ecosystem distribution of habitats in Habitats Directive; land use/land cover change; in the **community composition class**, specifically the community abundance of pollinator insects; in the **regulating services class**, specifically water quality regulation (Appendix 2, figure 11).

Several of the EBVs map to the existing monitoring indicators to report on the assessment of conservation status of habitat and species in the Habitats Directive under article 17[28]. For instance, population abundances or species distributions variables are required to monitor the range, population, and habitat of species and future prospects. Similarly, the ecosystem distribution of habitats, ecosystem distribution of connectivity, ecosystem function variables and EESVs are required to monitor the range, area, structure and function of the habitats. However, while the requirements for monitoring under the Habitats Directive only require an overall assessment for each biogeographic region, the EBVs and EESVs are spatially explicit and provide the underlying data needed for such assessments. In addition, while several EU policies (e.g., Water Framework Directive, Marine Strategy Framework Directive) emphasise the assessment of the „good" condition of habitats or species, typical in relation to a baseline and sometimes associated to thresholds, the EBVs and EESVs can be more general in that they are not necessarily measured in relation to a „healthy" baseline and do not assume thresholds. Instead they allow reconstructing the temporal trajectory of multiple aspects of the state of biodiversity and ecosystems, on which then derived indicators and assessments

28 For a discussion of how EBVs map to the Birds and Habitats Directive please see Geijzendorffer, et al. (2016). Bridging the gap between biodiversity data and policy reporting needs: An Essential Biodiversity Variables perspective. Journal of Applied Ecology, 53(5), 1341–1350.

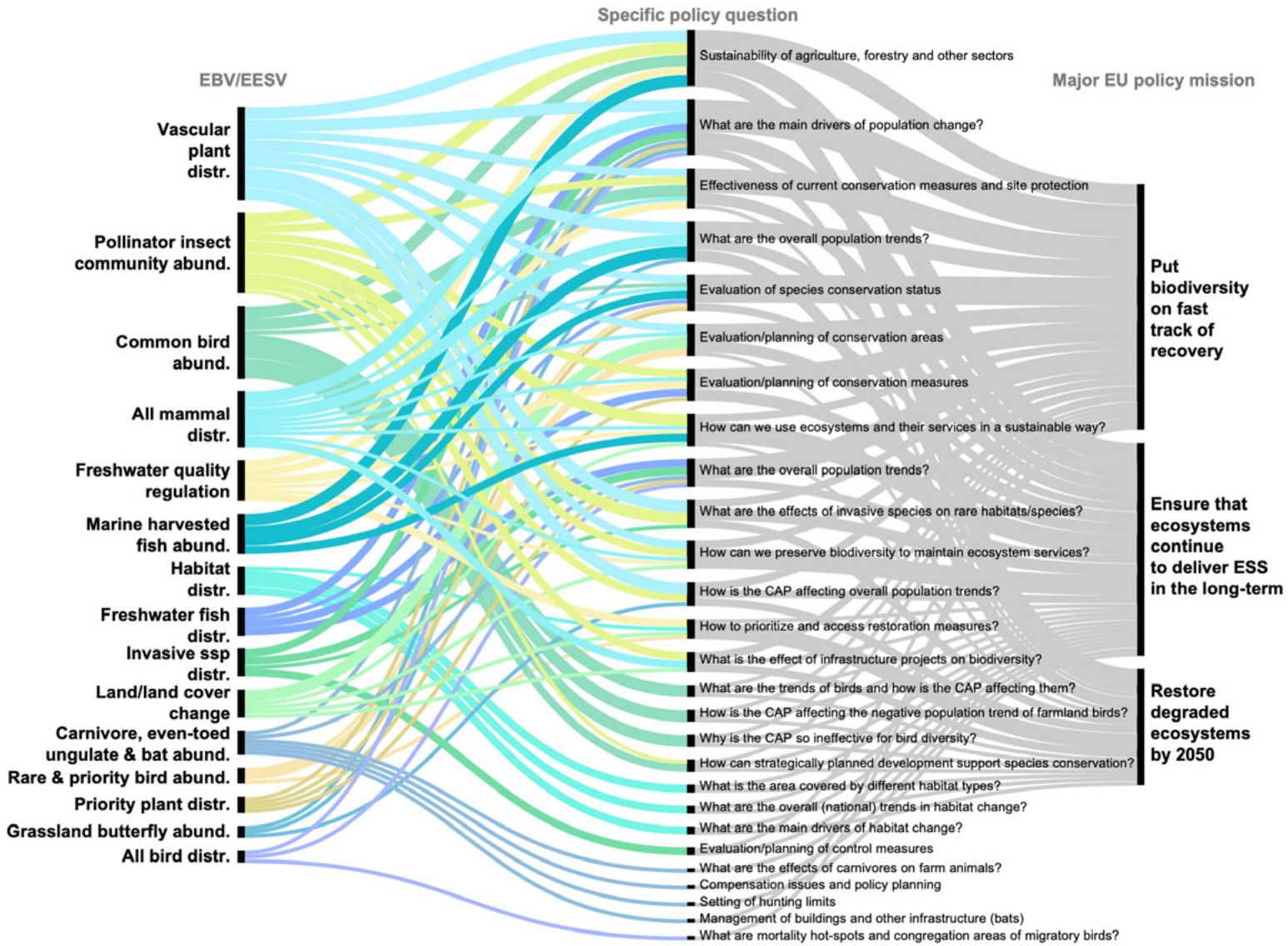


Figure 10: The top 15 EBVS/EESVs (on the left) as determined by participants from several European countries and listed according to the number of policy questions they address (centre). They also contribute to the three major EU-biodiversity goals (on the right). Data was sourced from the surveys.

like "good condition" can be made.

Of course, **identifying the fifteen top ranked variables remains arbitrary**, and different thresholds could be used to analyse the data. For instance, only one EESV (Regulation of freshwater quality) was ranked in the top one third, but several other EESVs were ranked in the top half of the variables, including: belowground carbon content, fish harvest, economic value of pollination and seed dispersal, and harmful algal blooms (Appendix 2). Similarly, other complementary EBVs were ranked in high importance such as ecosystem connectivity, and taxonomic diversity of soil biota and marine organisms. The bias of the top fifteen EBVs towards terrestrial biodiversity and towards the species and ecosystems level is worth noting, with EBVs at the genetic diversity level being ranked among the lowest in importance. The biases towards terrestrial systems can be partially explained by the underrepresentation of marine and freshwater experts among the survey respondents. The biases towards species and ecosystem level variables can reflect limited policy uptake of genetic diversity variables or could be due to the very recent development of the EBVs on genetic composition[29]. The long-noted barriers between conservation genetics and practice, which are recognized and are being addressed by several international NGOs (e.g., IUCN, SCB, GEO BON) and the European COST Action project G-BiKE (Genomic Biodiversity Knowledge for Resilient). In any case, some of the variables that were ranked in the bottom half of the table may be picked by EuropaBON for the monitoring system if they are deemed important or new variables may be identified to fill existing gaps in the EBV/EESV table.

One challenge in designing a European biodiversity monitoring system is that the set of user needs and policy questions for such a system is very diverse and broad (tables 2 and 3). Therefore, the highly-ranked **EBVs/EESVs address a wide variety of policy questions** (figure 10) across three key subcategories of the EU Biodiversity Strategy cluster identified in the previous section:

1. how to monitor biodiversity trends and assess that populations are on a path towards recovery;
2. how to monitor trends in key regulating and cultural ecosystem services to ensure that they continue to deliver in the long-term;
3. how to monitor ecosystem restoration to effectively restore degraded ecosystems by 2050 (figure 12, major EU policy missions).

The EBVs/EESVs are also relevant for other subcategories and the second cluster of integrated cross-sectorial policies identified in section 4.1, particularly the Common Agricultural Policy (figure 10, specific policy questions).

All EBVs/EESVs can be used to address multiple policy questions. Likewise, some of the policy questions, particularly at the level of the subcategories, cannot be answered sufficiently by monitoring only one EBV/EESV. For instance, the questions on biodiversity trends cannot be linked to only one specific EBV as several taxa may need to be monitored.

Overall, **the majority of highly-ranked EBVs/EESVs are not sufficiently monitored across Europe by member states** (figure 11) or EU agencies. However, most countries partially monitor a large proportion of the highest ranked EBVs/EESVs, with only a few countries indicating that one or more of the desired EBVs/EESVs are not yet monitored at all. Abundance of common birds is currently sufficiently monitored in nine of the 18 countries that filled in this part of the survey, followed by rare and priority bird species (7/18 countries), mammals, including carnivores, even-toed ungulates and bats (6/18 countries), and grassland butterflies, marine harvested fish species, bird species distributions, and regulation of fresh-water quality (5/18). The remaining EBVs are monitored by less than 30% of the countries that participated in the survey. Pollinator insects (0/18 countries) and invasive species (2/18 countries) are currently the least monitored variables across Europe - an important monitoring gap to be considered by EuropaBON. A note of caution is in order as our analysis in this report is not precise on how the EBVs/EESVs are being monitored. An EBV/EESV can be measured at: (1) a couple of sites in a country, providing only a local picture of what's happening; (2) a representative set of sites in a country, but providing mainly a national-level estimate; (3) in a grid sampling scheme or wall-to-wall, proving spatially explicit dynamics. The „wall-to-wall" monitoring is rare but can be estimated sometimes from combining some representative set of sites with remote sensing data and models. A more detailed analysis of how each EBV/EESV is being monitored and modelled is being carried out in WP3 of EuropaBON (for more details on other WPs, see EuropaBON grant proposal published in the EuropaBON RIO collection).

The top ranked EBVs had **high desired spatial and temporal resolutions of between 1*1 km - 50*50 km** (the exception being marine harvested fish abundance with a desired minimum spatial resolution of 200*200 km), **monitored every 1-5 years**, respectively (figure 12). For bioeconomy showcases, e.g., migration forecasts to reduce aerial conflicts between human activities and migratory birds, even higher temporal resolutions up to an hourly scale would be required. Overall, our results show that stakeholders wish for higher spatial and temporal resolution data, which are currently still lacking.

Ultimately, **the identification of essential variables to be monitored across Europe** will be done at a later stage of the EuropaBON project, based on the analysis of this report as well as further expert input by stakeholders and scientific expertise of the consortium and colleagues. This identification of EBVs and EESVs needs to consider **a balanced set of variables** across different EBV and EESV

29 The paper by the GEO BON Working Group on Genetic Composition variables is still in review at the moment of the publication of this report.

Table 4: EBVs and EESVs as ranked by importance to national policymaking by participating countries and EU services. For each EBV and EESV, the particular biological entities specifying the variable are listed and the ranking corresponds to the ranking of that specific variable. Further specification for each variable in terms of spatial and temporal resolution is provided in Appendix 2.

EBV	Taxa, ecosystem, other entity measured	Average of Importance for national policy	Rank
Species abundances	Birds: rare and priority species	4.5	1
	Birds: common	4.26	2
	Butterflies: grassland	4.15	4
	Mammals: Carnivora, Artiodactyla and Bats	4.13	7
	Marine harvested fish species	3.77	14
	Birds: migratory	3.7	17
Community abundance	Pollinator insects	3.95	12
	Completeness of apex predators	2.81	39
Ecosystem distribution	Habitats in Habitats Directive/ EUNIS Habitats	4.25	3
	Land-use/land cover change	4	10
	Connectivity of vegetation types	3.43	24
Species distributions	Freshwater fish species	4.15	4
	Invasive species	4.15	4
	Plants: priority	4.1	8
	Birds: all	4.09	9
	Plants: all vascular	3.81	13
	Mammals: all	3.76	15
	Marine fish species	3.62	19
	Amphibians	3.59	20
	Reptiles: all	3.43	24
Taxonomic/functional diversity	Soil biota: invertebrates, fungi and microbiota	3.65	18
	Marine/transitional plants, diatoms, zooplankton, macro-invertebrates	3.29	26
	Freshwater and transitional phytoplankton, zooplankton, phytobenthos, benthic invertebrates, macroalgae	3.25	28
	Arthropods	3.05	32
Regulating (dis)services	Harmful algal blooms threatening recreation and provisioning services	3.44	23
	Risk of infection by animal vectors	3.07	30
	Crop pest risk in agriculture	3.07	30
Non-material benefits	Public visitation rates to protected areas	3.26	27
	Recreation value from landscapes	3.12	29
Regulating services	Regulation of freshwater quality	4	10
	Belowground carbon content	3.58	21
	Economic value of pollination and seed dispersal	3.47	22
	Level of service based on species diversity or species providing units	2.89	37
	Elimination of carcasses by scavengers	1.87	45

Table 4 continued.

EBV	Taxa, ecosystem, other entity measured	Average of Importance for national policy	Rank
Effective size and/or inbreeding	Priority taxa in Birds and Habitats directive (e.g. all Annex II species)	3.05	32
Provisioning services	Fish harvest	3.75	16
	Mushroom and wild fruits production	2.31	43
Morphology	Fishes: harvested species	3	34
Phenology	Selected species: flowering and leaf senescence (plants); migration dates (birds)	3	34
Ecosystem vertical profile (e.g. vegetation height)	Vegetation	2.89	37
Intraspecific genetic diversity	Priority taxa in Birds and Habitats directive (e.g. all Annex II species)	2.9	36
	Trees	2.72	40
Primary productivity	Plants	2.68	41
Ecosystem phenology	Tree phenology	2.68	41
Interaction diversity	Insect predator-prey networks	2.11	44

classes (i.e., different levels of biological organisation and types of ecosystem services), **different realms** (marine, terrestrial, freshwater), and **different taxonomic groups**. It will also need to consider existing/available biodiversity data, the capacity of member states to monitor each EBV/EESV, as well as opportunities to expand that capacity based on available methods. The consolidated essential variable list will also need to address the three major key questions of the EU Biodiversity Strategy. This EBV/EESV consolidation process is important to provide a consistent and scientifically sound framework, building on existing monitoring initiatives and extending them in a cost-effective way through models and new monitoring.

This monitoring framework will need to connect with other processes, such as the System of Environmental Economic Accounting (SEEA) - Ecosystem Accounting, coordinated by the United Nations Statistical Division (UNSD).

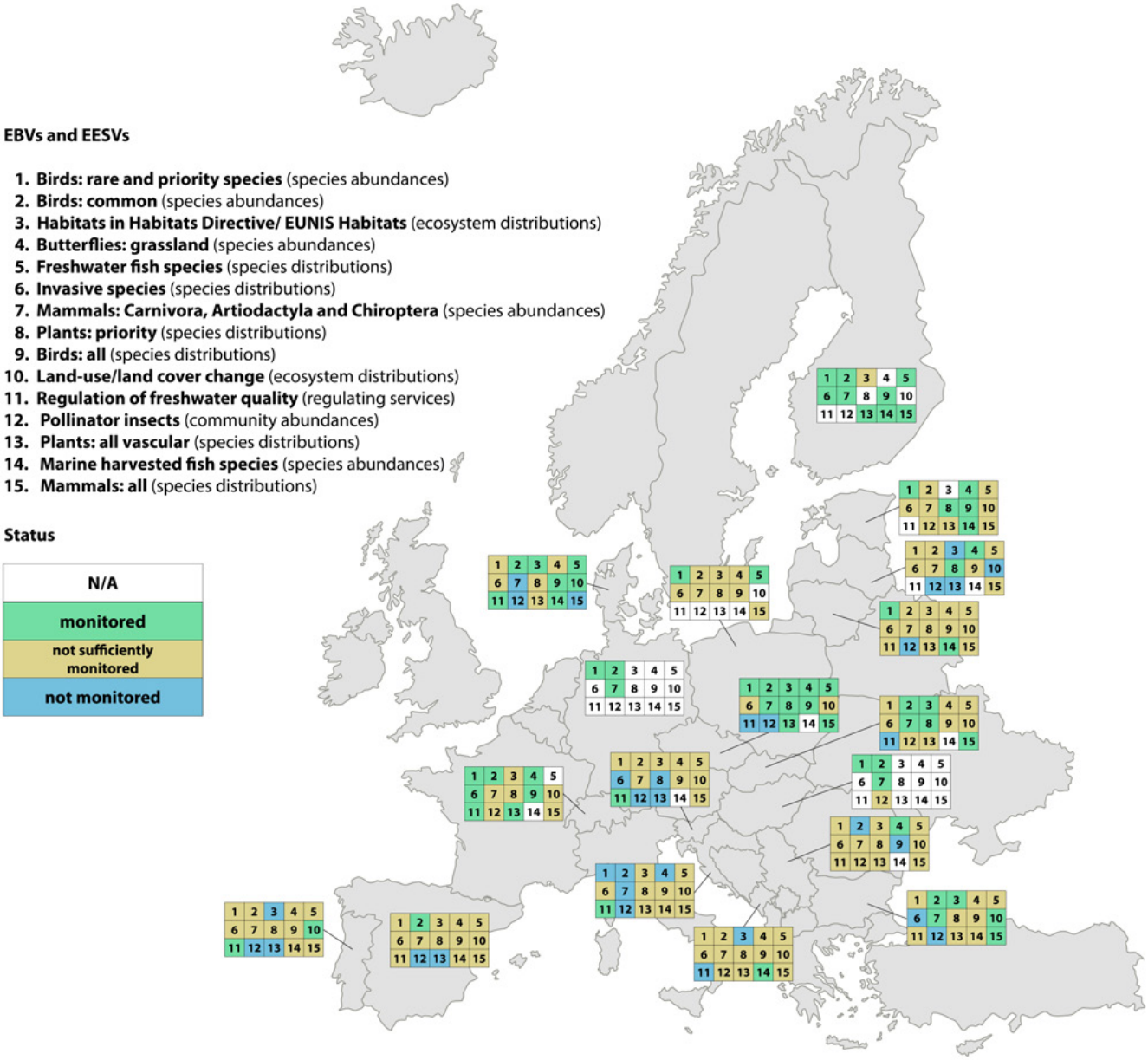


Figure 11: Monitoring status of the 15 most highly ranked Essential Biodiversity Variables (EBVs) and Essential Ecosystem Services Variables (EESVs) in Europe, as selected by participating countries and agencies. For each respondent country the monitoring status is given for each essential variable.

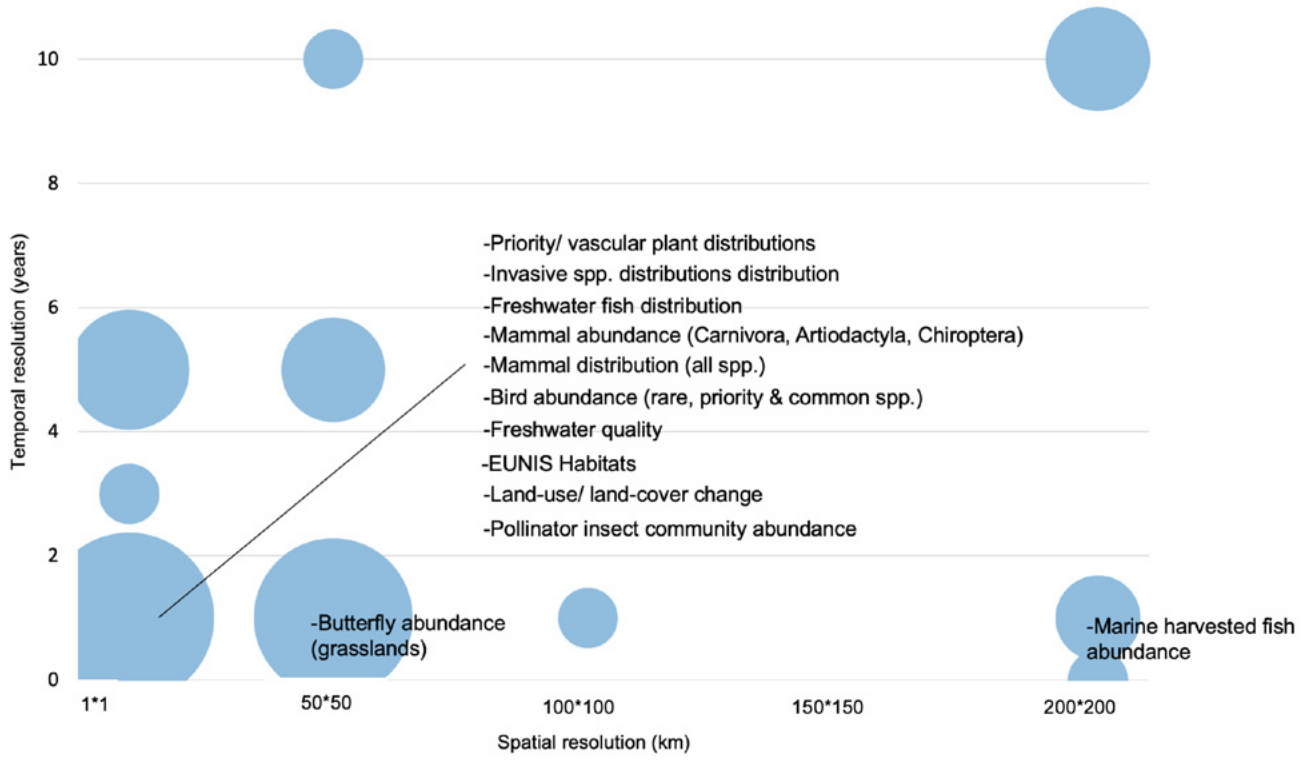


Figure 12: Desired temporal resolution plotted as a function of desired spatial resolution of all EBVs identified by EuropaBON stakeholders during the consulting process. The 15 most highly ranked EBVs are indicated with names. The size of the circle refers to the number of EBVs/EESVs in the respective resolution category. The different EBVs on birds have been grouped into one as they had the same desired resolutions. Note, since for most of the EBVs/EESVs, respondents indicated ranges for desired spatial and temporal resolutions, we used minimum temporal and spatial resolutions in this figure.

5 CONLUSIONS & OUTLOOK

5 CONCLUSIONS & OUTLOOK

This *User and Policy Needs Assessment* has evaluated the **current state of biodiversity monitoring in Europe**. It identified a fragmented biodiversity data landscape that cannot currently easily answer all relevant policy questions. Quantity and quality of biodiversity baseline datasets differ for the different countries, ranging from non-existent biodiversity monitoring due to capacity issues, to regular monitoring of ecosystem processes and state. By engaging stakeholders and experts in both member states and non-member states and from several EU bodies, we identified key challenges and ways to address these with targeted solutions towards building a joint European Biodiversity Monitoring Network. Solutions include focussing on cooperation and coordination, enhanced data standardisation and sharing, as well as the use of models and new technologies. These solutions can however only be realised with dedicated funding and capacity building, in coordination with all stakeholders in partnership.

This assessment is part of EuropaBON's stakeholder engagement strategy and forms the basis for EuropaBON's upcoming tasks. In this first step towards designing the European biodiversity monitoring system, we - together with EuropaBON's data users and providers - have identified data needs for addressing open policy questions at the European and national scales. Building upon these results to facilitate efficient use of data from existing monitoring schemes by policy, EuropaBON is currently conducting an extensive inventory of ongoing monitoring programmes and their characteristics at the EU and national level, including information collected by previous inventories. Taking insights from the results of this report into account for EuropaBON's upcoming activities, we aim to provide **geo-referenced datasets in our open-access web-based database** on current monitoring activities at EU and national levels.

The information collected from this *User and Policy Needs Assessment* will allow EuropaBON to determine which of the **open policy questions** identified by the stakeholders can be addressed with existing biodiversity data, which **data gaps** can be compensated for through biodiversity models (resulting in EBVs/EESVs products), and which of the data gaps will need to be targeted with **new monitoring schemes** with harmonised monitoring methods. Here, EuropaBON will also pay attention to aligning data and indicators that can feed directly (account-ready data) or indirectly (through modelling) into ecosystem accounts compiled at the national level for business applications (natural capital accounting).

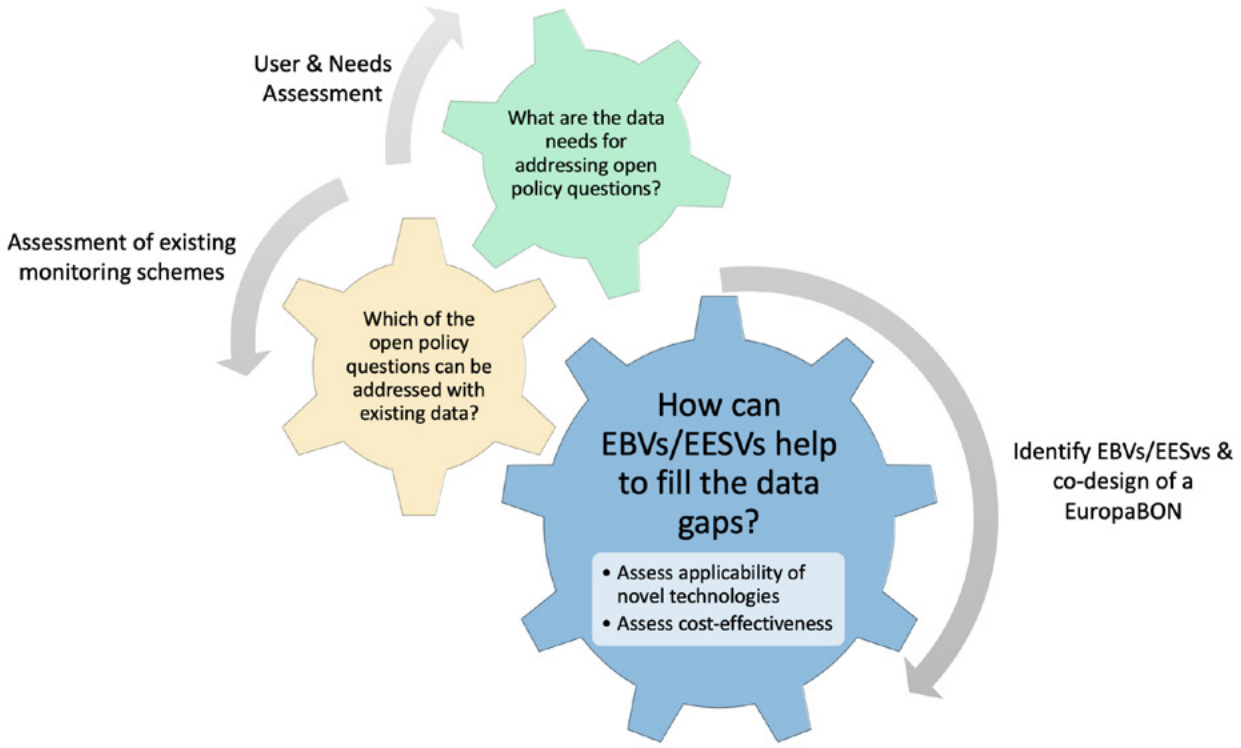


Figure 13: Visualisation of the overall processes of co-designing the European biodiversity observation network.

The co-design process will be complemented by investigating the applicability of novel biodiversity monitoring technologies and a cost-effectiveness analysis for developing the EBVs/EESVs that will form part of the final monitoring design (figure 13). Between-country differences in taxonomic and ecosystem composition, available monitoring budgets, as well as in-country monitoring and policy needs will be taken into account when designing the European biodiversity observation network.

Together with key stakeholders, **we will deliver the Terms of Reference for a *European Biodiversity Monitoring Coordination Centre (BMCC)*** to effectively implement the design produced by EuropaBON. The establishment of the BMCC will facilitate cooperation, data interoperability and alignment of sampling methods both across and within EU member states towards improving data comparability. The BMCC will play an important role in addressing the roadblocks identified in this assessment by effectively coordinating efforts across countries and relevant EU agencies to make better use of existing data and targeting monitoring efforts at important data gaps.

The BMCC will contribute to the work of the European Knowledge Centre for Biodiversity, which is the knowledge broker in the European Commission for all biodiversity topics, but which will not per se coordinate or implement biodiversity monitoring.
The stakeholder engagement process has to date provided strong guidance for how to develop a European biodiversity monitoring system and certainly does not end here. In EuropaBON, **we are committed to continue working with current stakeholders and reaching out to new members**, also from fields that have so far been **underrepresented in this assessment, including members from the business sector and other EU directives**.

We therefore call on all current and potential future members of our network to continue to engage with EuropaBON and actively shape all processes leading to the final design of a European monitoring system. EuropaBON begins with identifying user and policy needs for biodiversity monitoring and culminates by delivering the design that addresses those needs.

6 APPENDICES

Appendix 1: Survey to co-design the Europa Biodiversity Observation Network EuropaBON

Your Country/Organisation:

A. <u>Current State</u>: How do you use biodiversity data in policy making?

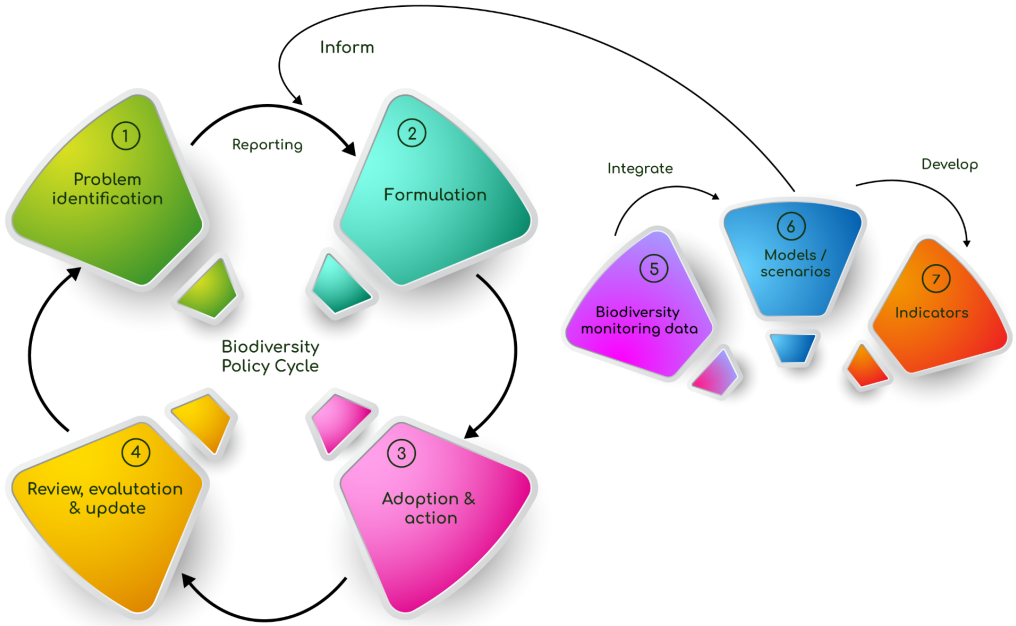


Figure 1: The four stages of the biodiversity policy cycle (1-4), including three stages of informing policy formulation (5-7) (adapted from IPBES, 2016[30]).

[30] IPBES (2016): The methodological assessment report on scenarios and models of biodiversity and ecosystem services. S. Ferrier, et al (eds.). Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany.

2. How are biodiversity monitoring data currently used for national and local policy making in your country/organisation (see figure 1)?

Please edit, remove, and add to the examples provided in the table.

Column A: Which monitoring schemes are currently carried out in your country/organisation, including their frequency?

Column B: Which EU or national policy or management action do they inform?

Column C: What are the relevant indicators and spatial resolution used for these monitoring schemes?

Column D: How exactly do these data lead to management action on the ground?

Column E: Please provide any relevant weblinks on the monitoring scheme.

A **Current biodiversity monitoring scheme (and frequency)**	**B** **Relevant policy or management action at national or local level**	**C** **Relevant indicator & spatial resolution**	**D** **How exactly does this data lead to action (decision making, planning, management)? Please describe**	**E** **Weblink URL to monitoring scheme**
E.g. National breeding bird survey (annually)	*Art. 12 Birds Directive / national biodiversity strategy / Ramsar sites*	*Number of breeding pairs of each bird species per km² (or per site or per district)*	*Data is sent to the EU for international reporting. Nationally, negative trends trigger restoration action of e.g. Ramsar wetland sites and species specific action programmes*	
E.g. Monitoring the impact of air pollution on ecosystems	*Air quality policy, reporting under Art. 9 of the National Emissions Ceiling directive*	*Ozone foliar damage to trees and crops (200 sites in the country)*	*Data is sent to the EU for international reporting. The data is used for monitoring the health of forests.*	
E.g. Monitoring of invasive alien species	*Management of natural areas, rivers and forests; EU regulation on invasive alien species*	*Monitoring programme based on a network of voluntary observations of invasive alien species and targeted species*	*Data is used for national and regional programmes that target the removal of invasive alien species (planning of resources, actions for removing IAS)*	

		monitoring in areas under high risk.		

3. Please expand your answer given in Table 1 by providing one or several concrete examples: How are biodiversity data used to identify biodiversity problems and trigger policy formulation in your country/organisation (figure 1, parts 1-2)?

4. Please expand your answer given in Table 1 by providing one or several concrete examples: How have biodiversity data informed national and local action in your country/organisation (e.g. establishment of new protected areas, triggering land use change, more sustainable forest management) (figure 1, parts 3-4)?

5. Please expand your answer given in Table 1 by providing one or several concrete examples: Does your country/organisation integrate biodiversity data in models and scenarios, e.g. modelling distribution of habitat suitability, future trends or the consequences of interventions (figure 1, parts 5-6)?

6. Please provide one or several concrete examples: If biodiversity data is currently not (sufficiently) used for policymaking or for informing action in your country/organisation, what would be needed for this to happen?

7. What is your ministry/organisation's approximate yearly budget on national biodiversity monitoring? What would incentivise an increase in this budget?

B. Challenges in biodiversity monitoring

8. **What are the main challenges you face in biodiversity monitoring and reporting, and where do you see most need for improvement?**

Ranking scale:

1 No relevance	**2** Low relevance	**3** Medium relevance	**4** Fairly high relevance	**5** Very high relevance

Challenge	**Ranking: Relevance of this challenge in your country**/organisation	**Do you know of any examples of how this challenge was overcome? How would this work in your country**/organisation**?**
Biased monitoring: under-representation of certain ecosystem types	Please rank here	
Biased monitoring: under-representation of certain taxonomic groups	Please rank here	
Diversity and complexity of various biodiversity monitoring actors and users	Please rank here	
Financial resource constraints	Please rank here	
Insufficient spatial coverage of monitoring programs	Please rank here	
Lack of (raw) free data	Please rank here	
Lack of human and technical capacities	Please rank here	
Lack of integration between data at different geographic scales	Please rank here	
Lack of integration between data on different ecosystems	Please rank here	
Lack of integration between data on different taxa	Please rank here	
Lack of integration between in situ and remote sensing data	Please rank here	
Lack of long-term policies for monitoring	Please rank here	
Lack of standardised data collection methods and protocols	Please rank here	
Lack of standardised monitoring methods and protocols	Please rank here	
Monitoring frequency is too low to detect meaningful trends	Please rank here	

No international agreement on which biodiversity variables should be measured	Please rank here	
No national agreement on which biodiversity variables should be measured	Please rank here	
Silos between different disciplines and roles	Please rank here	
Time lag between data collection and use	Please rank here	
Other:	Please rank here	

C. <u>Desired Future State</u>: Biodiversity monitoring variables and indicators

(This section will be reported anonymously and as a synthesis across countries)

9. The table below lists a set of desired **biodiversity variables and indicators identified for a desirable future state** identified at the first EuropaBON Stakeholder Workshop on 26-28 May 2021. Please rank and prioritise these variables and complete the table. These variables and indicators will serve as a basis for the following questions. The instructions will guide you through each column step by step.

a. *Columns A-D*: These are the priority desired variables that were identified by participants of the first EuropaBON workshop. If you have any comments on these variables, or their resolution, please add these in *Column G*.
b. *Column E*: Assuming no technical, budgetary or capacity restrictions in your country, please rank each listed variable/indicator in terms of its impact on national or EU policy-making in your country/organisation from high (5) to low (1).
c. *Column F*: Please indicate the current monitoring status of the variable/indicator.
d. *Column H*: Which future policy questions could these monitoring variables address, e.g. national policies or EU Directives? Please note down the relevant policy questions or specific policies/Directives, as well as any relevant links if available.

10. If you had no technical, budgetary or capacity restrictions in your country/organisation**,** which additional variables and indicators would you monitor nationally? Please add these to the bottom lines of the table, and fill out *Columns A-H* for them.

Ranking scale:

1 No relevance	2 Low relevance	3 Medium relevance	4 Fairly high relevance	5 Very high relevance

A **Desired variable/ indicator**	B **Taxa, ecosystem or other entity measured**	C **Spatial Resolu-tion**	D **Tempo ral Resolu - tion**	E **Ranking: impact of this variable/ indicator for national policy-making**	F **Current monitoring status**	G **Comments** (examples in grey)	H **Future policy/ management question(s)** (examples in grey)
Species abundances	Birds: common	1x1km - 10x10km	1 year	Please rank here	Please indicate	E.g., These data can be used at the community level or species level; Are these data realistic/feasible to collect?	E.g., What are the trends of birds and how is the CAP affecting them?
Species abundances	Birds: rare and priority species	1x1km - 10x10km	5 years	Please rank here	Please indicate		E.g., How to prioritize and access restoration measures?
Species abundances	Birds: migratory	1x1km - 10x10km	real-time	Please rank here	Please indicate		E.g., What are mortality hot-spots and congregation areas of migratory birds?
Species distributions	Birds: all	1x1km - 10x10km	5 years	Please rank here	Please indicate		E.g., What are the overall trends and what are the main drivers?
Species distributions	Amphibians	10x10 km - 50x50km	1 year	Please rank here	Please indicate	E.g., Probably not feasible at this moment	E.g., What are the overall trends of amphibians?

A **Desired variable/ indicator**	B **Taxa, ecosystem or other entity measured**	C **Spatial Resolu-tion**	D **Tempo ral Resolu - tion**	E **Ranking: impact of this variable/ indicator for national policy-making**	F **Current monitoring status**	G **Comments** (examples in grey)	H **Future policy/ management question(s)** (examples in grey)
Species abundances	Mammals: Carnivora, Artiodactyla and Bats	1x1km - 10x10km	1 year	Please rank here	Please indicate		
Species distributions	Mammals: all	10x10 km - 50x50km	5 year	Please rank here	Please indicate		
Species distributions	Reptiles: all	1x1km - 10x10km	5 year	Please rank here	Please indicate		
Species abundances	Butterflies: grassland	10x10 km - 50x50km	1 year	Please rank here	Please indicate		
Species distributions	Plants: all vascular	10x10 km - 50x50km	5 year	Please rank here	Please indicate		
Species distributions	Plants: priority	1x1km - 10x10km	1 year	Please rank here	Please indicate		
Species distributions	Freshwater fish species	10x10 km - 50x50km	5 year	Please rank here	Please indicate		
Species abundances	Marine harvested fish species	50x50km - 200x200km	1 year	Please rank here	Please indicate		
Species distributions	Marine fish species	50x50km - 200x200km	5 year	Please rank here	Please indicate		

A **Desired variable/ indicator**	B **Taxa, ecosystem or other entity measured**	C **Spatial Resolu-tion**	D **Tempo ral Resolu - tion**	E **Ranking: impact of this variable/ indicator for national policy-making**	F **Current monitoring status**	G **Comments** (examples in grey)	H **Future policy/ management question(s)** (examples in grey)
Species distributions	Invasive species	1x1km - 10x10km	5 year	Please rank here	Please indicate		
Taxonomic/f unctional diversity, and biomass	Arthropods	1x1km - 10x10km	1yr-3yr	Please rank here	Please indicate		
Community abundance	Pollinator insects	1x1km - 10x10km	1 year	Please rank here	Please indicate		
Taxonomic/f unctional diversity	Soil biota: invertebrates, fungi and microbiota	1x1km - 10x10km	1 year	Please rank here	Please indicate		
Taxonomic/f unctional diversity and abundance	Marine/transitio nal plants, diatoms, zooplankton, macro-invertebrates	10x10km - 50x50km	seasonal to 1 year	Please rank here	Please indicate		
Taxonomic/f unctional diversity and biomass	Freshwater and transitional phytoplankton, zooplankton, phytobenthos, benthic	10x10 km - 50x50km	1 year, real-time for bloom events (harmful algal	Please rank here	Please indicate		

A **Desired variable/ indicator**	B **Taxa, ecosystem or other entity measured**	C **Spatial Resolu-tion**	D **Tempo ral Resolu - tion**	E **Ranking: impact of this variable/ indicator for national policy-making**	F **Current monitoring status**	G **Comments** (examples in grey)	H **Future policy/ management question(s)** (examples in grey)
	invertebrates, macroalgae		blooms)				
Interaction diversity	Insect predator-prey networks	50x50km - 200x200km	1 year (sampled at multiple seasons)	Please rank here	Please indicate		
Intraspecific genetic diversity	Priority taxa in Birds and Habitats directive (e.g. all Annex II species)	50x50km - 200x200km	10 years	Please rank here	Please indicate		
Effective size and/or inbreeding	Priority taxa in Birds and Habitats directive (e.g. all Annex II species)	50x50km - 200x200km	10 years	Please rank here	Please indicate		
Intraspecific genetic diversity	Trees	50x50km - 200x200km	10 years	Please rank here	Please indicate		
Phenology	Selected species: flowering and	10x10 km - 50x50km	1 - 10 years	Please rank here	Please indicate		

A **Desired variable/ indicator**	B **Taxa, ecosystem or other entity measured**	C **Spatial Resolu-tion**	D **Tempo ral Resolu - tion**	E **Ranking: impact of this variable/ indicator for national policy-making**	F **Current monitoring status**	G **Comments** (examples in grey)	H **Future policy/ management question(s)** (examples in grey)
	leaf senescence (plants); migration dates (birds)						
Morphology: body mass	Fishes: harvested species	50x50km - 200x200km	1 year	Please rank here	Please indicate		
Ecosystem distribution: extent	Land-use/land cover change	100x100m - 1x1km	1 year	Please rank here	Please indicate		
Ecosystem distribution: extent	Habitats in Habitats Directive/ EUNIS Habitats	100x100m - 1x1 km	1 year	Please rank here	Please indicate		
Ecosystem distribution: connectivity	Vegetation types	1x1km - 10x10km	1 year	Please rank here	Please indicate		
Ecosystem vertical profile (e.g. vegetation height)	Vegetation	10x10m - 100x100m	1 year	Please rank here	Please indicate		
Primary productivity	Plants	100x100m - 1x1 km	Yearly dependin	Please rank here	Please indicate		

A **Desired variable/ indicator**	B **Taxa, ecosystem or other entity measured**	C **Spatial Resolu-tion**	D **Tempo ral Resolu - tion**	E **Ranking: impact of this variable/ indicator for national policy-making**	F **Current monitoring status**	G **Comments** (examples in grey)	H **Future policy/ management question(s)** (examples in grey)
			g of taxa				
Ecosystem phenology	Tree phenology	1x1km - 10x10km	1 year	Please rank here	Please indicate		
Regulating services	Belowground carbon content	100x100m - 1x1km	3 years	Please rank here	Please indicate		
Regulating services	Level of service based on species diversity or species providing units	100x100m - 1x1km	annual	Please rank here	Please indicate		
Regulating services	Regulation of freshwater quality	100x100m - 1x1km	6 months or 1 year	Please rank here	Please indicate		
Regulating (dis)services	Harmful algal blooms threatening recreation and provisioning services	1x1km - 10x10km	real-time, weekly or monthly	Please rank here	Please indicate		
Regulating services	Completeness of apex predators	10 x 10 km - 50 x 50 km	1 year	Please rank here	Please indicate		

A **Desired variable/ indicator**	B **Taxa, ecosystem or other entity measured**	C **Spatial Resolu-tion**	D **Tempo ral Resolu - tion**	E **Ranking: impact of this variable/ indicator for national policy-making**	F **Current monitoring status**	G **Comments** (examples in grey)	H **Future policy/ management question(s)** (examples in grey)
Regulating (dis)services	Crop pest risk in agriculture	100x100m - 1x1km		Please rank here	Please indicate		
Provisioning services	Mushroom and wild fruits production	1x1km - 10x10km	weekly	Please rank here	Please indicate		
Regulating (dis)services	Risk of infection by animal vectors	10x10 km - 50x50km	real time	Please rank here	Please indicate		
Regulating services	Elimination of carcasses by scavengers	10x10 km - 50x50km	1 year	Please rank here	Please indicate		
Regulating services	Economic value of pollination and seed dispersal	1x1km - 10x10km	1 year	Please rank here	Please indicate		
Provisioning services	Fish harvest	10x10 km - 50x50km	1 year	Please rank here	Please indicate		
Non-material benefits	Public visitation rates to protected areas	10x10 km - 50x50km	1 year	Please rank here	Please indicate		
Non-material benefits	Recreation value from landscapes	1x1km - 10x10km	1 year	Please rank here	Please indicate		

A **Desired variable/ indicator**	B **Taxa, ecosystem or other entity measured**	C **Spatial Resolu-tion**	D **Tempo ral Resolu - tion**	E **Ranking: impact of this variable/ indicator for national policy-making**	F **Current monitoring status**	G **Comments** (examples in grey)	H **Future policy/ management question(s)** (examples in grey)
Add biodiversity variables here if needed				Please rank here	Please indicate		
				Please rank here	Please indicate		
				Please rank here	Please indicate		
				Please rank here	Please indicate		

D. European Biodiversity Monitoring Observation Network

11. **What will be the most important benefit of a European Biodiversity Observation Network[31] to biodiversity monitoring and reporting in your country/organization in the next 5-10 years?** (E.g. data standardisation across Europe; enhanced national biodiversity reporting; filling data gaps; enabling coordinated action; etc.)

[31] EuropaBON aims at creating an active European Biodiversity Observation Network of policymakers, data providers, data users, and researchers at local, national and European levels to identify data needs of policies and targets aligned with the new European Green Deal. Its mission is to overcome existing data gaps and workflow bottlenecks by designing an EU-wide framework for monitoring biodiversity and ecosystem services.

12. How could your country/organisation contribute to a European Biodiversity Observation Network in the next 1-5 years?

Please provide the names and email addresses of all experts who contributed to this survey
(*for internal information only; names and contact details will not be published*)**:**

Appendix 2: Ranking & Monitoring status of EBV and EESVs[32]

Desired variable/ indicator	Taxa, ecosystem, other entity measured	Spatial resolution	Temporal resolution	Importance for national policy (1 - 5 from low to high)	Current monitoring status in %			Monitoring status not indicated
					currently monitored	currently not sufficiently monitored	currently not monitored	
Species abundances	Birds: rare and priority species	1x1km - 10x10km	5 years	4.50	33.33	47.62	9.52	9.52
Species abundances	Birds: common	1x1km - 10x10km	1 year	4.26	21.05	47.37	15.79	15.79
Ecosystem distribution: extent	Habitats in Habitats Directive/ EUNIS Habitats	100x100m - 1x1 km	1 year	4.25	42.86	33.33	14.29	9.52
Species abundances	Butterflies: grassland	10x10 km - 50x50km	1 year	4.15	31.58	42.11	10.53	15.79
Species distributions	Freshwater fish species	10x10 km - 50x50km	5 years	4.15	21.05	63.16	5.26	10.53
Species distributions	Invasive species	1x1km - 10x10km	5 years	4.15	20.00	55.00	10.00	15.00
Species abundances	Mammals: Carnivora, Artiodactyla and Bats	1x1km - 10x10km	1 year	4.13	22.22	55.56	5.56	16.67
Species distributions	Plants: priority	1x1km - 10x10km	1 year	4.10	23.81	52.38	14.29	9.52

[32] Please note that the ranking and monitoring status of EBVs and EESVs are based on all received survey responses, including such as EC services and, in some cases, multiple responses from one country.

Desired variable/ indicator	Taxa, ecosystem, other entity measured	Spatial resolution	Temporal resolution	Importance for national policy (1 - 5 from low to high)	Current monitoring status in %			Monitoring status not indicated
					currently monitored	currently not sufficiently monitored	currently not monitored	
Species distributions	Birds: all	1x1km - 10x10km	5 years	4.09	35.00	50.00	5.00	10.00
Ecosystem distribution: extent	Land-use/land cover change	100x100m - 1x1km	1 year	4.00	31.58	52.63	5.26	10.53
Regulating services	Regulation of freshwater quality	100x100m - 1x1km	6 months or 1 year	4.00	43.75	31.25	12.50	12.50
Community abundance	Pollinator insects	1x1km - 10x10km	1 year	3.95	5.00	35.00	40.00	20.00
Species distributions	Plants: all vascular	10x10 km - 50x50km	5 years	3.81	46.15	30.77	7.69	15.38
Species abundances	Marine harvested fish species	50x50km - 200x200km	1 year	3.77	21.05	42.11	21.05	15.79
Species distributions	Mammals: all	10x10 km - 50x50km	5 years	3.76	60.00	26.67	0.00	13.33
Provisioning services	Fish harvest	10x10 km - 50x50km	1 year	3.75	15.00	60.00	15.00	10.00
Species abundances	Birds: migratory	1x1km - 10x10km	real-time	3.70	7.14	42.86	35.71	14.29
Taxonomic/functional diversity	Soil biota: invertebrates, fungi and microbiota	1x1km - 10x10km	1 year	3.65	22.22	27.78	38.89	11.11
Species distributions	Marine fish species	50x50km - 200x200km	5 years	3.62	0.00	27.78	55.56	16.67

Desired variable/ indicator	Taxa, ecosystem, other entity measured	Spatial resolution	Temporal resolution	Importance for national policy (1 - 5 from low to high)	Current monitoring status in %			Monitoring status not indicated
					currently monitored	currently not sufficiently monitored	currently not monitored	
Species distributions	Amphibians	10x10 km - 50x50km	1 year	3.59	28.57	47.62	14.29	9.52
Regulating services	Belowground carbon content	100x100m - 1x1km	3 years	3.58	15.00	55.00	20.00	10.00
Regulating services	Economic value of pollination and seed dispersal	1x1km - 10x10km	1 year	3.47	37.50	18.75	25.00	18.75
Regulating (dis)services	Harmful algal blooms threatening recreation and provisioning services	1x1km - 10x10km	real-time, weekly, or monthly	3.44	10.00	40.00	35.00	15.00
Species distributions	Reptiles: all	1x1km - 10x10km	5 years	3.43	0.00	25.00	56.25	18.75
Ecosystem distribution: connectivity	Vegetation types	1x1km - 10x10km	1 year	3.43	10.00	65.00	15.00	10.00
Taxonomic/functional diversity and abundance	Marine/transitional plants, diatoms, zooplankton, macro-invertebrates	10x10km - 50x50km	seasonal to 1 year	3.29	33.33	20.00	33.33	13.33
Non-material benefits	Public visitation rates to protected areas	10x10 km - 50x50km	1 year	3.26	22.22	50.00	16.67	11.11
Taxonomic/functional diversity and biomass	Freshwater and transitional phytoplankton, zooplankton, phytobenthos, benthic invertebrates, macroalgae	10x10 km - 50x50km	1 year, real-time for bloom events (harmful	3.25	28.57	28.57	21.43	21.43

Desired variable/ indicator	Taxa, ecosystem, other entity measured	Spatial resolution	Temporal resolution	Importance for national policy (1 - 5 from low to high)	Current monitoring status in %			Monitoring status not indicated
					currently monitored	currently not sufficiently monitored	currently not monitored	
			algal blooms)					
Non-material benefits	Recreation value from landscapes	1x1km - 10x10km	1 year	3.12	0.00	9.52	0.00	90.48
Regulating (dis)services	Crop pest risk in agriculture	100x100m - 1x1km		3.07	0.00	31.58	52.63	15.79
Regulating (dis)services	Risk of infection by animal vectors	10x10 km - 50x50km	real time	3.07	17.65	41.18	23.53	17.65
Taxonomic/functional diversity, and biomass	Arthropods	1x1km - 10x10km	1year-3years	3.05	25.00	25.00	33.33	16.67
Effective size and/or inbreeding	Priority taxa in Birds and Habitats directive (e.g., all Annex II species)	50x50km - 200x200km	10 years	3.05	23.08	38.46	23.08	15.38
Phenology	Selected species: flowering and leaf senescence (plants); migration dates (birds)	10x10 km - 50x50km	1 - 10 years	3.00	5.26	15.79	63.16	15.79
Morphology: body mass	Fishes: harvested species	50x50km - 200x200km	1 year	3.00	40.00	26.67	20.00	13.33
Intraspecific genetic diversity	Priority taxa in Birds and Habitats directive (e.g. all Annex II species)	50x50km - 200x200km	10 years	2.90	5.88	5.88	70.59	17.65
Ecosystem vertical profile (e.g. vegetation height)	Vegetation	10x10m - 100x100m	1 year	2.89	10.53	26.32	47.37	15.79

Desired variable/ indicator	Taxa, ecosystem, other entity measured	Spatial resolution	Temporal resolution	Importance for national policy (1 - 5 from low to high)	Current monitoring status in %			Monitoring status not indicated
					currently monitored	currently not sufficiently monitored	currently not monitored	
Regulating services	Level of service based on species diversity or species providing units	100x100m - 1x1km	annual	2.89	0.00	5.56	77.78	16.67
Regulating services	Completeness of apex predators	10 x 10 km - 50 x 50 km	1 year	2.81	13.33	20.00	53.33	13.33
Intraspecific genetic diversity	Trees	50x50km - 200x200km	10 years	2.72	18.75	6.25	56.25	18.75
Primary productivity	Plants	100x100m - 1x1 km	Yearly depending of taxa	2.68	10.53	21.05	52.63	15.79
Ecosystem phenology	Tree phenology	1x1km - 10x10km	1 year	2.68	25.00	25.00	37.50	12.50
Provisioning services	Mushroom and wild fruits production	1x1km - 10x10km	weekly	2.31	7.14	28.57	50.00	14.29
Interaction diversity	Insect predator-prey networks	50x50km - 200x200km	1 year (sampled at multiple seasons)	2.11	6.25	0.00	75.00	18.75
Regulating services	Elimination of carcasses by scavengers	10x10 km - 50x50km	1 year	1.87	0.00	21.43	57.14	21.43

Appendix 3: List of challenges identified in the 1st Stakeholder workshop

Cluster	Challenges
Data standardization & management	Standardized data collection: Lack of harmonisation & standardization in data collection and analysis / Need for clear license options
	Data flows: Lack of data integration workflows /Need for more efficient systems to report data to integration nodes / Workflows too long, with diluted responsibilities
	Integration of data: Limited/insufficient integration of datasets, e.g., between in situ information and remote sensing data
	Monitoring programs heterogeneous and not interoperable, not easy to integrate
	Fragmented data landscape: Scattered databases, fragmentation of information / Unknown lineages of data products
	Lack of official hubs of data collection and harmonization at national and international levels
	Relevance of data collection & uptake: Much data are never analyzed properly /Data collection often primed or even biased towards a specific research goal/ Limited use of modelling
	Dissociation between restoration needs and data collection
Data sharing & availability	Systematic, coordinated sharing of raw data before aggregation needed
	Competitive funding reduces willingness to share data
	Uncertainty about licensing and user rights
	Limited accessibility of "older" data
	Lack of open and FAIR data sharing principles
Human resources, interpretation of data	Significant time lag between data collection and reporting
	High expert and time resource requirements of current monitoring schemes
	Declining number of taxonomists across Europe
	Allocation of expert time in repetitive tasks (gathering, identifying) instead of interpretation
	Monitoring programs not appealing for science careers
	Additional workload for nature conservation agencies due to standardized data collection
	Need for better tools to analyse already existing data
Lack of knowledge & skills, resistance to change	Heterogeneous data management/analysis capacities across Europe
	Insufficient knowledge on innovative methods and available tools
	Resistance to uptake of new monitoring methods & new technologies
	Lack of taxonomic expertise
	Limited integration and interchange of knowledge among different monitoring frameworks
Lack of policy support, conflicts in decision-making	Lack of interest and support at the policy level
	Lack of agreed definitions, road map, and targets
	Short-term policies of come administrations
	Opposing objectives by different decision-makers
New technologies & monitoring gaps	Monitoring efforts fail to capture the trade impacts of EU on other countries
	Lack of long-term monitoring of spatially contiguous data
	More efficient use and acceptance of new technologies needed
	Difficulties in monitoring rare biodiversity in remote areas
Lack of standardized monitoring methods	Lack of harmonized & standardized methods, indicators, data flows, data storing
	Lack of common monitoring design across Europe
	Lack of scalability & comparability of results due to lack of standardization
	Taxonomic biases
	Need for automated near-real time monitoring of biodiversity in Europe

Coordination of monitoring & policy	Dispersion of efforts along the road from data to policy
	Lack of communication along coordination
	Need for harmonization and coordination of policy and monitoring in Europe
Lack of financial resources	Long-term, stable financial commitments needed
	Europe-wide common coordination needed
	Current technology and methods still very resource/labour intensive
	Overall lack of financial resources for monitoring
	Increased funding needed for monitoring implementation (novel methods), skill development, technologies
	Large disparities of funding, logistics, and human resources across countries
	Data hoarding as a result of funding competition among universities and research institutes
	Lack of long-term Public Private Partnerships (PPPs) and private sector investment

Appendix 4: Solutions identified in the 1st Stakeholder workshop[33]

Cluster	Solution
Coordination & synchronization of monitoring efforts	Create a platform to integrate data, facilitate data flows and provide guidance at national and EU levels
	International collaboration and knowledge transfer
	Harmonize monitoring approaches across countries
	Form a consortium network like BirdLife to better integrate data collection and sharing and reduce redundancy
	Greater collaboration between organizations monitoring different taxa (e.g., plant monitoring transects could also do observational pollinator monitoring).
	Create themes across geographic borders (e.g., ecoregion, river) to harmonize and share best practices
	Cooperation agreements and financial compensation with NGOs that currently collect data
	Harmonize indicators and thresholds at least within specific policies (e.g., Habitats Directive)
	Integrate EU biodiversity monitoring with monitoring efforts at the global scale
	Increase coordination and knowledge exchange among the different actors involved in monitoring
	Establish a common EU approach, assistance and guidance for new initiatives
Data sharing & availability	Require mandated open data (from funders, governments etc.) & establish FAIR data principles
	Adopt a universal standard for biodiversity data structuring and storage
	Provide online open access to data collected under environmental impact assessments by private companies
	Acknowledging data providers in open access formats
	Provide open access to raw data collected under the Water Framework Directive, rather than just the five categories score of ecological quality
	Set up a positive feed-back loop by combining data sharing mechanisms with meetings on the outcomes of such sharing
Data standardization & flows	Harmonization of current and previous monitoring tools to understand and interpret long-term trends
	Create a European hub for mobilization, integration, harmonization of biodiversity data
	Public database for easy access to researchers and practitioners
	Greater focus on standardization
	Harmonization of taxonomy

[33] Answers given to the questions: How could we overcome obstacles preventing effective biodiversity monitoring? Which approaches are fundamental for this? What should we change in our actions today?

Cluster	Solution
	Create an efficient directory of existing data
	Ensure quantification of uncertainties to facilitate fusing of data products
	Creation and adoption of data standards
	Redesign the reward system in academia, so that data contribution to policy is a benefit for scientists and not 'loss of data property'
	Enable (fund, encourage, enforce) sharing of (raw) data.
	Creating and standardizing effective EBVs (guidance, templates, workflows, custodians)
	Put more effort on methods for making use of disparate datasets
Relevance to and support by policy and society	Raise awareness with decision-makers about the role of modelling
	Long-term support by politics and administrations needed for long-term monitoring
	Guidelines and a vision for monitoring based on desired policy questions supported by science
	Existing policy frameworks (e.g. WFD) that currently collect biological data need to be adapted to analyzing biodiversity
	Define a governance structure (EU regulation) at EU level, with sufficient budget, linked to an efficient member state level
Effectiveness & impact of monitoring	Mandate biodiversity impact assessments in a wider range of contexts in the public and private sector. Ensure that this data is then provided into central databases.
	Find effective ways of collating and compiling standardized and harmonized data collected for appropriate spatial units
	Design a framework of variables to observe at large spatial scales and over long time periods and clear measurement protocols (like in meteorology for supporting climate modeling)
	Establish a baseline in monitoring before installing biodiversity-friendly interventions in cities
	Create a service like the climate Copernicus service or the Land Copernicus service which turns monitoring products into regularly updated maps or data
	Set up a positive feed-back loop on data integration and sharing mechanisms combined with meetings on their outcomes
Technology & research development	Create simpler apps that are accessible to a wider audience of researchers and citizens
	Better involvement of experts on product and platform development (web, mobile applications, partner ecosystem building)
	Scale up and integrate new monitoring technologies with large potential to improve standardize biomonitoring across Europe (e.g., eDNA, remote sensing)
	Invest in technologies that allow the automated and high frequency detection of species across representative sites at large scale
	Make available/generate quality information at European level, e.g., high resolution/multiple bands satellite data.
	Making extensive use of new technologies (bioacoustics, metagenomics, remote sensing).

Cluster	Solution
Stakeholder engagement, citizen science	Work with all stakeholders, public sectors, and science in collecting and sharing biodiversity data
	Derive more clarity on policy targets and implement more extensive consultation
	Create better dialogue with the agricultural sector and other sectors causing biodiversity deterioration
	Acknowledge and support the role of volunteers in running monitoring organizations (particularly small, natural history societies that have generated a lot of long-term data for many taxa)
	Make better use of information collected in large citizen science platforms like e-Bird or iNaturalist
	Cooperation among regions and communities of people studying different taxa & integration of stakeholder nodes
	More collaboration with the private sector
Financial resources	Identification of priority long-term monitoring efforts and ensuring funding of coordination
	More funding to support long-term biodiversity monitoring in extensive networks, including citizen scientists
	Develop incentives (financial and attribution) for data sharing
	Cooperation agreements and financial compensation with NGOs that currently collect data
Capacity building & human resources	More training of volunteers
	More funding to close capacity gaps (human resources and infrastructure) in Europe
	Continuous interaction of scientists through virtual platforms to share ideas
	Increase number of qualified experts across disciplines
	Encourage open-mindedness and adaptability to new proposals
	More education on data management, including development of relevant tools
New monitoring approaches	Stronger consideration of monitoring of soil biodiversity.
	Identify innovative, interdisciplinary approaches that are less resource consuming
	Apply non-deadly monitoring of invertebrates, following the example of butterflies.
	Give more importance to vegetation, invertebrates, ecological processes

Appendix 5: Key relevant past projects, data users and providers in Europe

Directorate-General for Environment (DG ENV)

As its name suggests, DG ENV is responsible for EU policy on the environment. Since the adoption of the Birds Directive in April 1979, it proposes and implements policies that ensure environmental protection in Europe. Additionally, the Habitats Directive (adopted in 1992) helps maintain biodiversity by protecting over 1000 animals and plant species and over 200 types of habitat through the Natura 2000 network of protected areas.

To monitor biodiversity in Europe, DG ENV relies on data collected and reported in a consistent and comparable way. Every 6 years, EU Member States are therefore required to report on the sizes of and trends in bird populations (according to Article 12 of the Birds Directive) and on the conservation status of and trends in targeted habitats and species (according to Article 17 of the Habitats Directive) within their territories. Reporting under the Birds Directive covers all species of naturally occurring wild birds in Europe, while reporting under the Habitats Directive only covers a selection of habitats and species that are either characteristic of Europe, rare and/or endangered. The Habitats Directive also requires Member States to report on the compensation measures taken for projects having a negative impact on Natura 2000 sites or on derogations they may have applied to the strict protection measures.

Every six years since 2015, progress reporting under the Birds Directive is streamlined with the Habitats Directive and integrated in the composite "State of Nature in the EU" report. This report is prepared in collaboration with the European Environment Agency's (EEA) European Information and Observation Network (Eionet). National government agencies have the responsibility to report on the state of the environment in their country, which involves the aggregation and summarising of suitable data, information and statistics from a national perspective.

Commission's Directorate-General for Agriculture and Rural Development (DG AGRI)

DG AGRI is responsible for EU policy on agriculture and rural development. Its mission is to promote the sustainable development of Europe's agriculture and to ensure the well-being of its rural areas. DG AGRI deals with all aspects of the Common Agricultural Policy (CAP), including enhancing the variety of species, habitats and landscape features found in the farmland ecosystems of the EU. Under cross-compliance rules, all beneficiaries of the CAP must meet a set of statutory management requirements (SMRs) and good agricultural and environmental conditions (GAECs), including:

- Farmers must comply with EU directives on the conservation of wild birds (SMR 2) and natural habitats (SMR 3), which involves protecting Natura 2000 areas;
- Requirements to comply with EU directives on nitrates (SMR 1) and pesticides (SMR 10) also protect biodiversity;and
- Under GAEC 7, farmers must ensure the retention of landscape features such as walls, hedges, banks, watercourses and trees; other GAECs safeguard soil and water, bringing knock-on benefits for biodiversity.

In order to monitor the CAP's progress towards reaching biodiversity objectives, a number of tools and mechanisms have been implemented. For example, the agri-food data portal includes a dashboard with indicators for biodiversity (Directorate-General for Agriculture and Rural Development, n.d.). The data sources of the agri-food portal include Member States notifications through the information system for agricultural markets (ISAMM) and Eurostat. Additionally, an evaluation of the impact of the CAP on habitats, landscapes, and biodiversity was published on behalf of the Commission in 2019 (Alliance Environnement, 2019). The new

CAP, which is due to start in 2023, is also intended to reinforce contributions to the goals of the EU's biodiversity strategy for 2030.

European Environment Agency (EEA)

The EEA aims to deliver timely, targeted, relevant and reliable data to inform environmental policies in Europe. As such, it supports the European Commission in collecting and reviewing the data submitted by EU Member States to report towards the "State of Nature in the EU" report. Such data are subsequently used to assess the conservation status of Europe's environment. It not only evaluates how EU nature legislation has fared in meeting its biodiversity objectives, but it also provides good quality data to inform future decisions in relation to EU nature policy and legislation. Data management, analysis and assessment are not centralised within the EEA, but carried out by national monitoring centres and other bodies in a European Information and Observation Network (Eionet).

In addition, the EEA hosts the European Biodiversity Data Centre, the Biodiversity Information System for Europe (BISE) and the European Nature Information System (EUNIS), providing information on protected areas, habitat types and species. The EUNIS habitat classification provides standardised names and descriptions of European natural habitats, which is critical for countries' joint efforts on biodiversity.

Directorate-General Research & Innovation (DG RTD)

DG-RTD is responsible for the development and implementation of EU research and innovation policies. It manages the European Framework Programmes that support research and innovation. Since it coordinates the European research activities in its Member States, DG RTD is not a data user as such - rather, the projects funded under its Framework Programmes produce data. DG RTD manages data according to the FAIR principles (Findable, Accessible, Interoperable, Re-usable).

European Topical Centre on Biological Diversity (ETC/BD)

The ETC/BD is one of 6 international consortia of scientific institutions collaborating with the European Environment Agency (EEA) through a framework partnership agreement which generally lasts 3-5 years. The ETC/BD collaborates and liaises with a wide range of biodiversity reference centres, thus acting as a link between local and regional data providers. They further assist the EEA in building capacity in reporting on Europe's environment, amongst others by working closely with the European Information and Observation Network (Eionet) and providing scientific and technical support to EU Member States.

Key biodiversity data providers in Europe

European Information and Observation Network (Eionet)

Eionet represents a partnership network of the EEA and its members. Eionet has seven European Topic Centres (ETCs) focused on specific environmental topics. The EEA coordinates Eionet's activities together with National Focal Points (NFPs), who are responsible for coordinating networks of National Reference Centres (NRCs).

NFPs are very diverse in their functioning and range from environment agencies, environment ministries, centralised national administrations, to federal systems. NFPs are tasked to maintain and develop the national network and facilitate and coordinate contacts, requests and deliveries at national and EU level.

NRCs gather experts from national institutions and other bodies involved in environmental information. NRCs are located in organisations which are regular collectors or suppliers of environmental data at the national level and/or possess relevant knowledge regarding various environmental issues, monitoring or modelling. Within the Eionet, data are shared through the Eionet Portal which hosts both publicly accessible information and information only accessible by logged in users.

Eurostat

Eurostat provides a range of statistics, accounts and indicators on the state of the environment and the drivers, pressures and impacts of societies on the environment in Europe. Eurostat statistics support policies about climate change, the circular economy, sustainable development, biodiversity and natural capital, among others. Eurostat also re-disseminates relevant data by e.g., the European Environmental Agency and the Joint Research Centre. Eurostat uses biodiversity data collected by other organisations, analyses them and prepares them for sustainable development indicators; resource efficiency indicators; and the European Commission's agri-environmental indicators.

Joint Research Centre (JRC)

The Joint Research Centre (JRC) is a research-based, policy support organisation that belongs to the European Commission. As a service of the European Commission, the JRC provides scientific and technical advice on the conception, development, implementation and monitoring of EU policies. In 2020, the European Commission launched the European Knowledge Centre for Biodiversity under the leadership of the JRC. The Knowledge Centre will help to monitor the implementation of the EU Biodiversity Strategy for 2030.

European Partnership on Biodiversity

Starting officially on October 1st, 2021, the European Partnership on biodiversity will implement a programme of activities organised in four Working Areas to help ensure that the EU reaches the 2030 biodiversity strategy's targets and goals (Le Roux & Eggermont, 2020). It thus first and foremost aims to improve monitoring of biodiversity and ecosystem services across Europe and will to this end establish overarching and harmonized biodiversity monitoring schemes across Europe. The Partnership will promote the collaboration between national, local and European biodiversity policy makers and increase synergies between existing biodiversity monitoring initiatives. The Partnership builds on previous initiatives and results, such as the BiodivERsA network and Mapping and Assessment of Ecosystem Services (MAES). Key collaborators include the Joint Research Centre (JRC), the Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services (IPBES), the European Environmental Agency (EEA) and its European Environment Information and Observation Network (Eionet).

GEO BON

GEO BON is a part of GEO, The Group on Earth Observations. Within the GEO family, GEO BON (GEO Biodiversity Observation Network) represents biodiversity, one of GEO's nine Societal-Benefit-Areas. GEO BON's mission is to improve the acquisition, coordination and delivery of biodiversity observations and related services to users including decision makers and the scientific community. Their vision is to create a global biodiversity observation network that contributes to effective management policies for the world's biodiversity and ecosystem services. GEO BON has developed into an internationally recognised organisation with 800 members registered on the online platform from over 560 institutions and 90 countries.

GEO BON is building up a pathway to link biodiversity data and metadata to GEOSS, the Global Earth Observation System of Systems. GEOSS will provide decision-support tools to a wide variety of users. As with the Internet, GEOSS will be a global and flexible network of content providers allowing decision makers to access a wide range of information at their desk.

GEO BON works through a network of regional, national and thematic BONs which are recipients of the outputs of the EBV Working Groups (e.g. EBV monitoring frameworks and tools) but also contributors via the development and contribution of useful tools for EBV generation and application at national, regional and thematic scales. GEO BON is governed by a Steering Committee which meets annually. The contributors to GEO BON consist mostly of national governmental institutions (Members of GEO), intergovernmental and non-governmental organisations, and academic institutions. These contributors collaborate on a voluntary

basis to advance the development and dissemination of observations, data, information, analyses and decision-support services on biodiversity.

Relevant previous projects

EUMON

A number of projects set the basis for EuropaBON's work. The EU-wide monitoring methods and systems of surveillance for species and habitats of Community interest (EUMON) project (Grant agreement number: 6463) ran from 2004-2008. It aimed to create a EU framework for standardizing, focusing and coordinating existing biodiversity monitoring programs in Europe. The EUMON project compared existing methods and monitoring schemes of key habitats and species, and provided recommendations on how new and successful monitoring programs could be established based on this. The project further developed three internet based support tools and published a best practice manual for monitoring species and habitats of community interests (Framstad, 2008).

EU BON

Four years after EUMON's completion, the Building the European Biodiversity Observation Network (EU BON) project was funded by the European Union's Seventh Programme for research, technological development and demonstration (Grant agreement number: 308454) in 2012-2017. Its main objective was to build a substantial part of the Group on Earth Observation's Biodiversity Observation Network (GEO BON) by delivering near-real-time relevant data – both from on-ground observation and remote sensing – to the various stakeholders and end users ranging from local to global levels. EU BON also included a series of stakeholder roundtables in which the views of stakeholders were elicited. Key findings included the greater need for visual and easy-to-use data tools for policy-makers (e.g. through showcases highlighting the workflow from data mobilization into the desired product), the general lack of a framework for harmonized biodiversity monitoring across Europe, and the importance of long-term biodiversity data for reporting on the progress, state and trends of biodiversity (Vohland et al., 2016).

Key non-governmental and intergovernmental organisations working on biodiversity

BirdLife International

BirdLife International is the globally leading non-governmental organisation (NGO) for the protection of birds. BirdLife partners, volunteers, members, supporters, and staff collect data on the condition of birds and their habitats, which are then consolidated and analysed by BirdLife scientists in a central office in Cambridge, United Kingdom. Finally, some of these data are made available in BirdLife's data platform. The BirdLife Partnership has 6 Regional Coordination Offices throughout the world and a Global Office based in Cambridge, UK. BirdLife works as a unique partnership composed of more than 100 regional independent NGOs. For example, the Royal Society for the Protection of Birds (RSPB) is the UK Partner organisation of BirdLife International.

UN Environment Programme World Conservation Monitoring Centre (UNEP-WCMC)

UNEP-WCMC is a collaboration between the World Conservation Monitoring Centre, a UK-based charity, and the United Nations Environment Program (UNEP). UNEP-WCMC work at the science-policy interface by delivering and developing capacity on biodiversity information systems addressing data access, data management and data processing. In addition to identifying, curating and collating data sources, they are the hosts of a number of key global data products, such as protected Planet's World Database on Protected Areas (WDPA) and the Integrated Biodiversity Assessment Tool (IBAT). Data workflows are managed on an individual project- or tool-specific basis.

Convention on Biological Diversity (CBD)

The Convention on Biological Diversity (CBD) is the international legal instrument for the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources. It has been ratified by 196 nations. The CBD's governing body is the Conference of the Parties (COP) who meets every two years to review progress, set priorities and commit to work plans. Under the CBD, the 196 member states have to publish their National Biodiversity Strategies and Action Plans (NBSAPs). The International Union for Conservation of Nature (IUCN) and its Regional and Country Offices play a key role in assisting countries in developing and updating their NBSAPs.

Additionally, the Global Biodiversity Outlook is the flagship publication of the CBD. This periodic report summarizes the latest data on the status and trends of biodiversity globally and tracks progress towards the Aichi Biodiversity Targets. The report draws on findings from countries NBSAPSs and the IPBES Global Assessment on Biodiversity and Ecosystem Services.

Appendix 6: Raw data from survey responses

Country 1 (Czech Republic)

1. How are biodiversity monitoring data currently used for national and local policy making in your country?

A Current biodiversity monitoring scheme (and frequency)	B Relevant policy or management action at national or local level	C Relevant indicator & spatial resolution	D How exactly does this data lead to action (decision making, planning, management)? Please describe	E Weblink URL to monitoring scheme
Habitat Mapping (permanent)	*Art 17 Hab Directive / national biodiversity strategy*	*Area and coverage of natural habitats*	*Article 17 reporting, national environmental yearbook, indicators of structural funds, on local level: management plans of protected areas, authorized assessment*	https://portal.nature.cz/publik_syst/ctihtmlpage.php?what=1035
Habitat Directive Species Monitoring (permanent)	*Art 17 Hab Directive / national biodiversity strategy*	*Distribution and population trends of HD species)*	*Article 17 reporting, national environmental yearbook, indicators of structural funds, on local level: management plans of protected areas, authorized assessment*	https://portal.nature.cz/nd/x_mod_sez_evd.php?druhy=0
Annex I BirDir Bird Species Monitoring (permanent)	*Art 12 Bird Directive / national biodiversity strategy*	*Distribution and population trends of BD1 species)*	*Article 12 reporting, on local level: management plans of protected areas, authorized assessment*	https://portal.nature.cz/publik_syst/ctihtmlpage.php?what=6184&X=X
Surveillance of target species in SPAs *(permanent)*	*Art 12 Bird Directive / national biodiversity strategy*	Population trends in SPAs	*Article 12 reporting, on local level: management plans of protected areas, authorized assessment*	https://priroda.nature.cz/index.php/priroda/issue/view/5
Butterfly Monitoring Scheme (transect monitoring)	*Art 17 Hab Directive / national biodiversity strategy*	Population trend of butterflies	*Article 17 reporting, on local level: management plans of protected areas, authorized assessment*	https://priroda.nature.cz/index.php/priroda/article/view/14

(permanent)				
Line Bird Species Counts (LSD) *(permanent)*		Population trends of birds	Strategic assessment of conservation of birds, agricultural indicators	https://www.birdlife.cz/co-delame/vyzkum-a-ochrana-ptaku/vyzkum-ptaku/lsd/
International Waterbird Census - IWC		Population trends of birds	Strategic assessment of conservation of birds	http://www.waterbirdmonitoring.cz/monitorovaci-programy/mezinarodni-scitani-vodnich-ptaku/
Monitoring of non-intervention forests		Structural changes of non-intervention forest ecosystem	Selection and assessment of non-intervention sites	https://aopkcr.maps.arcgis.com/apps/MapJournal/index.html?appid=acdb76ffe3ca431aa885f88423a74d17
Water monitoring under Water Framework Directive (monitoring of macrophyta, phytobenthos, phytoplankton, macrozoobenthos, fish)		Status of water bodies	Hydrological policy	https://www.mzp.cz/cz/ramcovy_program_monitoringu
Phenological monitoring				https://www.fenofaze.cz/cz/

13. Please expand your answer given in Table 1 by providing one or several concrete examples: How are biodiversity data used to identify biodiversity problems and trigger policy formulation in your country (figure 1, parts 1-2)?

The data from the habitat directive surveillance (Habitat Mapping and Species Monitoring) are regularly assessed in the reporting procedure under Article 17 of HD. The results - conservation statuses -are one of the indicators for structural funds, therefore, successful projects should aim on improving of the conservation status.
The data of habitat mapping are universal background information for assessment of the status of SACs (in the scope ouf SDF update) and of the nationally protected sites, for their management plans.

14. Please expand your answer given in Table 1 by providing one or several concrete examples: How have biodiversity data informed national and local action in your country (e.g., establishment of new protected areas, triggering land use change, more sustainable forest management) (figure 1, parts 3-4)?

Results of habitat and species monitoring and mapping, are publicly available and used as a standard background for authorized assessment of SACs and for administration (management planning and action) in protected sites, too.

15. Please expand your answer given in Table 1 by providing one or several concrete examples: Does your country integrate biodiversity data in models and scenarios, e.g. modelling distribution of habitat suitability, future trends or the consequences of interventions (figure 1, parts 5-6)?

The habitat data are used in modelling of habitat suitability and modelling distribution in particular species (e.g. large carnivors, other protected species (in the scope of research projects, not as official task)

16. Please provide one or several concrete examples: If biodiversity data is currently not (sufficiently) used for policymaking or for informing action in your country, what would be needed for this to happen?

BD data are used in wide spectrum of policy issues, on central, regional and local level. Wider and more frequent use is dependent on PR & disseminating activities (workshops, seminars)

Survey respondent 2 (North Macedonia)

1. How are biodiversity monitoring data currently used for national and local policy making in your country?

A Current biodiversity monitoring scheme (and frequency)	B Relevant policy or management action at national or local level	C Relevant indicator & spatial resolution	D How exactly does this data lead to action (decision making, planning, management)? Please describe	E Weblink URL to monitoring scheme
Monitoring of trends in number and surface of protected areas by category	*Law on Nature Protection, National Biodiversity Strategy and Action Plan (2018-2023) and National Strategy for Nature Protection with an Action Plan (2017-2027, Spatial Plan of the Republic of North Macedonia*	*Number and surface of protected areas by category*	*The indicator is a very useful tool for monitoring the implementation of Aichi objectives of CBD, as well the objectives, measures and actions for conservation and protection of biodiversity according to National Biodiversity Strategy and Action Plan (2018-2023) and National Strategy for Nature Protection with an Action Plan (2017-2027). The indicator can be used to monitor progress in implementing the EU Habitats and Birds Directive and other obligations towards international conventions for nature conservation (CBD, Bern, CITES, Bonn, YHECKO, Ramsar, etc. Data on protected areas are annually reported to the EEA, CDDA, as well.)*	*https://cdr.eionet.europa.eu/mk/eea/cdda1/envybuung/* *https://www.moepp.gov.mk/wp-content/uploads/2014/10/0301_Infografici_2020.pdf*
Monitoring of trends in surface of identified potential Natura 2000 areas	*Law on Nature Protection provides a legal basis for the establishment of Natura 2000 network.* *National targets, measures and activities for identification of Natura 2000 are included in the Biodiversity Strategy*	*Monitoring the trends in surface and number of identified potential Natura 2000 areas in the overall territory of the country.* *At the national level process of identification for eligible areas for Natura 2000*	*Data is sent to EEA .*	*https://www.moepp.gov.mk/wp-content/uploads/2014/10/0301_Infografici_2020.pdf*

	and Action Plan (2018-2023) and National Strategy for Nature Protection with Action Plan (2017-2027	*started in 2016. Positive trend in surface of identified potential Natura 2000 areas would be expected in the coming years*		
Monitoring of Balkan lynx population trend in the Republic of North Macedonia	*Low on Nature Protection, Biodiversity Strategy and Action Plan (2018-2023), National Strategy for Nature Protection with Action Plan (2017-2027), Balkan Lynx Recover Programme (2016-2019), International agreements for nature protection and species conservation.*	*This indicator provides measure of the success of the conservation efforts undertaken in regards to recovery of the Balkan lynx population in North Macedonia. The monitoring program is implemented through the NGO - Macedonian Ecological Society in cooperation with national institutions.*	*Data collected during 10-year monitoring programme within Balkan Lynx Recovery Programme indicate a positive trend of Balkan lynx population at least in Mavrovo NP and its adjacent areas, which means that population started to recover. The conservation efforts should continue in the next decades in order to maintain positive trend of the population that will enable spreading of the population in new areas in North Macedonia and broader, as well as downgrading the red list status of the Balkan lynx from CR to EN. The positive trend is a result of increased conservation efforts in the country, regular monitoring of the population and raised awareness among the population. Positive trend or steady state can be expected in the next few decades.*	*Reliable source of data are published in scientific articles for Balkan lynx, project reports and databases, mainly generated within the project Balkan Lynx Recover Programme in the period 2006-2019 https://www.cbd.int/reports/search/?country=mk*
Monitoring of National Griffon vulture population trends	*Low on Nature Protection, Biodiversity Strategy and Action Plan (2018-2023),*	*The indicator is used to assess the population viability of the national Griffon*	*The presence of this species serves as a fairly good indicator for the overall welfare of the environment in terms of: viable population of wild megafauna, presence of extensive livestock husbandry, healthy agricultural practices, low*	*Urgent Actions to Strengthen the Balkan Population of the Egyptian Vulture and Secure Its*

	National Strategy for Nature Protection with Action Plan (2017-2027), Urgent Actions to Strengthen the Balkan Population of the Egyptian Vulture and Secure Its Flyway" (LIFE16 NAT/BG/000874)	*vulture population.The monitoring program is implemented through the NGO - Macedonian Ecological Society in cooperation with national institutions*.	*impact of agricultural and other types of dangerous chemicals, level of disturbance etc. In addition, it is also possible to monitor the effectiveness of the conservation measures that are being implemented*	*Flyway" (LIFE16 NAT/BG/000874): http://www.lifeneophron.eu/#a-resultsof-the-2019-balkan-population-monitoring-the-last-stronghold-holds-strong*
Monitoring of National Egyptian vulture population trends	*Low on Nature Protection, Biodiversity Strategy and Action Plan (2018-2023), National Strategy for Nature Protection with Action Plan (2017-2027)*	*The indicator should be used to assess the population viability of the national Egyptian vulture population. The presence of this species serves as a fairly good indicator for the overall welfare of the environment in terms of: viable population of wild megafauna, presence of extensive livestock husbandry, healthy agricultural practices, low impact of agricultural and*	*The presence of this species serves as a fairly good indicator for the overall welfare of the environment in terms of: viable population of wild megafauna, presence of extensive livestock husbandry, healthy agricultural practices, low impact of agricultural and other types of dangerous chemicals, level of disturbance etc*	*The most reliable sources are private or published datasets of territory monitoring studies*

		other types of dangerous chemicals, level of disturbance etc. In addition, it is also possible to monitor the effectiveness of the conservation measures that are being implemented. The monitoring program is implemented through the NGO - Macedonian Ecological Society in cooperation with national institutions.		
Monitoring of White Stork population size and breeding parameters	*Low on Nature Protection, Biodiversity Strategy and Action Plan (2018-2023), National Strategy for Nature Protection with Action Plan (2017-2027)*	*This indicator is used in order to follow the distribution and population size of the White stork Ciconia ciconia in different regions of North Macedonia, and on country-wide scale. The monitoring program is implemented through the NGO -*		*National census was performed in 1956 and 2015. Regional censuses were performed in 1988 (Skopje region, 2002 and 2012 (Pelagonia region) and Southeastern parts of North Macedonia (2010).*

		Macedonian Ecological Society in cooperation with national institutions.		
National amphibian population trends	*Low on Nature Protection, Biodiversity Strategy and Action Plan (2018-2023), National Strategy for Nature Protection with Action Plan (2017-2027*	*This indicator should be used to assess population viability of national amphibian populations. This can in turn be the result of effective governance and management of natural habitats particularly in protected areas, or effectiveness of conservation efforts.* *The monitoring program is implemented through the NGO - Macedonian Ecological Society in cooperation with national institutions*		*The most reliable sources are private or published datasets of capture-recapture studies.*
Monitoring the National reptile population trends	*Low on Nature Protection, Biodiversity Strategy*	*The indicator should be used to assess population*		*The most reliable sources are private or published datasets of*

	and Action Plan (2018-2023), National Strategy for Nature Protection with Action Plan (2017-2027	*viability of national reptile populations. The monitoring program is implemented through the NGO - Macedonian Ecological Society in cooperation with national institutions*		*capture-recapture studies.*

1. Please expand your answer given in Table 1 by providing one or several concrete examples: How are biodiversity data used to identify biodiversity problems and trigger policy formulation in your country (figure 1, parts 1-2)?

Monitoring of nature as required tool for determination and monitoring of the state of the biodiversity is described in the Law on Nature Protection. According to the Law, Ministry of Environment and Physical Planning (MoEPP) is responsible entity for organization of the monitoring of the nature status and undertaking of appropriate measures for its protection and preservation. However, besides MoEPP, monitoring of the state of nature and its components invovles other institutions and organizations, protected areas management bodies, scientific institutions (Institute of Biology - Faculty of Natural Sciences and Mathematics, Ss. Cyril and Methodius University, Skopje, Hydrobiological Institute, Museum of Natural History of the Republic of North Macedonia), and conservation NGOs such as Macedonian Ecological Society, BIOECO, etc.
A Biodiversity Monitoring System in the Republic of North Macedonia is not in place and regular multi-year monitoring is only implemented for some select habitats and species due to lack of institutional, human and financial resources.
Monitoring activities are implemented throughout separate projects with international funding, apply only to certain habitats and species (Monitoring of Blakan Lynx, monitoring od Egyptian Vulture etc.) and usually during the project life span. There is no integrated national monitoring system established in the country.
However, in these past 2 years, the activities related to monitoring of species and habitats from the EU Directves for habitats and birds related have been intensified, and draft protocols for monitoring of 20 habitats, 20 plant and animal species and 20 birds with a conservation assessment have been prepared. A manual for monitoring selected species and habitats has been prepared at the national level and is recommended for use by various stakeholders.
However,it is important to note that the country is in the early stages of establishment of functional, integrated and effective monitoring system and responsible institutions are constantly making efforts to overcome the current obstacles and improve the conditions.

2. Please expand your answer given in Table 1 by providing one or several concrete examples: How have biodiversity data informed national and local action in your country (e.g. establishment of new protected areas, triggering land use change, more sustainable forest management) (figure 1, parts 3-4)?

Due to unestablished biodiversity information system on national level and different and unstandardized format of data storage, data processing and analysis has been identified as one of obstacles in most of the institutions dealing with biodiversity information. In most of the cases authorities rely on the private expert data and data from scientific institutions which is insufficient for developing indicators or using statistical approach for biodiversity analysis. Thus, even collected data is hardly usable for reporting purposes and policy making.

3. Please expand your answer given in Table 1 by providing one or several concrete examples: Does your country integrate biodiversity data in models and scenarios, e.g. modelling distribution of habitat suitability, future trends or the consequences of interventions (figure 1, parts 5-6)?

Due to lack of institutional, human and financial resources biodiversity data on country level is not properly used and is mainly used in some expert studies and projects.

4. Please provide one or several concrete examples: If biodiversity data is currently not (sufficiently) used for policymaking or for informing action in your country, what would be needed for this to happen?

Establishment of functional, effective and integrated monitoring system on national level;
Strengthening and enhancing capacities, institutional, human and financial;
Regular collection of biodiversity data in systematic way;
Establishment and maintaining functional Biodiversity Information System;
Increasing financial and expert support;
Conduct regular training to develop the capacity of civil servants involved in biodiversity conservation and nature protection activities.

Survey respondent 3 (Portugal)

1. How are biodiversity monitoring data currently used for national and local policy making in your country?

A Current biodiversity monitoring scheme (and frequency)	B Relevant policy or management action at national or local level	C Relevant indicator & spatial resolution	D How exactly does this data lead to action (decision making, planning, management)? Please describe	E Weblink URL to monitoring scheme
National level: Several continual (Annual) schemes of bird monitoring: Storks; passeriforms; aquatic colonial birds; constant effort ringing stations	*Art. 12 Birds Directive / national biodiversity strategy / Ramsar sites*	*count*	*Data is sent to the EU for international reporting. Nationally, negative trends trigger restoration action of e.g. Ramsar wetland sites and species specific action programmes*	https://geocatalogo.icnf.pt/catalogo.html
E.g. Monitoring the impact of air pollution on ecosystems	*Air quality policy, reporting under Art. 9 of the National Emissions Ceiling directive*	*Ozone foliar damage to trees and crops (200 sites in the country)*	*Data is sent to the EU for international reporting. The data is used for monitoring the health of forests.*	
Several schemes on IAS at species level (cortaderia,; euchornia; procambarus) carried out with academia and ong	*Management of natural areas, rivers and forests; EU regulation on invasive alien species*	*Monitoring programme based on a network of voluntary observations of invasive alien species and targeted species monitoring in areas under high risk.*	*Data is used for national and regional programmes that target the removal of invasive alien species (planning of resources, actions for removing IAS)*	
Bird ringing	*Art. 12 Birds Directive*	Count, coordinated, and other parameters	Ringing database	http://www2.icnf.pt/portal/pn/biodiversidade/ei/cempa/cna/

				cna-euring
constant effort ringing stations	*Art. 12 Birds Directive*	Count, coordinated, and other parameters	Ringing database	http://www2.icnf.pt/portal/pn/biodiversidade/ei/cempa/cna/peec
National level: Monitoring Programme of Cave-dwelling Bats (annual)	*Habitats Directive / national biodiversity strategy / EUROBATS / EU Bats Action Plan / UICN / EIA*	*Count / abundance / point resolution*	*Data is sent by international reporting. Raw data are used for EIA.*	https://geocatalogo.icnf.pt/catalogo.html
Census of rabit in areas of Imperial eagle	*Habitats Directive / national biodiversity strategy*	*Count / abundance / point resolution*	Data is used on reports	
Iberian Linx	*Habitats Directive / national biodiversity strategy*	Ocurrence	Data is used on reports	
Wolf Census	*Habitats Directive / national biodiversity strategy*	Ocurrence	Data is used on reports	
Protected Habitats mapping	*Habitats Directive / national biodiversity strategy*	Mapping, ocurrence	Data is used on management	

2. Please expand your answer given in Table 1 by providing one or several concrete examples: How are biodiversity data used to identify biodiversity problems and trigger policy formulation in your country (figure 1, parts 1-2)?

Data is used for reporting under Habitats and Bird directives, along with Bern and Bonn conventions. It is also used to assess projects in course (eg Linx re-introduction). Data is made available to external sources, either at request or by publishing at ICNF site. ICNF is also publishing data series by GBIF.
National monitoring periodical schemes are still very focused on birds. There are punctual efforts (not periodical) of data collection, namely by census, atlas and/or redbook revisions. These provide information of that moment.
There are local schemes, at protected areas level, that provide data for the area management.
There is a lack of a continuous scheme at national level. This has been identified and efforts are being made to implement it.

3. Please expand your answer given in Table 1 by providing one or several concrete examples: How have biodiversity data informed national and local action in your country (e.g. establishment of new protected areas, triggering land use change, more sustainable forest management) (figure 1, parts 3-4)?

Data is used on the development of species action plans and SAC management plans. It is also used on EIA of projects that could affect classified areas.

4. Please expand your answer given in Table 1 by providing one or several concrete examples: Does your country integrate biodiversity data in models and scenarios, e.g. modelling distribution of habitat suitability, future trends or the consequences of interventions (figure 1, parts 5-6)?

The data is made available to academia and research centers, and can be used on models.

5. Please provide one or several concrete examples: If biodiversity data is currently not (sufficiently) used for policymaking or for informing action in your country, what would be needed for this to happen?

As said, being used on action plans for species and management plans for classified areas, it is somewhat used in policymaking. Other exemple, the wolf data was used to help drawing the 2016 revision of the law and will be used to assess this revision.
Nevertheless the lack of continuous data series, long term, makes it difficult to provide better information for policymaking.
A need for more ample schemes (both in terms of area as species/values) that will stand in the future, providing comparable long term data series, is identified.

Survey respondent 4 (EBPD)

1. How are biodiversity monitoring data currently used for national and local policy making in your country?

A **Current biodiversity monitoring scheme (and frequency)**	B **Relevant policy or management action at national or EU level**	C **Relevant indicator & spatial resolution**	D **How exactly does this data lead to action (decision making, planning, management)? Please describe**	E **Weblink URL to monitoring scheme**
E.g. National breeding bird survey (annually)	*Art. 12 Birds Directive / national biodiversity strategy / Ramsar sites*	*Number of breeding pairs of each bird species per km² (or per site or per district)*	*Data is sent to the EU for international reporting. Nationally, negative trends trigger restoration action of e.g. Ramsar wetland sites and species specific action programmes*	
E.g. Monitoring the impact of air pollution on ecosystems	*Air quality policy, reporting under Art. 9 of the National Emissions Ceiling directive*	*Ozone foliar damage to trees and crops (200 sites in the country)*	*Data is sent to the EU for international reporting. The data is used for monitoring the health of forests.*	
E.g. Monitoring of invasive alien species	*Management of natural areas, rivers and forests; EU regulation on invasive alien species*	*Monitoring programme based on a network of voluntary observations of invasive alien species and targeted species monitoring in areas under high risk.*	*Data is used for national and regional programmes that target the removal of invasive alien species (planning of resources, actions for removing IAS)*	
Habitats	Habitat Directive; IUCN Assessment of threatened habitats;			

	MAES process and ecosystem accounting (extent, condition)			
Terrestrial and marine protected areas (incl. Natura2000)	Habitat Directive			
Pollinators, butterflies and other insects	Common Agriculture Policy CAP; EU Pollinators Initiative			
Invasive alien species	European Strategy on Invasive Alien Species			
Soil biodiversity	EU Soil Strategy; CAP; LUCAS			
Offshore marine biodiversity and/or marine megafauna				
Wildlife diseases and bd facets linked to health issues				
Transversal monitoring activities	EU Biodiversity Strategy			

2. Please expand your answer given in Table 1 by providing one or several concrete examples: How are biodiversity data used to identify biodiversity problems and trigger policy formulation in your organisation/directorate (figure 1, parts 1-2)?

The biodiversity facets in Table 1 were prioritized by partners for the first two years of the partnership. Some monitoring is ongoing already (e.g. with habitats and protected areas as well as pollinators), but most of those BD facets are still poorly monitored and support & harmonization is needed. EU level policy processes are important rationale for the selection of prioritized BD facets.

Note: It is important to interpret the 'biodiversity facets' (i.e. monitoring schemes listed) here correctly: these represent the major priorities for Biodiversa+ members for the set up of the network of harmonised monitoring schemes ***at this stage***. But other types of activities or monitoring of other biodiversity facets are also foreseen, and these can cover a broader range of biodiversity aspects. The pre-defined priorities will be further refined (according to scientific & policy priorities) building on outputs from EuropaBON, and a continuous dialogue between the Partnership members and relevant initiatives in particular other Partnerships and Missions, the EC KCBD, research infrastructures, science-policy processes etc. The Partnership will also define the needs for (i) increasing the coverage and representativeness of biodiversity monitoring schemes and (ii) making the link with some ecosystem services (e.g. pollination or health issues) and drivers (including land-use change).

3. Please expand your answer given in Table 1 by providing one or several concrete examples: How have biodiversity data informed action at national or EU level (e.g. establishment of new protected areas, triggering land use change, more sustainable forest management) (figure 1, parts 3-4)?

EU level policy mandate is often important leverage for national authorities (e.g. ministries of the environment), and EU collaboration can progress also national activities (e.g. implementation of directives, and provisioning of data needed).

Note for interpretation of our answers across the questionnary: it's clear the survey is targeting biodiversity monitoring performing organisations, whereas Biodiversa+ is gathering (as full members) ministries, agencies and organisations that fund and steer national/sub-national biodiversity monitoring schemes. Hence, the complementarity between the Partnership & EuropaBON. Good to make this very clear - see also below Q11. Organisations performing biodiversity monitoring activities on the ground will be linked as third parties (with in-kind contributions valorized)!

It is also important to make clear that the biodiversity monitoring component is *only one* aspect of a larger portfolio of activities of Biodiversa+ (even if it constitutes a major part); and that it will be tightly linked to the R&I while informing efficiently the policy arena

4. Please expand your answer given in Table 1 by providing one or several concrete examples: Does your organisation/directorate integrate biodiversity data in models and scenarios, e.g. modelling distribution of habitat suitability, future trends or the consequences of interventions (figure 1, parts 5-6)?

We are not yet aware of such use of current monitoring data at EU level among the partners of Biodiversa+, but certainly there are research groups and some countries involved in modelling.

5. Please provide one or several concrete examples: If biodiversity data is currently not (sufficiently) used for policymaking or for informing action in your organisation/directorate, what would be needed for this to happen?

At the EU level and among the partners of Biodiversa+ (especially MoEs) there is need for harmonized methods and guidance across several BD facets. This might need continuous interaction among researchers, national monitoring communities, and national and EU policy authorities. Open data and common standards for observations are crucial. Direct linkage of bd data and indicators to policy targets and goals must be co-designed by biodiversity and policy experts.

Survey respondent 5 (Denmark)

1. How are biodiversity monitoring data currently used for national and local policy making in your country?

A **Current biodiversity monitoring scheme (and frequency)**	B **Relevant policy or management action at national or local level**	C **Relevant indicator & spatial resolution**	D **How exactly does this data lead to action (decision making, planning, management)? Please describe**	E **Weblink URL to monitoring scheme**
National nature and water monitoring program (NOVANA) focusing on Natura 2000 sites, trigger species for designation, annex IV species and designated habitats covering 82 bird species 60 habitats and about 60 HD species. A national monitoring scheme lay out in detail the frequencies of surveys	Art. 17 reporting according to the Habitats Directive and Art. 12 reporting according to the Birds Directive. The national Natura 2000 management scheme, running in 6 yr planning cycles integrating	Site level and breeding localities. Conservation Status for 60 habitats and 83 species. (2019).	Data is sent to the EU KOMMISSION according to the BHD/HD art. 12 and 17 reporting cycles. Data also feeds in to the national Natura 2000 management scheme, running in 6 yr planning cycles integrating monitoring, basis analysis and management on both local and national level. As part of this system corresponding Natura 2000 site plans are updated and re-published every 6th year. In this ay monitoring data feeds directly in to which management actions are done on the ground.	National nature and water monitoring program (NOVANA, 2017-21): https://www2.mst.dk/Udgiv/publikationer/2017/novana.pdf The next program 2022-2027 is expected to be published later this year.

and data collection. Conducted by Ministry of Environment.	monitoring, basis analysis and management on both local and national level. As part of this system corresponding Natura 2000 site plans are updated and re-published every 6th year.			
National breeding and wintering bird survey (annually since 1975) – covering 133 breeding bird species and 101 wintering bird species. Conducted by DOF BirdLife Danmark and supported financially by the Environmental Protection Agency.	Art. 12 reporting according to the Birds Directive.	Indices and trends for 133 breeding bird species and for 101 wintering species (2021).	Data is sent to the EU KOMMISSION according to the art. 12 reporting cycle and to PECBMS/EEA to be used for the EU biodiversity indicators: All common birds, Farmland birds and Forest birds.	Breeding/wintering bird survey: https://www.dof.dk/images/projekter/punkttaelling/dokumenter/Punkttaellingsrapport_2021_revideret_17052021.pdf PECBMS: https://pecbms.info/
Monitoring the impact of air pollution on ecosystems. Data collected annually for a number of indicators.	Air quality policy, reporting under Art. 9 of the National Emissions Ceiling directive.	A number of chemical compounds given in the NEC directive collected at a network of survey stations across the country in forest, open country, lakes & streams.	Data is sent to the EU every 4th yr for international reporting. The data is used for monitoring the health of forests, open ecosystems, lakes and streams.	Aarhus University: https://dce.au.dk/fileadmin/dce.au.dk/YA_LER_2021.pdf

Monitoring of invasive alien species	EU regulation on invasive alien species no. 1143/2014; Action plan against invasive species (2017)	The invasive species on the EU list of union concern are included in the national monitoring programme (NOVANA). Individual current projects targeting monitoring of invasive species including the monitoring of Invasive crayfish in Denmark, high school students sampling E-DNA for monitoring invasive species in marine and freshwater habitats, monitoring vespa velutina in Danish bee farms, monitoring new alien fish species in Denmark. Also invasive data from Citizen science project Arter.dk is used in management and eradication of	The collected data is used for reporting the distribution of invasive species (art. 24b) and baseline distribution when invasive species are added to the EU list. Monitoring is used in case of early detection and eradication (art.16). Data is also used for national and regional programs that target the removal of invasive alien species (planning of resources, actions for removing IAS).	Action plan against invasive species https://eng.mst.dk/media/191170/04_uk_handlingsplan_invasive-arter_a4.pdf

		invasive species in Denmark		
Mapping and supervision of legally protected habitat types in Denmark	Danish lakes, streams, heaths, bogs, salt marshes, beach swamps, fresh meadows and biological grasslands over a certain size are formally protected by the Nature Conservation Act § 3. The general protection of the habitat types includes approx. 9.4% of Denmark's area comprising around 238,000 individual sites and is thus a very important contribution to ensuring an ecologically functional network of nature.	The § 3 protected areas was protected and mapped in 1992-2007. The § 3 areas also contain a large part of the habitats for the Annex IV species of the Habitats Directive as well as Annex 1 breeding birds, whose breeding and resting areas must not be damaged or destroyed.	According to the Nature Conservation Act, no changes may be made to the condition of the protected habitats. It is the municipalities that, as the authority, must supervise the areas and ensure that the legislation is not violated.	https://naturstyrelsen.dk/publikationer/2009/jun/vejledning-om-naturbeskyttelseslovens-3/
Ecosystem services (MAES)	EU MAES project, EU Biodiversity Strategy, Surveillance of MDG's,	A national study and a local ecosystem service research project have been carried out at local level,	In 2015, a status was prepared for mapping ecosystems, ecosystem services and biodiversity in Denmark. It describes relevant initiatives for mapping the economic value in relation to ecosystem services and biodiversity. The report focuses on 16 ecosystem services	https://dce2.au.dk/pub/SR147.pdf Modelling, mapping and valuing ecosystem services

		where ecosystem services have been mapped and the economic significance calculated.	including utilities, regulatory services and cultural services. The report describes the existing data sources and models that are considered relevant for mapping. In addition, the status of the work in relation to the EU initiative MAES is assessed.	and biodiversity: synergies and trade-offs in land use planning *[unpublished].* Termansen, M, Konrad, M., Levin, G., Hasler, B, Thorsen, BJ, Aslam, U, Bojesen, M, Lundhede, TH, Panduro, TE, Andersen, HE, Strange, N,
Citizen science data collected daily via the national biodiversity portal Arter.dk (species)	.	Arter.dk is a community where citizens can help find, register and determine species. You can also get inspiration for nature experiences and knowledge about Denmark's species richness	Data feeds into e.g. national red lists. Arter.dk supports popular participation in biodiversity data collection, thereby increasing public interest in and knowledge about biodiversity and public support to biodiversity conservation.	https://arter.dk/landing-page

2. Please expand your answer given in Table 1 by providing one or several concrete examples: How are biodiversity data used to identify biodiversity problems and trigger policy formulation in your country (figure 1, parts 1-2)?

Data on the occurrence of invasive species have led to the preparation of a national action plan and targeted efforts with the aim of limiting these IAS.

3. Please expand your answer given in Table 1 by providing one or several concrete examples: How have biodiversity data informed national and local action in your country (e.g. establishment of new protected areas, triggering land use change, more sustainable forest management) (figure 1, parts 3-4)?

Data on the occurrence of marine migratory birds have recently triggered the designation of 6 new marine bird protection areas in Denmark, comprising approx. 1 million ha of new, suitable sea areas for staging migratory birds. Currently the designation is in the final stages of formal political approval.

4. Please expand your answer given in Table 1 by providing one or several concrete examples: Does your country integrate biodiversity data in models and scenarios, e.g. modelling distribution of habitat suitability, future trends or the consequences of interventions (figure 1, parts 5-6)?

In a collaboration between the Ministry of the Environment and researchers, we have used data on the geographical occurrence of a number of different national red listed and nature directive trigger species for a national biodiversity map, which i.a. used as a basis for prioritizing agricultural support for nature conservation on those areas that are particularly rich in biodiversity

5. Please provide one or several concrete examples: If biodiversity data is currently not (sufficiently) used for policymaking or for informing action in your country, what would be needed for this to happen?

1) There is a need for biodiversity data (birds, bats and marine mammals) to be collected, supplemented and used proactively as a basis for planning large infrastructure projects such as energy facilities (wind farms and artificial energy islands), so that conflicts between these facilities and biodiversity protection are minimized. This could be done by, on the basis of data, creating natural zones at sea and / or on land where such facilities are not built. 2) There is a national and European need to lift and operationalize the protection of endangered red-listed species that are not specifically and formally protected by the nature directives. The endangered red-listed species suffer from a lack of formal prioritization both in terms of financial resources and conservation.

Survey respondent 6 (Hungary)

1. How are biodiversity monitoring data currently used for national and local policy making in your country?

A **Current biodiversity monitoring scheme (and frequency)**	B **Relevant policy or management action at national or local level**	C **Relevant indicator & spatial resolution**	D **How exactly does this data lead to action (decision making, planning, management)? Please describe**	E **Weblink URL to monitoring scheme**
E.g. National breeding bird survey (annually)	*Art. 12 Birds Directive / national biodiversity strategy / Ramsar sites*	*Number of breeding pairs of each bird species per km² (or per site or per district)*	*Data is sent to the EU for international reporting. Nationally, negative trends trigger restoration action of e.g. Ramsar wetland sites and species specific action programmes*	
E.g. Monitoring the impact of air pollution on ecosystems	*Air quality policy, reporting under Art. 9 of the National Emissions Ceiling directive*	*Ozone foliar damage to trees and crops (200 sites in the country)*	*Data is sent to the EU for international reporting. The data is used for monitoring the health of forests.*	
E.g. Monitoring of invasive alien species	*Management of natural areas, rivers and forests; EU regulation on invasive alien species*	*Monitoring programme based on a network of voluntary observations of invasive alien species and targeted species monitoring in areas under high risk.*	*Data is used for national and regional programmes that target the removal of invasive alien species (planning of resources, actions for removing IAS)*	
Hungarian Biodiversity Monitoring System(the frequency depends on the monitored taxa, mainly 1-3 years)	EU Natura 2000 reporting system National Biodiversity Strategy	Mainly number of individuals or density	The Ministry of Agriculture (Depatment for Nature Conservation) and the National Park Directorates take part in the implementation of the monitoring system. Part of the surveys are carried out by specialist teams, the others by	in Hungarian: https://termeszetvedelem.hu/mintaveteli-modszerek/

	in the frame of the Convention on Biological Diversity National Law on Nature Conservation Management of protected and endangered species and areas		experts of National Park Directorates in the coordination of Nature Conservation Department of Ministry. The locally surveyed data are used directly at NPDs. The nationwide data evaluation is realized at the Ministry.	
Common Bird Monitoring	Art. 12 Birds Directive reporting	National population trend and population figures	Data is sent to the EU for international reporting.	
Rare and colonially nesting Birds Monitoring	Art. 12 Birds Directive reporting/ national use for site management	Number of breeding pairs of each bird species in the country	Data is sent to the EU for international reporting. Nationally, negative trends trigger restoration action of e.g. Ramsar wetland sites and species specific action programmes	
Monitoring of Waterfowls	Art. 12 Birds Directive reporting/ national use for site management	Number of individuals of each waterbird species in the migration season	Data is sent to the EU for international reporting. Nationally, negative trends trigger restoration action of e.g. Ramsar wetland sites and species specific action programmes	

2. Please expand your answer given in Table 1 by providing one or several concrete examples: How are biodiversity data used to identify biodiversity problems and trigger policy formulation in your country (figure 1, parts 1-2)?

The evaluated data are used mainly to demonstrate the condition of ecosystems / species. In some cases to present trends, which can support the needs of nature conservation actions or restauration of habitats. For example, Greylag Goose (Anser anser) became protected in 1946 when it was recognised that the species had declined seriously. After decades of conservation, the population increased significantly and reached a

favourable status which allowed utilisation again. So the species became huntable again in 2012, but its population is still monitored annually.

3. Please expand your answer given in Table 1 by providing one or several concrete examples: How have biodiversity data informed national and local action in your country (e.g. establishment of new protected areas, triggering land use change, more sustainable forest management) (figure 1, parts 3-4)?

The data are used as background information for planning and contribute to strategic documents such as the Prioritised Action Framework, last approved for 2021-2027.

4. Please expand your answer given in Table 1 by providing one or several concrete examples: Does your country integrate biodiversity data in models and scenarios, e.g. modelling distribution of habitat suitability, future trends or the consequences of interventions (figure 1, parts 5-6)?

not regularly, in some case studies. For example, modelling of home range needs of Saker Falcon (Falco cherrug) helped to establish carrying capacity of Hungary for this species:
https://www.researchgate.net/publication/328783446_Home_Range_Size_and_Habitat_Use_of_Adult_Saker_Falcons_Falco_cherrug_in_the_Breeding_Season_in_Hungary

5. Please provide one or several concrete examples: If biodiversity data is currently not (sufficiently) used for policymaking or for informing action in your country, what would be needed for this to happen?

In order to improve the usage of biodiversity data in policymaking, we are planning a new, better-functioning data information system. In parallel with the development of this system, the budget and capacity for data evaluation /modelling should also be improved..

Survey respondent 7 (Bulgaria)

1. How are biodiversity monitoring data currently used for national and local policy making in your country?

A Current biodiversity monitoring scheme (and frequency)	B Relevant policy or management action at national or local level	C Relevant indicator & spatial resolution	D How exactly does this data lead to action (decision making, planning, management)? Please describe	E Weblink URL to monitoring scheme
National breeding bird survey	*Art. 12 Birds Directive / National Biodiversity Strategy/Species Action Plans*	*Number of breeding pairs of each bird species per 10x10 km² and National assessment*	*Data are sent to the EU for international reporting. Nationally - data are used for management of the protected sites and NATURA2000 sites. Development and implementation of Species Management Plans. Data is used for development and implementation of Environmental Plans for Municipalities in Bulgaria. Data are used for publication by Bulgarian and foreign scientists. Students for Master and PHD thesis use data.*	http://eea.government.bg/bg/bio/nsmbr/osnoven-dokument-na-nsmbr/Spisak_Ptici.pdf - Bird species list; http://eea.government.bg/bg/bio/nsmbr/prakticheskо-rakovodstvo-metodiki-za-monitoring-i-otsenka/ptitsi - Bird monitoring schemes
Mid-winter Waterbird census	*Wetlands International, art.12 Birds Directive/Ramsar convention/ National Biodiversity Strategy/Species Management Plans*	*Number of wintering individuals*	*Data are sent to the EU for international reporting. Nationally - data are used for management of the protected sites and NATURA2000 sites. Development and implementation of Species Management Plans. Also biodiversity data are used for development and implementation of Environmental Plans for Municipalities in Bulgaria . Students for Master and PHD thesis use data.*	http://eea.government.bg/bg/bio/nsmbr/osnoven-dokument-na-nsmbr/Spisak_Ptici.pdf - Bird species list; http://eea.government.bg/bg/bio/nsmbr/prakticheskо-rakovodstvo-metodiki-za-monitoring-i-otsenka/ptitsi - Bird monitoring schemes

Monitoring of migratory birds	*Art.12 Birds Directive/Ramsar convention / National Biodiversity Strategy/Species Management Plans*	*Number of individuals ; Sites mainly on the Black sea coast*	*Data are sent to the EU for international reporting. Nationally - data are used for management of the protected sites and NATURA2000 sites. Development and implementation of Species Action Plans. Also biodiversity data are used for development and implementation of Environmental Plans for Municipalities in Bulgaria) Also biodiversity data are used for development and implementation of Environmental Plans for Municipalities in Bulgaria . Students for Master and PHD thesis use data.*	http://eea.government.bg/bg/bio/nsmbr/osnoven-dokument-na-nsmbr/Spisak_Ptici.pdf - Bird species list; http://eea.government.bg/bg/bio/nsmbr/praktichesko-rakovodstvo-metodiki-za-monitoring-i-otsenka/ptitsi - Bird monitoring schemes
Common bird monitoring scheme	*Art.12 Birds Directive/ National Biodiversity Strategy/Species Sction Plans/*	Number of individuals, Trim Index – tendency, 1x1 km^2	Data are sent to the EU for international reporting. Nationally - data are used for management of the protected sites and NATURA2000 sites. Development and implementation of Species Action Plans. Also biodiversity data are used for development and implementation of Environmental Plans for Municipalities in Bulgaria) Also biodiversity data are used for development and implementation of Environmental Plans for Municipalities in Bulgaria . Students for Master and PHD thesis use data.	http://eea.government.bg/bg/bio/nsmbr/osnoven-dokument-na-nsmbr/Spisak_Ptici.pdf - Bird species list; http://eea.government.bg/bg/bio/nsmbr/praktichesko-rakovodstvo-metodiki-za-monitoring-i-otsenka/ptitsi - Bird monitoring schemes
Monitoring of amphibians and reptiles – 55 species	*Art 17 Habitat Directive 92/43/ National Biodiversity Strategy/Species Action Plans/*	Number of individuals per 1x1 sq.km, 10x10 sq.km. Assessment on biogeographical	Data are sent to the EU for international reporting. Nationally - data are used for management of the protected sites and NATURA2000 sites. Development and implementation of Species Action Plans. Also biodiversity data are used for development	Species list and monitoring sites- http://eea.government.bg/bg/bio/nsmbr/osnoven-dokument-na-

		and National level	and implementation of Environmental Plans for Municipalities in Bulgaria) Also biodiversity data are used for development and implementation of Environmental Plans for Municipalities in Bulgaria . Students for Master and PHD thesis use data.	nsmbr/Spisak_Zemnovodni_i_vlechugi.pdf http://eea.government.bg/bg/bio/nsmbr/prakticheskо-rakovodstvo-metodiki-za-monitoring-i-otsenka/zemnovodni-i-vlechugi - Monitoring scheme and field form.
Monitoring of Vascular plants (200 species), Fungi(14 species) and Mosses (13 species)	*Art 17 Habitat Directive 92/43/ National Biodiversity Strategy/Species Action Plans/*	Number of individuals per Geographical area – population size, Biogeographical and National level	Data are sent to the EU for international reporting. Nationally - data are used for management of the protected sites and NATURA2000 sites. Development and implementation of Species Action Plans. Also biodiversity data are used for development and implementation of Environmental Plans for Municipalities in Bulgaria) Also biodiversity data are used for development and implementation of Environmental Plans for Municipalities in Bulgaria . Students for Master and PHD thesis use data.	Fungi - species and monitoring sites;http://eea.government.bg/bg/bio/nsmbr/osnoven-dokument-na-nsmbr/Spisak_Gabi.pdf ; Monitoring scheme and field form: http://eea.government.bg/bg/bio/nsmbr/prakticheskо-rakovodstvo-metodiki-za-monitoring-i-otsenka/gabi Mosses - species and monitoring sites: http://eea.government.bg/bg/bio/nsmbr/

				osnoven-dokument-na-nsmbr/Spisak_Mahove.pdf . Monitoring scheme and field form: http://eea.government.bg/bg/bio/nsmbr/prakticheskо-rakovodstvo-metodiki-za-monitoring-i-otsenka/mahove - Vascular plants: Species and monitoring sites- http://eea.government.bg/bg/bio/nsmbr/osnoven-dokument-na-nsmbr/Spisak_Visshi_rastenia.pdf -. Monitoring scheme and field form: http://eea.government.bg/bg/bio/nsmbr/prakticheskо-rakovodstvo-metodiki-za-monitoring-i-otsenka/visshi-rasteniya
Monitoring of mammals :	*Art 17 Habitat*	Number of	Data are sent to the EU for international	Mammals - species

for example – *Ursus arctos, Rupicapra rupicapra*, Bats, *Canis lupus, Cervus elaphus*, Spermophillus citellus and etc	*Directive 92/43/ National Biodiversity Strategy/Species Action Plans/*	individuals per monitoring site, 10x10 km^2, Biogeographical level, Mountain and National level	reporting. Nationally - data are used for management of the protected sites and NATURA2000 sites. Development and implementation of Species Action Plans. Also biodiversity data are used for development and implementation of Environmental Plans for Municipalities in Bulgaria) Also biodiversity data are used for development and implementation of Environmental Plans for Municipalities in Bulgaria . Students for Master and PHD thesis use data.	list and monitoring sites http://eea.government.bg/bg/bio/nsmbr/osnoven-dokument-na-nsmbr/Spisak_Bozainitsi_bez_prilepi.pdf ; Monitoring schemes, field forms and Assessment methodology - http://eea.government.bg/bg/bio/nsmbr/prakticheskо-rakovodstvo-metodiki-za-monitoring-i-otsenka/bozaynitsi-bez-prilepi Bats species list - http://eea.government.bg/bg/bio/nsmbr/osnoven-dokument-na-nsmbr/Spisak_Prilepi.pdf ; Monitoring of Bats in caves http://eea.government.bg/bg/bio/nsmbr/prakticheskо-

				rakovodstvo-metodiki-za-monitoring-i-otsenka/Metodika_monitoring_otsenka_peshteroluibivi_prilepi.pdf
Monitoring of marine and freshwater fish	*Art 17 Habitat Directive 92/43/ National Biodiversity Strategy/Species Action Plans/*	Number of individuals per monitoring sites, biogeographical region and Marine Black sea region, National level	Data are sent to the EU for international reporting. Nationally - data are used for management of the protected sites and NATURA2000 sites. Development and implementation of Species Action Plans. Also biodiversity data are used for development and implementation of Environmental Plans for Municipalities in Bulgaria) Also biodiversity data are used for development and implementation of Environmental Plans for Municipalities in Bulgaria . Students for Master and PHD thesis use data.	Species and monitoring sites: http://eea.government.bg/bg/bio/nsmbr/osnoven-dokument-na-nsmbr/Spisak_Ribi.pdf Monitoring schemes, field forms and Assessment methodology - http://eea.government.bg/bg/bio/nsmbr/prakticheskо-rakovodstvo-metodiki-za-monitoring-i-otsenka/ribi
Monitoring of invertebrates – insects, Crustacean, Mollusks and etc	*Art 17 Habitat Directive 92/43/ National Biodiversity Strategy/Species Action Plans/*	Number of individuals per monitoring site, transect, 10x10 km^2, Biogeographicaland National level	Data are sent to the EU for international reporting. Nationally - data are used for management of the protected sites and NATURA2000 sites. Development and implementation of Species Action Plans. Also biodiversity data are used for development and implementation of Environmental Plans for	Invertebrates – species and monitoring sites: http://eea.government.bg/bg/bio/nsmbr/osnoven-dokument-na-

			Municipalities in Bulgaria) Also biodiversity data are used for development and implementation of Environmental Plans for Municipalities in Bulgaria . Students for Master and PHD thesis use data.	nsmbr/Spisak_Bezgrabnachni_zhivotni.pdf ; Monitoring schemes, field forms and Assessment methodology http://eea.government.bg/bg/bio/nsmbr/prakticheskо-rakovodstvo-metodiki-za-monitoring-i-otsenka/bezgrabnachni-zhivotni

2. Please expand your answer given in Table 1 by providing one or several concrete examples: How are biodiversity data used to identify biodiversity problems and trigger policy formulation in your country (figure 1, parts 1-2)?

By monitoring of the species, when we identify any threat to the species or its habitat, all threats or impacts are recorded in the field forms. After an analysis of the collected primary data, and through the assessment methods, we estimate the status of the species on different levels as - national, biogeographical level or at the level of geographical territory (mountain or localities). All data are reported, either through official reports or to inter-ministerial working groups, which decide on the designation of new protected areas, Natura2000 sites or action plans for specific species.

3. Please expand your answer given in Table 1 by providing one or several concrete examples: How have biodiversity data informed national and local action in your country (e.g. establishment of new protected areas, triggering land use change, more sustainable forest management) (figure 1, parts 3-4)?

When we have data with good quality on National level, we published these data as Biodiversity indicators in the National report of the State of Environment. The report is available on ExEA web site.

4. Please expand your answer given in Table 1 by providing one or several concrete examples: Does your country integrate biodiversity data in models and scenarios, e.g. modelling distribution of habitat suitability, future trends or the consequences of interventions (figure 1, parts 5-6)?

In the process of preparation of reports to Nature Directives (Habitat and Birds Directives) for habitats and for widespread species, we use models to determine their distribution. For the reporting 2007-2012 for most of the species, we have models, for habitat suitability on national level.

5. Please provide one or several concrete examples: If biodiversity data is currently not (sufficiently) used for policymaking or for informing action in your country, what would be needed for this to happen?

In our National biodiversity monitoring system we have a lot of species (around 700 species) from all biological groups, which species are key or specific for the ecosystem types and habitats, we need regularly monitoring activities to have enough data for trend estimation – short and long trends. So monitoring activities must be regularly financed.

Survey respondent 8 (Lithuania)

1. How are biodiversity monitoring data currently used for national and local policy making in your country?

A **Current biodiversity monitoring scheme (and frequency)**	B **Relevant policy or management action at national or local level**	C **Relevant indicator & spatial resolution**	D **How exactly does this data lead to action (decision making, planning, management)? Please describe**	E **Weblink URL to monitoring scheme**
Monitoring of habitats of EU importance. Every 4 year, except habitat type 1170 Reefs which is monitored every 3 years.	Art. 17 Habitats Directive / National State Monitoring Programme for 2018-2023	Spatial coverage (changes of the range and habitat area); habitat structure and functions; main	Data is sent to the EU institutions as part of reporting exercise on EU legislation implementation. Nationally, negative trends trigger conservation and restoration actions of e.g. wetland sites.	https://www.e-tar.lt/portal/lt/legalAct/d6fdb4b0c89a11e8bf37fd1541d65f38/asr;

		impacts and threats)		
Monitoring of species of EU importance (except of birds) for the conservation of which it is necessary to designated Natura 2000 sites. Frequency depends on species or taxon: every 3 year (for plant, amphibian, fish and bat species and majority of insect species); every 5 year (for some beetle and dragonfly species); every 6 year (for mollusca species and otter)	Art. 17 Habitats Directive / National State Monitoring Programme for 2018-2023	Species range changes, species population size, species habitat size and quality, main impacts and threats, population part in Natura 2000 network.	Data is sent to the EU institutions as part of reporting exercise on EU legislation implementation. Nationally, negative trends trigger species specific action programmes and designation of protected areas.	https://www.e-tar.lt/portal/lt/legalAct/d6fdb4b0c89a11e8bf37fd1541d65f38/asr; https://vstt.lrv.lt/lt/teisine-informacija/teises-aktai/direktoriaus-isakymai
Monitoring of bird species of EU importance for the conservation of which it is necessary to designated Natura 2000 sites. Frequency depends on species: annually, every 2, 3 or 5 year.	Art. 12 Birds Directive / National State Monitoring Programme for 2018-2023	For breeding species: population size, population change, breeding distribution area, changes in breeding distribution area, main impacts and threats, population part in Natura 2000 network. For wintering marine species: abundance and	Data is sent to the EU institutions as part of reporting exercise on EU legislation implementation. Nationally, negative trends trigger species specific action programmes or designation of protected areas.	https://www.e-tar.lt/portal/lt/legalAct/d6fdb4b0c89a11e8bf37fd1541d65f38/asr; https://vstt.lrv.lt/lt/teisine-informacija/teises-aktai/direktoriaus-isakymai

		distribution parameters.		
Monitoring of dead waterfowl found on the sea coast (every 2 year).	National State Monitoring Programme for 2018-2023	Species composition, abundance (density), proportion of oil-contaminated birds in different sections of the coast.	Data is used to develop oil spill prevention and response plans.	https://www.e-tar.lt/portal/lt/legalAct/d6fdb4b0c89a11e8bf37fd1541d65f38/asr
Monitoring of breeding Great Cormorant (annually).	National State Monitoring Programme for 2018-2023	Abundance.	Data is used for assessment of damage done to old-growth forest or aquaculture.	https://www.e-tar.lt/portal/lt/legalAct/d6fdb4b0c89a11e8bf37fd1541d65f38/asr
Monitoring of other species of EU importance (for which is not necessary to designate Natura 2000 sites – wolves, beavers and European bison). Annually.	National State Monitoring Programme for 2018-2023	Abundance and distribution parameters.	Data is used for assessment of damage done to livestock and agriculture.	https://www.e-tar.lt/portal/lt/legalAct/d6fdb4b0c89a11e8bf37fd1541d65f38/asr
Monitoring of Black-tailed Godwit, Redshank and Lapwing (annually).	National State Monitoring Programme for 2018-2023	Range change, species population size, species habitat size and quality, main impacts and threats.	Nationally, negative trends trigger species specific action programmes.	https://www.e-tar.lt/portal/lt/legalAct/d6fdb4b0c89a11e8bf37fd1541d65f38/asr
Monitoring of Curlew (every 2 year).	National State Monitoring Programme for	Range change, species population size,	Nationally, negative trends trigger species specific action programmes.	https://www.e-tar.lt/portal/lt/legalAct/d6fdb4b0c89a11e

	2018-2023	species habitat size and quality, main impacts and threats.		8bf37fd1541d65f38/asr
Monitoring of Habitats Directive Annex IV species which are listed in the list of protected animals, plants and fungi species of the Republic of Lithuania (every 3 year).	Art. 17 Habitats Directive; National State Monitoring Programme for 2018-2023; Law on protected animal, plant and fungi species.	Range change, species population size, species habitat size and quality, main impacts and threats.	Data is sent to the EU institutions as part of reporting exercise on EU legislation implementation. Nationally, negative trends trigger species specific action programmes.	https://www.e-tar.lt/portal/lt/legalAct/d6fdb4b0c89a11e8bf37fd1541d65f38/asr
Monitoring of Habitats Directive Annex IV meadows butterfly species which are listed in the list of protected animals, plants and fungi species of the Republic of Lithuania (every 6 year).	Art. 17 Habitats Directive; National State Monitoring Programme for 2018-2023; Law on protected animal, plant and fungi species.	Range change, species population size, species habitat size and quality, main impacts and threats.	Data is sent to the EU institutions as part of reporting exercise on EU legislation implementation. Nationally, negative trends trigger species specific action programmes.	https://www.e-tar.lt/portal/lt/legalAct/d6fdb4b0c89a11e8bf37fd1541d65f38/asr
Monitoring of 14 common rural bird species (annually).	National State Monitoring Programme for 2018-2023	Common rural bird population index.	Data is sent to the EU institutions as part of reporting exercise on impacts of Common Agricultural Policy. Nationally, negative trends trigger species specific action programmes.	https://www.e-tar.lt/portal/lt/legalAct/d6fdb4b0c89a11e8bf37fd1541d65f38/asr
Monitoring of phytoplankton, zooplankton and zoobenthos in the Lithuanian EEZ of the Baltic Sea (annually)	National State Monitoring Programme for 2018-2023	Taxonomic composition, abundance and biomass.	Data is used for assessment of ecological status of Lithuanian EEZ of the Baltic Sea.	https://www.e-tar.lt/portal/lt/legalAct/d6fdb4b0c89a11e8bf37fd1541d65f38/asr
Monitoring of	National State	Taxonomic	Data is used for assessment of ecological status	https://www.e-

phytoplankton, zooplankton, zoobenthos, macroalgae, angiosperms and fish species in the Lithuanian coastal and territorial waters of the Baltic Sea (for macroalgae and angiosperms every 2 year, for the other groups - annually).	Monitoring Programme for 2018-2023	composition, abundance and biomass plus age structure for fish species.	of Lithuanian coastal and territorial waters of the Baltic Sea.	tar.lt/portal/lt/legalAct/d6fdb4b0c89a11e8bf37fd1541d65f38/asr
Monitoring of phytoplankton, zooplankton, zoobenthos, macroalgae, angiosperms and fish species in the Curonian Lagoon (for macroalgae and angiosperms every 2 year, for the other groups – annually).	National State Monitoring Programme for 2018-2023	Taxonomic composition, abundance and biomass plus age structure for fish species.	Data is used for assessment of ecological status of Curonian Lagoon.	https://www.e-tar.lt/portal/lt/legalAct/d6fdb4b0c89a11e8bf37fd1541d65f38/asr
Monitoring of phytoplankton, zoobenthos, macrophyte, phytobenthos and fish species if the lakes and ponds (every 3 year).	National State Monitoring Programme for 2018-2023.	Taxonomic composition, abundance plus age structure for fish species.	Data is used for assessment of ecological status of the lakes and ponds.	https://www.e-tar.lt/portal/lt/legalAct/d6fdb4b0c89a11e8bf37fd1541d65f38/asr
Monitoring of phytoplankton, zoobenthos, macrophyte, phytobenthos and fish species if the rivers (every 3 year).	National State Monitoring Programme for 2018-2023.	Taxonomic composition, abundance plus age structure for fish species.	Data is used for assessment of ecological status of the rivers.	https://www.e-tar.lt/portal/lt/legalAct/d6fdb4b0c89a11e8bf37fd1541d65f38/asr

2. Please expand your answer given in Table 1 by providing one or several concrete examples: How are biodiversity data used to identify biodiversity problems and trigger policy formulation in your country (figure 1, parts 1-2)?

Monitoring shows the status of habitats and species populations (deteriorating / declining, stable, improving / increasing). Based on the monitoring data, a problem is identified and decisions how to tackle it are made, e.g. agreement on the population level of wolves as management objective has been reached. Consequently, the number of reproductive units of wolves is annually identified; together with the level of damage to livestock it serves as the basis for reasoned decisions on annual hunting limits (hunting quotas). Similar example could be with the monitoring of Great cormorant and their damage done to old-growth forest or fishery ponds.

3. Please expand your answer given in Table 1 by providing one or several concrete examples: How have biodiversity data informed national and local action in your country (e.g. establishment of new protected areas, triggering land use change, more sustainable forest management) (figure 1, parts 3-4)?

Annual monitoring of globally threatened species of Aquatic warbler (*Acrocephalus paludicola*) at site level allows for farmers to modify the management regime of the meadows in such a way as to protect the breeding this species and get special support payments as a reward (a special agri-environmental measure has been developed and implemented). For example monitoring of birds of prey in forests leads more sustainable forest management (decisions on restrictions on felling at a certain distance from bird nests and periods). The data collected during the monitoring on certain butterfly and bird species formed the basis for the establishment of a new protected area. Monitoring data also provide a basis for deciding whether specific management measures (preparation of a management plan) are required in the particular area. Also, regular monitoring allows assessing whether the implemented measures give the desired result, whether they need to be changed (update the nature management plan).

4. Please expand your answer given in Table 1 by providing one or several concrete examples: Does your country integrate biodiversity data in models and scenarios, e.g. modelling distribution of habitat suitability, future trends or the consequences of interventions (figure 1, parts 5-6)?

Only partially, e.g. monitoring of some bird species allows us to predict (draw future scenarios) how they will spread in the future. Another example of modelling might be the evaluation of afforestation potential (increase of forest coverage nationally) taking into account the current distribution and future prospects of protected species and habitats.

5. Please provide one or several concrete examples: If biodiversity data is currently not (sufficiently) used for policymaking or for informing action in your country, what would be needed for this to happen?

For biodiversity monitoring data to be effectively used in policymaking, it is necessary to introduce the legal obligation to evaluate the long-term consequences for biodiversity and ecosystem services in all relevant decision making processes.

Survey respondent 9 (JRC)

1. How are biodiversity monitoring data currently used for national and local policy making in your country?

A **Current biodiversity monitoring scheme (and frequency)**	B **Relevant policy or management action at national or EU level**	C **Relevant indicator & spatial resolution**	D **How exactly does this data lead to action (decision making, planning, management)? Please describe**	E **Weblink URL to monitoring scheme**
LUCAS *Every ~3 years since 2006* *Coordinated by Eurostat* *Land cover (76 subclasses)* *Land use (31 subclasses)* *Land management (different types)* *Water management (different types)* *Tree height* *Feature width* *In LUCAS 2022:* *Grassland assessment* *Landscape features*	*provides harmonised and comparable statistics on land use and land cover across the whole of the EU's territory. Relevant for the EU's territorial policies such as CAP, Regional and Cohesion policy and environmental policy* *In 2018, the main objective was to land cover/ land use, soil*	SDG indicators: Forest area 15_10 https://ec.europa.eu/eurostat/databrowser/view/sdg_15_10/default/table?lang=en Settlement area per capita 11_31 https://ec.europa.eu/eurostat/databrowser/view/sdg_	*EU has an SDG monitoring scheme* *Soil indicators (see LUCAS soil below)* *Land cover/land use statistics:* *Policy uptake is limited, but statistics are useful for benchmarking.* *LUCAS sampling scheme improved over time, which however can lead to breaks in series between 2015-2018, especially for smaller classes.* *Lessons learned can be of interest to EuropaBON.* *Large number of surveyors, detailed documentation, for some parameters classification changes over time. See*	https://ec.europa.eu/eurostat/web/lucas/overview

Copernicus module (LC assessment for use as reference data for EO)	*In 2022 biodiversity of grassland, landscape features (CAP) and reference data for EO are assessed*	11_31/default/table?lang=en *Soil indicators (see LUCAS soil below)* *Land/cover/land use statistics* *Spatial resolution: NUTS 0, NUTS 2*	*https://www.nature.com/articles/s41597-020-00675-z*	
LUCAS Soil *Every three years since 2009 (Biodiversity and pesticides components started in 2018)* *There are other LUCAS modules (e.g. on grasslands or landscape elements) but we consider these modules in the answers below together with LUCAS*	*CAP, EU Biodiversity Strategy to 2030, Zero Pollution Action Plan and Farm to Fork Strategy*	*Coarse fragments (>2 mm)/%* *PSD1: clay, silt, sand/%* *pH (CaCl2, H2O)* *Organic carbon/g kg-1* *Carbonate content/g kg-1* *Total nitrogen content/g kg-1* *Extractable potassium content/mg kg-1* *Phosphorous content/mg kg-1* *Cation exchange capacity/cmol(+) kg-1* *Electrical conductivity/mS m-1* *Bacteria and*	*Some of the indicators developed by LUCAS Soil became part of the officially monitoring scheme of the CAP implementation.*	https://esdac.jrc.ec.europa.eu/projects/lucas

		Archaea (16S rDNA) *Fungi (ITS)* *Eukaryotes (18S rDNA)* *Microfauna (nematodes)* *Mesofauna (arthropods)* *Macrofauna (earthworms)* *Metagenomics* *Bulk density* *Soil moisture* *Soil erosion by water and wind* *Thickness of organic layer in Histosols* *Soil structure* *Organic pollutants* *Pesticides residues.* *Resolution: 500/250 meter depending on the indicators*		
EU PoMS *EU pollinator monitoring scheme* *(this scheme is still in a test phase, it is funded by the European Parliament)*	*EU pollinators initiative: the scheme is designed to monitor trends in the EU's pollinating insects. It needs to feed also a pollinator indicator and an*	*The indicators are still under development. There should be one generic pollinator indicator (such as the common birds*	*Clearly, reports and publications that demonstrated the declining trends in pollinator have been the basis for the EU to take action on pollinators. At the same time, knowledge gaps exists so improving knowledge on pollinators has been a key objective of the EU policy on pollinators.* *It is expected that the implementation of the EU*	EU pollinator policy: https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1528213737113&uri=CELEX:52018DC0395 Proposal for the EU

	indicator to assess the impact of CAP	*index) and one CAP related indicator (such as the farmland birds)*	*PoMS can further support the review of the policy + help assess the impacts of CAP*	Pollinator Monitoring Scheme https://ec.europa.eu/jrc/en/science-update/proposal-eu-pollinator-monitoring-scheme-eu-poms
EMBAL: European Monitoring of Biodiversity in Agricultural Landscapes The survey is still under development	Main goal is to monitor farmland biodiversity as a tool to assess the impacts of the Common Agricultural policy	The survey is done on a selection of LUCAS sampling points in each country Observations: Land cover Landscape elements Irregularities Agroenvironmental impacts Nature value of different landscape elements Vegetation monitoring based on transect walks	The scheme is still under development.	https://ec.europa.eu/environment/nature/knowledge/pdf/embal_survey_manual.pdf

2. Please expand your answer given in Table 1 by providing one or several concrete examples: How are biodiversity data used to identify biodiversity problems and trigger policy formulation in your organisation/directorate (figure 1, parts 1-2)?

LUCAS: LUCAS is originally set up to monitor land cover and land use on agricultural lands to monitor the CAP and to understand land use by farmers (e.g., which crops are grown). Since its start and because of its implementation, LUCAS has allowed policy DGs to consider demands and questions that would not have been raised in absence of LUCAS. The presence of the monitoring schemes allows policy DGs to request new monitoring modules that address specific policy needs. Clear examples are the LUCAS soil module to fill the large gap of our knowledge in soil, and the newly developed LUCAS grassland module, the specific monitoring on agroforestry, or the specific module on landscape elements in agroecosystems.
LUCAS LC/LU data is being used for modelling the geographic distribution of permanent agricultural grassland, permanent semi-natural grassland, temporary grassland and other grassland, providing a better knowledge on the distribution of these important land covers. This allows to increase the limited knowledge of grassland available in the EU.

These modules and models are important information for biodiversity and to monitor the impact of CAP. It is important to emphasize that the existence of a regular monitoring scheme on land triggers policy questions that otherwise would not have been raised or addressed.

Both EMBAL and EU POMS are under a testing phase. However, it is clear that monitoring data of pollinators and agrobiodiversity that have been reported in articles and press are at the basis of a policy response. EU policy on pollinators and farmland biodiversity (as part of the EU biodiversity strategy, the farm to fork strategy, the CAP and the European Green deal) are established as response to alarming trends coming from monitoring. Both EMBAL and EU POMS are immediate results of these policies. These schemes are established to better understand declining trends to that policy can take necessary actions. they illustrate well the policy cycle explained at the start of this survey.

3. Please expand your answer given in Table 1 by providing one or several concrete examples: How have biodiversity data informed action at national or EU level (e.g. establishment of new protected areas, triggering land use change, more sustainable forest management) (figure 1, parts 3-4)?

Uses of LUCAS

- The European Commission's Directorate-General for Agriculture and Rural Development, for evaluating the impact of agriculture on the environment through agri-environmental indicators (AEI), including for organic soil matter and soil erosion as well as indicators on the structure of landscape elements within the framework of the integration of environmental concerns into the Common Agricultural Policy (CAP) post-2013;
- the European Commission's Directorate-General for Environment, for soil protection and for grassland monitoring;
- the European Commission's Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, where in situ data from LUCAS contribute to the production, verification and validation processes relating to pan-European datasets describing the main land cover types, which are derived from satellite images, as conducted by Copernicus observation programme;
- the European Commission's Directorate-General for Climate Action, for land use, land use change and forestry (LULUCF) statistics in relation to the reduction of greenhouse gas emissions.

- the European Statistical Office, for the SDG indicators

EMBAL and EU POMS are not operational yet and have not been used for informing other policies

4. Please expand your answer given in Table 1 by providing one or several concrete examples: Does your organisation/directorate integrate biodiversity data in models and scenarios, e.g. modelling distribution of habitat suitability, future trends or the consequences of interventions (figure 1, parts 5-6)?

An important application of LUCAS data for biodiversity research is the calibration of remote sensing land cover and land use data as well as the development of land cover and land use models. Such data and models are essential inputs to species distribution models, habitat and ecosystem classifications, habitat suitability models, landscape models, etc.
LUCAS also has a photo archive of photos taken on the sites, including crop photos, which can be used for modelling landscapes or flower diversity.
LUCAS also provide crop statistics which are important to model ecosystem services such as pollination and biological control.

5. Please provide one or several concrete examples: If biodiversity data is currently not (sufficiently) used for policymaking or for informing action in your organisation/directorate, what would be needed for this to happen?

A key issue or problem with monitoring schemes like LUCAS or with remote sensing data from Copernicus is the lack of "biodiversity ready data". Usually biodiversity policymakers are not the direct consumers or users of LUCAS data (or COPERNICUS) data as they are made available in databases or datasets. Usually an intermediate (such as JRC, EEA, or contactors, research institutes) has to provide custom-based solutions (or biodiversity ready data). They have to translate first the observations into a usable map or indicator. This creates a dependency on scientific and technical expertise which is expensive (but far less expensive than collecting the data) and time consuming. This probably also explains the success of the common bird index or the grassland butterfly index as key indicators to report the state and trends of biodiversity in the EU. Policymakers won't have to analyse the bird and butterfly data but can download from the Eurostat website the index per year per country. This greatly facilitates their use and their uptake in policy. So a key element for EuropaBON would be to ensure that there is capacity to turn biodiversity observations into a usable metric, dataset or indicator that can be directly used and interpreted by policymakers or that does require minimum calculation or analysis.
For instance, LUCAS could consider developing more derived products based on the LUCAS data and make them available each time the results of the LUCAS survey are published. Now the impression exists that LUCAS is underused.

Survey respondent 10 (Croatia)

1. How are biodiversity monitoring data currently used for national and local policy making in your country?

A **Current biodiversity monitoring scheme (and frequency)**	B **Relevant policy or management action at national or local level**	C **Relevant indicator & spatial resolution**	D **How exactly does this data lead to action (decision making, planning, management)? Please describe**	E **Weblink URL to monitoring scheme**
Monitoring System for the Assessment of the Status of the Adriatic Sea (annually)	Marine Strategy Framework Directive	Database of data and indicators of the state of the marine environment, mariculture, and fisheries: http://baltazar.izor.hr/azopub/bindex; Maps of sampling stations: http://jadran.izor.hr/geo/msfd_mon.html	Data is sent to the EU for international reporting; Data used during the preparation of national marine management strategies	https://mingor.gov.hr/UserDocsImages/Uprava_vodnoga_gospodarstva_i_zast_mora/Strategija_upravljanja_morem/Akcijski%20program%20Sustav%20pra%C4%87enja%202021_2026.pdf
	The EU Water Framework Directive	https://www.voda.hr/hr/metodologije	Data is sent to the EU for international reporting; Data used for national freshwater management plan	https://www.voda.hr/sites/default/files/dokumenti/plan_monitoringa_stanja_voda_u_2019._godini.pdf; https://www.voda.hr/sites/default/files/plan_upravljanja_vod

				nim_podrucjima_2016._-_2021.pdf
Common Farmland Bird monitoring in Croatia, annually	COMMISSION IMPLEMENTING REGULATION (EU) No 834/2014 of 22 July 2014 laying down rules for the application of the common monitoring and evaluation framework of the common agricultural policy and COMMISSION IMPLEMENTING REGULATION (EU) No 808/2014 of 17 July 2014 laying down rules for the application of Regulation (EU) No 1305/2013 of the European Parliament and of the Council on support for rural development by the European Agricultural Fund for Rural Development	Farmland birds index (FBI); Art 12 BD population trend of farmland bird species	Data is sent to the EU for international reporting; The farmland bird indicator is intended as proxy to assess the biodiversity status of agricultural landscapes in Europe; for the same purpose it is used on national level .	http://www.haop.hr/sites/default/files/uploads/dokumenti/03_prirodne/monitoring_prog/ceste%20vrste%20ptica.pdf

	(EAFRD); Art. 12 Birds Directive			
Monitoring of impact of the Corncrake (Crex crex) agri-envirnomental measure on species conservation status/Procjene utjecaja Pilot mjere za zaštitu ptice kosca (Crex crex) iz Programa ruralnog razvoja Republike Hrvatske za razdoblje 2014.-2020. na očuvanje vrste uz prijedlog poboljšanja provedbe	Art. 12 Birds Directive	Species population (size and area) trend; species distribution 10x10 km	Data used during the preparation of national agriculture strategies , for planning of agri-environment scheme for conservation of the species	http://www.haop.hr/sites/default/files/uploads/dokumenti/03_prirodne/monitoring_prog/Program%20monitoringa%20Crex%20crex.pdf , additional methodology defined within specific purpose of this specific impact monitoring
International Waterbird Census	Art. 12 Birds Directive / Ramsar sites	Species population trend; national population size (ind.)	Data is sent to the Wetlands international for international reporting; data used for Art. 12 Birds Directive reporting , Ramsar sites monitoring	http://iwc.wetlands.org/index.php/
Monitoring of the white stork (*Ciconia ciconia*)	Art. 12 Birds Directive	Species population trend; national population size(pairs); distribution 10x10 km	data used for Art. 12 Birds Directive reporting; data used for planning of conservation activities for white stork	http://www.haop.hr/sites/default/files/uploads/dokumenti/03_prirodne/monitoring_prog/Ciconia%20ciconia_Programme.pdf
Monitoring of the White-tailed Eagle (*Haliaeetus albicilla*)	Art. 12 Birds Directive	Species population trend; national population size(pairs);	data used for Art. 12 Birds Directive reporting; data used for forest management plans	http://www.haop.hr/sites/default/files/uploads/dokumenti/03_prirodne/monitoring_prog/Program%2

		distribution 10x10 km		0monitoringa%20haliaaetus%20albicilla%20%C5%A1tekavac.pdf
Monitoring of invasive alien species	EU regulation on invasive alien species	IAS observation distribution	Data is used for national and regional projects that target the removal of invasive alien species (planning of resources, actions for removing IAS)	Monitoring programme based on a network of voluntary observations of invasive alien species https://invazivnevrste.haop.hr/
E.g. National breeding bird survey (annually)	*Art. 12 Birds Directive / national biodiversity strategy / Ramsar sites*	*Number of breeding pairs of each bird species per km² (or per site or per district)*	*Data is sent to the EU for international reporting. Nationally, negative trends trigger restoration action of e.g. Ramsar wetland sites and species specific action programmes*	
E.g. Monitoring the impact of air pollution on ecosystems	*Air quality policy, reporting under Art. 9 of the National Emissions Ceiling directive*	*Ozone foliar damage to trees and crops (200 sites in the country)*	*Data is sent to the EU for international reporting. The data is used for monitoring the health of forests.*	
E.g. Monitoring of invasive alien species	*Management of natural areas, rivers and forests; EU regulation on invasive alien species*	*Monitoring programme based on a network of voluntary observations of invasive alien species and targeted species monitoring in*	*Data is used for national and regional programmes that target the removal of invasive alien species (planning of resources, actions for removing IAS)*	

		areas under high risk.		

2. Please expand your answer given in Table 1 by providing one or several concrete examples: How are biodiversity data used to identify biodiversity problems and trigger policy formulation in your country (figure 1, parts 1-2)?

Please see answer on question3., below

3. Please expand your answer given in Table 1 by providing one or several concrete examples: How have biodiversity data informed national and local action in your country (e.g. establishment of new protected areas, triggering land use change, more sustainable forest management) (figure 1, parts 3-4)?

Monitoring schemes (given in Table 1) are implemented during 5 or less years, sometimes only partially, so trends in results and indicators are statistically insignificant or are hard to be properly interpreted. Nature conservation actions are mostly triggered by inventory data (e.g. to conserve habitat for endangered species or by establishment of new protected areas) or by specific actions to prevent direct mortality of endangered species (e.g. retrofitting electricity infrastructure to prevent birds electrocution and collision)

4. Please expand your answer given in Table 1 by providing one or several concrete examples: Does your country integrate biodiversity data in models and scenarios, e.g. modelling distribution of habitat suitability, future trends or the consequences of interventions (figure 1, parts 5-6)?

Biodiversity data have been integrated in models and scenario on limited basis, for example habitat suitability for large carnivores (wolf, lynx and brown bear) in EIA and AA procedures. http://www.haop.hr/hr/publikacije/strucni-prirucnik-za-procjenu-utjecaja-zahvata-na-velike-zvijeri-pojedinacno-te-u

5. Please provide one or several concrete examples: If biodiversity data is currently not (sufficiently) used for policymaking or for informing action in your country, what would be needed for this to happen?

The most important activities for using biodiversity data for policymaking are:

- Continuation of existing monitoring schemes
- Development of new monitoring schemes with appropriate methodology and clearly defined variables –monitoring variables should be defined in such way to be able to trigger policymaking and to inform conservation action in relevant sector. Monitoring schemes should clearly address drivers of observed changes in biodiversity, species and habitat types.
- Development of database and data management and reporting platform
- Capacity building for monitoring
- Strong legal connection of the status of the indicators and variables describing conservation of the species/habitat types and availability of EU or national funds for projects, plans or strategies that can cause further deterioration of species and habitat types. In other words each project, plan or strategy must include results on national monitoring schemes as indicator of their sustainability. For example management plans can be evaluated as sustainable or not-deteriorating nature conservation goals if the conservation status and trend of the species and habitat types to be impacted by the specific plan are known.

Survey respondent 11 (Montenegro)

1. How are biodiversity monitoring data currently used for national and local policy making in your country?

A **Current biodiversity monitoring scheme (and frequency)**	**B** **Relevant policy or management action at national or local level**	**C** **Relevant indicator & spatial resolution**	**D** **How exactly does this data lead to action (decision making, planning, management)? Please describe**	**E** **Weblink URL to monitoring scheme**
Annual Monitoring and evaluating the status of wild species of plants, animals and fungi, including birds, their habitats and habitat types; Has the monitoring plan been adopted yet? If so, when?	*Law on Nature Protection (Official Gazette of montenegro 54/16 - Article 100 Monitoring the state of conservation of nature* *State of conservation shall be monitored*	*Number of breeding pairs of each bird species per km² (or per site or per district)* The indicator lists the number of breeding birds. Are there other	*Based on data from realization of the Monitoring programme Information on the state of the Environment with proposal of measures is developed and adopted by the Goverment annually . Also, Indicator based State of Environment report is developed on a period of 4 years* Would this annual monitoring also serve as the reporting for the Birds and Habitats Directives,	https://www.gov.me/dokumenta/8872a45c-bd86-4241-af1c-16d6a166b168

	on the basis of the five-year monitoring plan (hereinafter referred to as: the monitoring plan) which shall be adopted by the Government. *The monitoring plan shall be implemented on the basis of the annual monitoring program, which shall be adopted by the Government by 31 December of the current year for the following year.* *The monitoring plan and program referred to in paragraph 2 hereof shall in particular contain:* *- method of monitoring and evaluating the status of wild species of plants, animals and fungi, including birds, their habitats and habitat types;* *- method of monitoring the state of protected areas.* *Monitoring shall be*	indicators to measure plants, habitats, fungi, etc?	if Montenegro was accepted as an EU member state?	

	conducted by the administration body. For specific tasks of a monitoring program, legal and natural persons that meet the requirements in terms of personnel and equipment, may be engaged by the administration body. Local government can monitor the state of conservation of nature on its territory at its own expense. Funds for the implementation of the monitoring plan and the annual monitoring program shall be provided from the Budget of Montenegro. More detailed content of the monitoring plan and annual monitoring program and the requirements referred to in paragraph 5 hereof shall be prescribed by the Ministry.			

2. Please expand your answer given in Table 1 by providing one or several concrete examples: How are biodiversity data used to identify biodiversity problems and trigger policy formulation in your country (figure 1, parts 1-2)?

Based on data from realization of the Monitoring programme Information on the state of the Environment with proposal of measures is developed and adopted by the Government annually . Program of measures contain what should be corrected. Sometimes it leads to some concrete activities such as initiation of proclamation of some area as a protected area.

3. Please expand your answer given in Table 1 by providing one or several concrete examples: How have biodiversity data informed national and local action in your country (e.g. establishment of new protected areas, triggering land use change, more sustainable forest management) (figure 1, parts 3-4)?

the Monitoring programme Information on the state of the Environment with proposal of measures is developed and adopted by the Government annually. Sometimes it leads to some concrete activities such as initiation of proclamation of some area as a protected area.

4. Please expand your answer given in Table 1 by providing one or several concrete examples: Does your country integrate biodiversity data in models and scenarios, e.g. modelling distribution of habitat suitability, future trends or the consequences of interventions (figure 1, parts 5-6)?

No

5. Please provide one or several concrete examples: If biodiversity data is currently not (sufficiently) used for policymaking or for informing action in your country, what would be needed for this to happen?

Sustainable finances of national monitoring, common methodology, capacity building on specific new methodologies and analyses of the data such as modeling, gis tools use in analyses of the data)

Survey respondent 12 (EEA)

1. How are biodiversity monitoring data currently used for national and local policy making in your country?

A **Current biodiversity monitoring scheme (and frequency)**	B **Relevant policy or management action at national or EU level**	C **Relevant indicator & spatial resolution**	D **How exactly does this data lead to action (decision making, planning, management)? Please describe**	E **Weblink URL to monitoring scheme**
E.g. National breeding bird survey (annually)	*Art. 12 Birds Directive / national biodiversity strategy / Ramsar sites*	*Number of breeding pairs of each bird species per km² (or per site or per district)*	*Data is sent to the EU for international reporting. Nationally, negative trends trigger restoration action of e.g. Ramsar wetland sites and species specific action programmes*	
E.g. Monitoring the impact of air pollution on ecosystems	*Air quality policy, reporting under Art. 9 of the National Emissions Ceiling directive*	*Ozone foliar damage to trees and crops (200 sites in the country)*	*Data is sent to the EU for international reporting. The data is used for monitoring the health of forests.*	
E.g. Monitoring of invasive alien species	*Management of natural areas, rivers and forests; EU regulation on invasive alien species*	*Monitoring programme based on a network of voluntary observations of invasive alien species and targeted species monitoring in areas under high risk.*	*Data is used for national and regional programmes that target the removal of invasive alien species (planning of resources, actions for removing IAS)*	
EEA comments on examples above: If we talk about monitoring schemes carried out in EEA, then this is not the case, as we				

do not carry out any monitoring. If we want to capture the Art 12 reporting on birds (under BD) we could include that there are national bird surveys but we do not know if they are annual or based on projects with an unknown frequency. We only get the results every 6 years. Surveys ideally do not include only breeding but also key wintering populations.				
Re bird monitoring: EEA compiles the data that are sent to the EU for reporting under Art 12 (BD). In 2019 there was the first reporting in the frame of Bern convention. Similar to the birds data, we receive data for habitats and species in the frame of the Habitats Directive. Maps are again in 10X10 km, population units are variable.		For Art 12 reporting the unit that is used for population is breeding pairs or individual or breeding females or calling males, depending on the species. The data we receive concern in general distribution (surface area), population size (not abundance as described), population trend. We also receive		

		gridded maps 10X10 km		
EEA received the first reports for the IAS Regulation reporting in 2019.		EEA receives information on distribution but not on population sizes (also information on measures, permits etc).		

2. Please expand your answer given in Table 1 by providing one or several concrete examples: How are biodiversity data used to identify biodiversity problems and trigger policy formulation in your organisation/directorate (figure 1, parts 1-2)?

EEA assessments work across the entire DPSIR domain, hence contribute to different stages of the policy cycle.
Their impact depends however on a range of factors, including timing of publication, strength of data and analysis, interest by policy makers in the European Commission, and the policy trade-offs that all policy decisions, incl those with biodiversity relevance, are exposed to. The type and remit of EEA analytical output leads to more focus on stages 1, 2 and 4 in Figure 1 than on stage 3.

3. Please expand your answer given in Table 1 by providing one or several concrete examples: How have biodiversity data informed action at national or EU level (e.g. establishment of new protected areas, triggering land use change, more sustainable forest management) (figure 1, parts 3-4)?

This is partly too difficult and partly too comprehensive to answer; the EU Biod. Strategy and the EU Green Deal are examples of general policy responses to biodiversity decline. Many other examples can be found in the EU CAP or energy policies etc, whether these are sufficient is a different question though.

4. Please expand your answer given in Table 1 by providing one or several concrete examples: Does your organisation/directorate integrate biodiversity data in models and scenarios, e.g. modelling distribution of habitat suitability, future trends or the consequences of interventions (figure 1, parts 5-6)?

We focus most of our capacity on reporting and trend description with regard to biodiversity data. However, we have produced assessments of direct relevance to biodiversity in the past years that used a substantial amount of modelling, eg this report on the EU bioenergy potential: EU bioenergy potential from a resource efficiency perspective — European Environment Agency (europa.eu)

Other modelling is used in the regular EU state of the environment reports, please see The European environment — state and outlook — European Environment Agency (europa.eu)

Furthermore, we have also developed with the aid of ETC/BD EUNIS habitat suitability and probability maps which have not been used so far for assessments..

5. Please provide one or several concrete examples: If biodiversity data is currently not (sufficiently) used for policymaking or for informing action in your organisation/directorate, what would be needed for this to happen?

EEA has no responsibility for policy making; however, we use all possible biodiversity data in our assessments.

Survey respondent 13 (Netherlands)

1. How are biodiversity monitoring data currently used for national and local policy making in your country?

A **Current biodiversity monitoring scheme (and frequency)**	B **Relevant policy or management action at national or local level**	C **Relevant indicator & spatial resolution**	D **How exactly does this data lead to action (decision making, planning, management)? Please describe**	E **Weblink URL to monitoring scheme**
The information provided is mainly derived from the Network Ecological Monitoring In addition: - National Forest Inventory (based				http://www.netwerkecologischemonitoring.nl/wp-content/uploads/2021/04/Meetprogrammasfloraenfauna2020.pdf Tabel 2.1

on sampling) - Sequential vegetation and habitat type mapping is carried out on site level - Monitoring of the ecological status in the framework of the Water Framework Directive				Meetdoelen van het Netwerk Ecologische Monitoring (page 9, 10 en 11) in Dutch
Netwerk Ecologische Monitoring has the following monitoring objectives				
1	*Habitat directive species described in annex II and IV en all indigenous birds*	*National trends in population size*	*Data is sent by the national government to the EU for international reporting*	
2	*Habitat and birds directive*	*Trends in distribution (10x10km) of species in appendix II, IV and V of the Habitat directive and all indigenous birds*	*Data is sent by the national government to the EU for international reporting*	
3	*Natura 2000 areas*	Trends in population size of species in all	*Data is sent by the national government to the EU for international reporting*	

		Nature 2000 areas. Some Annex II Habitat directive and Annex 1 Birds directive and the so called 1% species of the Birds directive		
4	*Natura 2000 areas population statistics*	See line above	This is an indirect measured indicator for the provincial governments	
5	*Habitat and birds directive. Trends in joint HD/BD areas.*	Trends in species in all population size in the Nature 2000 network. Annex II Habitat directive and Annex 1 Birds directive and the so called 1% species of the Birds directive	Reporting to the EU of this data is currently on voluntary basis	
6	Habitat directive: structure and function of habitat types	National trends in species composition of habitat types	ed to determine the quality of habitat types lists of characteristic (partly typical) species are used For forest types structural characteristics are monitored in the framework of the National Forest Inventory For marine and aquatic habitats different species are monitored in the framework of TMAP as well OSPAR, the Water Framework and Marine Strategy Framework Directive	

7	Habitat directive: number of species and occurrence as indicator of structure and function	Datagathering is linited to 10 km grid (target 2). For a subset of the species the resolution of the data is good enough to provide information on the level of a km grid		
8	Trilateral Monitoring and Assessment Program	Trends of population size of birds species in the Wadden Sea area	Trilateral agreement with the Wadden Sea countries Netherlands, Germany and Denmark	
9 10 11 12	Farmland Bird Index Red List status of species Ramsar (wetlands): trends Convention on Biological Diversity	Trends in farmland birds species National distribution on 5km grid level Trends in numbers of bird species in Ramsar area's Indirect indicator: data derived from above mentioned monitoring	Indicator provided to the EU Data provided for the EU under the Bern convention Provided to the Ramsar convention Information provided to Convention on Biological Diversity	

		programs is adjusted to be suited for providing information to CBD		
13	OSPAR(Oslo/Paris treaty on the protection of the NW Atlantic)	Set of Biodiversity indicators developed by the OSPAR countries. A list of predefined species is used	Information on a 10 year basis in the Quality status reports (with intermediate assessments)	
14	African Eurasian Waterbird Agreement (under the convention of Bonn)	National trends of migratory waterbirds	Data and monitoring format is not described in detail	
15	EU Directive 2005/94/EC Aviaire Influenza: national trend and occurance	Overview of birds with Aviaire Influenza	Data provided to EU	
16	Eurobats. Bonn-convention (Convention on the Conservation of Migratory Species)	National trends in occurrence of bats	Data and monitoring format is not described in detail	
	Distribution of alien species	Data provided to EU on basis of the EU list of alien		

17	Breeding success farmland birds and birds in the Wadden sea area	species (10 km grid)	Provided to EU every 6 years	
18	Overview of species (their numbers) that can be harmful to agricultural crops	Mainly birds and their numbers are monitored	For national and regional policy	
19	Quality of agricultural areas	National trends in population Farmland Birds and breeding numbers	For national and regional policy	
20	Quality of main inland surface waters: trends of birds	Water birds trends and breeding success	Specific for provincial evaluation of Farmland Bird policies and trends in geese/swans. The later for provincial policies of damage to agricultural crops by wildlife	
21	Environmental (national and regional trends)quality	Mainly trends in vegetation (species distribution) in relation to pressures like nitrogen, SOx etc	Information for the Ministry of Infrastructure and water to determine the quality of the national main water systems Information for ministries and provinces responsible for environmental and nature policies in the Netherlands	
22	Climate change:	National trends of species favoring cold and warm		

	national trend and phenological shifts	temperature and phenological shifts		
23	Composite indicators for trends in nature	Monitoring the quality of nature	For the ministries responsible for climate mitigation and adaptation policies	
24	Urban nature.	Distribution and national trends of species in urban areas	For policy evaluation on national and provincial level composite indicators are reported to describe the developments in biodiversity. **This is one of the main purposes of the NEM on the national/regional level**	
25			For policy evaluation on national and provincial level	

2. Please expand your answer given in Table 1 by providing one or several concrete examples: How are biodiversity data used to identify biodiversity problems and trigger policy formulation in your country (figure 1, parts 1-2)?

See table above

3. Please expand your answer given in Table 1 by providing one or several concrete examples: How have biodiversity data informed national and local action in your country (e.g. establishment of new protected areas, triggering land use change, more sustainable forest management) (figure 1, parts 3-4)?

See table above monitoring targets no 20-25 are specific dedicated to national and regional policies Biodiversity data are use for the implementation of the Birds and Habitat directive such as designation of Natura 2000 sites, monitoring the effects of conservation measures etc. Biodiversity data are used as well for the common management of the Wadden Sea (Quality Status Report)

4. Please expand your answer given in Table 1 by providing one or several concrete examples: Does your country integrate biodiversity data in models and scenarios, e.g. modelling distribution of habitat suitability, future trends or the consequences of interventions (figure 1, parts 5-6)?

Biodiversity data is used in models and scenario studies aiming to improve the national nature policies. For example the regularly published nature outlook e.g. Referentiescenario's Natuur Tussenrapportage Natuurverkenning 2050 (in Dutch)https://www.pbl.nl/publicaties/referentiescenarios-natuur

5. Please provide one or several concrete examples: If biodiversity data is currently not (sufficiently) used for policymaking or for informing action in your country, what would be needed for this to happen?

Survey respondent 14 (Finland)

1. How are biodiversity monitoring data currently used for national and local policy making in your country?

A **Current biodiversity monitoring scheme (and frequency)**	B **Relevant policy or management action at national or local level**	C **Relevant indicator & spatial resolution**	D **How exactly does this data lead to action (decision making, planning, management)? Please describe**	E **Weblink URL to monitoring scheme**
E.g. National breeding bird survey (annually)	*Art. 12 Birds Directive / national biodiversity strategy / Ramsar sites*	*Number of breeding pairs of each bird species per km² (or per site or per district)*	*Data is sent to the EU for international reporting. Nationally, negative trends trigger restoration action of e.g. Ramsar wetland sites and species specific action programmes*	
E.g. Monitoring the impact of air pollution on ecosystems	*Air quality policy, reporting under Art. 9 of the National Emissions Ceiling directive*	*Ozone foliar damage to trees and crops (200 sites in the country)*	*Data is sent to the EU for international reporting. The data is used for monitoring the health of forests.*	
E.g. Monitoring of invasive alien species	*Management of natural areas, rivers and forests; EU regulation on invasive alien species*	*Monitoring programme based on a network of voluntary observations of invasive alien species and targeted species monitoring in areas under high risk.*	*Data is used for national and regional programmes that target the removal of invasive alien species (planning of resources, actions for removing IAS)*	
Pollinators, butterflies and other insects	CAP (theoretically - not sure if used); Red List of Species; National Biodiversity Strategy	i) poorly known pollinators surveys; ii) butterflies, moths and bumblebees;	Through increased knowledge on species status and trends. Information delivered through reports, websites, other publications, press releases.	Butterflies in agricultural landscapes: https://www.ymparisto.fi/en-

	indicators (eg. mire and agriculture butterflies); Monitoring of climate change impact on moths	iii) endangered species monitoring groups Trends of Species abundance trends at national or regional scale.		US/Nature/Species/Species_monitoring/Monitoring_butterflies_in_Finnish_agricultural_landscapes Bumblebees: https://www.syke.fi/hankkeet/polyhyoty Moths: https://www.ymparisto.fi/fi-fi/luonto/lajit/lajien_seuranta/Yoperhosseuranta Butterflies: https://laji.fi/en/project/MHL.6/about
Threatened, endangered habitats	Directive reporting; Red List of Habitats; National Conservation Act in review	i) threatened habitat survey projects (PUTTE); ii) development of national monitoring schemes for threatened habitats		
Bat surveys (Chrioptera)	Habitat Directive Annex II & IV; Land use planning & management			

Amphibians	Habitat Directive Annex IV			
Remote sensing of habitats/ ecosystems (extent/condition/structure/function)		i) FEO - Finnish Ecosystem Observatory (project); ii) Earth Observation of Finnish Lapland (project)		
Invasive alien species	IAS act	i) monitoring of marine invasive alien species (mainly macro- and microinvertebrates) in the vicinity of major Finnish ports; ii) monitoring of species mentioned by IAS act		
Bird surveys	Reporting for Birds and Habitats Directives; Red List of Species	i) atlas; ii) line transects (agriculture, forests)		
Vegetation survey of national forest inventory (NFI)				
Marine birds (annual counts in selected monitoring areas, supplemented with	*Art. 12 Birds Directive / national biodiversity strategy /*	*1.Number of breeding pairs of each bird species*	*Data is sent to the EU for international reporting. Nationally, negative trends trigger restoration action of e.g. Ramsar wetland sites and species*	https://helda.helsinki.fi/handle/10138/323600

volunatary observations and migration monitoring in a couple of selected spots)	*Ramsar sites / Marine Strategy Framework Directive*	*per km² (or per site or per district)* 2.Temporal change in population abundance.	*specific action programmes*	
Marine mammals (seals and harbour porpoise), annually	*Habitats Directive, Marine Strategy Framework Directive*	*Population abundance, distribution and population condition (reproduction and nutrition)*	*Data is sent to the EU for international reporting. The data is used for conservation.*	https://helda.helsinki.fi/handle/10138/323600
Monitoring of marine alien species, annual	*EU regulation on invasive alien species; Marine Strategy Framework Directive*	*Monitoring programme based on a network of voluntary observations of invasive alien species and targeted species monitoring in areas under high risk.*	*Data is used for national and regional programmes that target the removal of invasive alien species (planning of resources, actions for removing IAS).* International indicators for management effectiveness (Ballast Water Treatment).	https://helda.helsinki.fi/handle/10138/323600
Commercially harvested marine fish, annual	Common Fisheries Policy, National regulations on fisheries, *Marine Strategy Framework Directive*	Spawning stock biomass, Fishing mortality, size distribution	Setting quotas and fishery regulations	https://helda.helsinki.fi/handle/10138/323600
Marine fish (non commercial), annual	Habitats Directive; *Marine Strategy*	Abundance changes	Conservation plans for seatrout, white fish, grayling and eel.	https://helda.helsinki.fi/handle/10138/323

	Framework Directive			600
Marine phytoplankton, Zooplankton and macrozoobenthos (soft, sandy and hard bottom)	*Marine Strategy Framework Directive; Water Framework Directive*	Community indices indicating diversity, abundance and temporal change (thresholds for good state included)	Data is used for national and international reporting and following effectiveness of management measures towards good ecological/environmental status. No indicators available for hard bottom macrozoobenthos and no thresholds set fo sandy bottoms.	https://helda.helsinki.fi/handle/10138/323600
Marine and transitional water benthic plants, shallow water invertebrates	*Marine Strategy Framework Directive; Water Framework Directive; VELMU - Finnish Inventory Programme for Marine Underwater Diversity*	Change in diversity and species composition	Data is reported internationally and used to indicate human impacts on soft-bottom plants and hard-bottom macroalgae. Spatial inventory data is stored in national biodiversity databases	https://helda.helsinki.fi/handle/10138/323600 https://laji.fi/en

2. Please expand your answer given in Table 1 by providing one or several concrete examples: How are biodiversity data used to identify biodiversity problems and trigger policy formulation in your country (figure 1, parts 1-2)?

BD data with concrete link to directives can influence land use decisions (e.g. flying squirrel, bats etc.). Conservation Act is currently under review and threatened habitats are suggested to be protected in the future. Knowledge about mire or agriculture butterflies, for example, can be used as indicators for estimating impacts of restoration efforts or sustainable land use decisions.

Marine biodiversity data is mainly about species population abundance, temporal change of abundance in selected spots (not counting whole population), species community composition or population condition (demographics). The focus is always in following how human impacts are disturbing the monitored variable (or the indicator derived from it). Hence, the regular marine monitoring is not directly focused to the BDS2030

3. Please expand your answer given in Table 1 by providing one or several concrete examples: How have biodiversity data informed national and local action in your country (e.g. establishment of new protected areas, triggering land use change, more sustainable forest management) (figure 1, parts 3-4)?

VELMU, the Finnish Inventory Programme for Marine Underwater Diversity has collected a large database of species and habitats that has been used in biodiversity assessments and in developing biodiversity protection. These include, e.g., analysis of the efficiency of the current MPA network https://www.frontiersin.org/articles/10.3389/fmars.2018.00402/full, for the updates of Finnish Red Lists for species https://www.ymparisto.fi/en-US/Nature/Species/Threatened_species/The_2019_Red_List_of_Finnish_species and assessment of threatened habitats https://www.ymparisto.fi/en-US/Nature/Natural_habitats/Assessment_of_threatened_habitat_types_in_Finland/Assessment_of_threatened_habitat_types_in_Finland_2018), in developing the Finnish N2000 network https://www.ymparisto.fi/en-US/Nature/Protected_areas/Natura_2000_areas_in_Finland/Expanding_the_Natura_2000_network_and_ve(50165), in proposing CBD EBSAs for the Baltic Sea https://www.ymparisto.fi/en-US/Sea/Marine_researchers_propose_declaring_23_(46193), and as background information for national maritime spatial plans according to the EU MSD Directive https://www.merialuesuunnittelu.fi/en/msp-draft-2030/

4. Please expand your answer given in Table 1 by providing one or several concrete examples: Does your country integrate biodiversity data in models and scenarios, e.g. modelling distribution of habitat suitability, future trends or the consequences of interventions (figure 1, parts 5-6)?

Yes, for instance climate change forecasts for species distributions, and further, their implications to protected area networks. Success of national restoration programme is monitored, for instance, via condition of mire habitats.

VELMU, the Finnish Inventory Programme for Marine Underwater Diversity, has collected 170.000 spatially explicit observations on benthic habitats and species (algae, vascular plants, benthic invertebrates) in 2004-2021. These data have been used for creating ca. 240 species distribution models and ca 25 models for biologically defined habitats. The models have been used in various assessments of biodiversity and MPA efficiency. In ongoing projects, they will be combined with climate driven oceanographic-biogeochemical models, in order to project future distributions of species and habitats. The aim of the modelling is to develop climate proof marine protected areas and to determine where restoration activities are most urgently needed.

5. Please provide one or several concrete examples: If biodiversity data is currently not (sufficiently) used for policymaking or for informing action in your country, what would be needed for this to happen?

It would be very important to provide access to accurate data at all scale: from very local level land-use planning to national scale decision-making. FAIR and open data should be mandatory. Scattered landscape of biodiversity monitoring communities needs national coordination, preferably by the ministry of the environment. The link between biodiversity monitoring, indicators and decision making needs to be also clarified and developed further

Survey respondent 15 (Kosovo)

1. How are biodiversity monitoring data currently used for national and local policy making in your country?

A **Current biodiversity monitoring scheme (and frequency)**	B **Relevant policy or management action at national or local level**	C **Relevant indicator & spatial resolution**	D **How exactly does this data lead to action (decision making, planning, management)? Please describe**	E **Weblink URL to monitoring scheme**
No national breeding bird survey (annually)	*Art. 12 Birds Directive / national biodiversity strategy / Ramsar sites*	*Number of breeding pairs of each bird species per km² (or per site or per district)*	*Data is sent to the EU for international reporting. Nationally, negative trends trigger restoration action of e.g. Ramsar wetland sites and species specific action programmes*	
No monitoring the impact of air pollution on ecosystems	*Air quality policy, reporting under Art. 9 of the National Emissions Ceiling directive*	*Ozone foliar damage to trees and crops (200 sites in the country)*	*Data is sent to the EU for international reporting. The data is used for monitoring the health of forests.*	
We have a short report of the invasive alien species, but actually we aren't do the monitoring of this plants, yet	*No management of natural areas, rivers and forests; EU regulation on invasive alien species*	*No monitoring programme based on a network of voluntary observations of invasive alien species and targeted species monitoring in areas under high risk.*	*No data is used for national and regional programmes that target the removal of invasive alien species (planning of resources, actions for removing IAS)*	No

2. Please expand your answer given in Table 1 by providing one or several concrete examples: How are biodiversity data used to identify biodiversity problems and trigger policy formulation in your country (figure 1, parts 1-2)?

The Kosovo Institute for Nature Protection – KINP is responsible to monitor the biodiversity and during this process we saw that the biodiversity in some parts is in the threats, because of Hydropower, constructions and quarry activities. After the field visit we prepare the report and send them to the responsible institution in the ministry (or municipality) and inform them about the impact of these activities on the biodiversity and nature values.
Based on the real situation recently there were established the working group for reviewing the all documents of the Hydropower and the quarry's company in order to see if they are working/respecting the environmental rules and the laws

3. Please expand your answer given in Table 1 by providing one or several concrete examples: How have biodiversity data informed national and local action in your country (e.g. establishment of new protected areas, triggering land use change, more sustainable forest management) (figure 1, parts 3-4)?

The two national parks were established based in the existing biodiversity data, same is for the establishing process of the other category of the protect areas

4. Please expand your answer given in Table 1 by providing one or several concrete examples: Does your country integrate biodiversity data in models and scenarios, e.g. modelling distribution of habitat suitability, future trends or the consequences of interventions (figure 1, parts 5-6)?

Not yet

5. Please provide one or several concrete examples: If biodiversity data is currently not (sufficiently) used for policymaking or for informing action in your country, what would be needed for this to happen?

The problem is that till now here the environment issues in general and the nature issues in particular weren't priority for the government, but now I hope the situation will be changed

Survey respondent 16 (Switzerland)

1. How are biodiversity monitoring data currently used for national and local policy making in your country?

A **Current biodiversity monitoring scheme (and frequency)**	B **Relevant policy or management action at national or local level**	C **Relevant indicator & spatial resolution**	D **How exactly does this data lead to action (decision making, planning, management)? Please describe**	E **Weblink URL to monitoring scheme**
Red Lists - *Species* - *Habitats* *Species specific nationwide monitoring projects (e.g. some amphibians like salamanders, …)*		*Rote Liste Gefässpflanzen* 2016 *Rote Liste der Prachtkäfer, Bockkäfer, Rosenkäfer und Schröter* 2016 *Rote Liste Fledermäuse* 2011 *Rote Liste der Tagfalter und Widderchen* Papilionoidea, Hesperioidea und Zygaenidae. 2012 *Rote Liste Weichtiere (Schnecken und Muscheln)* 2010 *Rote Listen Eintagsfliegen,*	*Determination of priorities in species and habitat conservation* *Elaboration of action plans*	https://www.bafu.admin.ch/bafu/de/home/themen/biodiversitaet/zustand/biodiversitaet--monitoringprogramme/rote-listen.html https://www.infospecies.ch/de/ https://www.infoflora.ch/en/habitats/red-list.html

		Steinfliegen, Köcherfliegen Stand 2010. *Rote Liste Armleuchteralgen* 2010 *Rote Liste Brutvögel* 2010 *Rote Liste der gefährdeten Arten der Schweiz: Grosspilze* 2007 *Rote Liste der gefährdeten Arten der Schweiz: Heuschrecken* 2007 *Rote Liste der gefährdeten Arten der Schweiz: Fische und Rundmäuler* 2007 *Rote Liste der gefährdeten Arten der Schweiz: Amphibien* 2005 *Rote Liste der gefährdeten Arten*		

		der Schweiz: Reptilien 2005 *Rote Liste der gefährdeten Arten der Schweiz: Moose* 2004 *Rote Liste der gefährdeten Arten der Schweiz: Baum- und erdbewohnende Flechten* 2002 *Rote Liste der gefährdeten Arten der Schweiz: Libellen* 2002 *Rote Liste der gefährdeten Arten der Schweiz: Farn- und Blütenpflanzen* 2002 *Rote Listen der gefährdeten Tierarten der Schweiz* 1994		

		Red List of 162 habitat types		
Swiss Biodiversity Monitoring				https://www.biodiversitymonitoring.ch/index.php/en/
Bird Monitorings: - *Common Breeding Birds* - *Swiss Breeding Bird Atlas* - *Wintering Waterbirds* - *Rare breeding and visiting birds* - *Breeding birds in wetlands* - *Selected species*				https://www.vogelwarte.ch/en/projects/monitoring/

Monitoring the Effectiveness of Habitat Conservation in Switzerland WBS		remote sensing approaches as well as extensive floristic and faunistic field surveys mires (fens and raised bogs), dry grasslands, and flood plain habitats as well as amphibian breeding sites	*Data is used for national and regional programmes and measures that are co-financed by the Federation and the cantons.* Traffic light system informs cantonal administration about necessity of conservation/restoration measures	https://biotopschutz.wsl.ch/en/index.html
ALL-EMA 'Agricultural Species and Habitats' Monitoring Programme			Optimization of agrienvironmental schemes (compensation measures, financing,…)	https://www.agroscope.admin.ch/agroscope/en/home/topics/environment-resources/monitoring-analytics/monitoring-programm-all-ema.html
Swiss National Forest Inventory				https://www.lfi.ch/

Monitoring natural forest reserves in Switzerland				https://www.wsl.ch/en/forest/biodiversity-conservation-and-primeval-forests/natural-forest-reserves.html
hunting statistics large carnivores national beaver counting				https://www.jagdstatistik.ch/de/home https://www.kora.ch/index.php?id=5&L=1 http://www.cscf.ch/cscf/de/home/biberfachstelle/nationale-biberbestandeserhebu-2.html
Fisheries statistics				www.fischereistatistik.ch
National Surface Water Quality Monitoring Programme (NAWA) and National River Monitoring and Survey Programme (NADUF)		NAWA and NADUF NABO-BIO Classical microbiological		https://www.bafu.admin.ch/bafu/en/home/topics/water/state/water--monitoring-networks/national-surface-water-quality-monitoring-programme--nawa-.html

NABObio – biological soil monitoring of NABO		parameters, such as microbial biomass and soil respiration composition of fungal and bacterial		https://www.agroscope.admin.ch/agroscope/en/home/topics/environment-resources/soil-bodies-water-nutrients/nabo/monitoring/nabobio.html
Landscape monitoring				https://www.wsl.ch/en/landscape/landscape-development-and-monitoring/landscape-monitoring.html

2. Please expand your answer given in Table 1 by providing one or several concrete examples: How are biodiversity data used to identify biodiversity problems and trigger policy formulation in your country (figure 1, parts 1-2)?

Indicators presented on website and partly integrated in sustainability indicators Regular reports of different monitoring programs, synthesis reports of monitoring programs and red lists, integration in federal environmental reports Factsheets on selected issues based on monitorings (e.g. linking nitrogen deposition or climate change with changes in species abundance, distribution and community composition) Traffic light system for nationally protected habitats

Scientific analysis, publication in peer-reviewed journals which are for example communicated to administration and policy by a newsletter or reports of the Swiss biodiversity forum

Basis for stakeholder-workshops

3. Please expand your answer given in Table 1 by providing one or several concrete examples: How have biodiversity data informed national and local action in your country (e.g. establishment of new protected areas, triggering land use change, more sustainable forest management) (figure 1, parts 3-4)?

Evaluation of agri-envrionmental schemes and optimization of compensation measures

Allocation of financial ressources for a Restoration program of nationally protected areas

Identifiying priority species for conservation projects/action plans, setting regional conservation priorities in cantons and corresponding and allocation of financial ressources

identifiying target species in agriculture

Basis of identification of important biodiversity areas for the planning of an ecological infrastructure in Switzerland

4. Please expand your answer given in Table 1 by providing one or several concrete examples: Does your country integrate biodiversity data in models and scenarios, e.g. modelling distribution of habitat suitability, future trends or the consequences of interventions (figure 1, parts 5-6)?

ValPar.CH – Values of the ecological infrastructure in Swiss parks
Commissioned by the Swiss Federal Office for the Environment (FOEN), the interdisciplinary research team in charge of the research project ValPar.CH examines the benefits and added values of the ecological infrastructure (EI) in parks of national importance. This network of ecologically valuable areas forms the basis of ensuring the social, economic and ecological values of nature's contributions to people (NCP, ecosystem services).
https://valpar.ch/index_en.php?page=home_en

Habitat Map of Switzerland

The Federal Office for the Environment (FOEN) therefore commissioned WSL to carry out a pilot study.
https://www.wsl.ch/en/publicationssearch/diagonal-the-wsl-magazine/focus/biodiversity-living-varieties-under-pressure/habitat-map-of-switzerland.html

Analysis for an Ecological Infrastructure in Switzerland
The Federal Office for the Environment (FOEN) commissioned InfoSpecies to carry out an analysis for the most important sites in Switzerland to conserve biodiversity.
https://www.infospecies.ch/de/projekte/ökologische-infrastruktur.html

Scientific studies on different species

5. Please provide one or several concrete examples: If biodiversity data is currently not (sufficiently) used for policymaking or for informing action in your country, what would be needed for this to happen?

- Linking pressure data and biodiversity data
- lacking data on management
- Some Data is not accessible and easier access to data
- Lacking funds for analysis of collected data
- "hot topic" data or longtime data series lacking as for example for insect biomass and abundance
- No demand on the part of politicans (who have other higher ranking priorities than biodiversity)
- Lacking understanding or disinterest on differences in long- and shortterm trends respectively "what is an intact biodiversity state" by decision makers
- national data "not sufficient" to inform decisions on cantonal or communal levels and lacking links/coordination between national and cantonal data
- …

Survey respondent 17 (Slovakia)

1. How are biodiversity monitoring data currently used for national and local policy making in your country?

A **Current biodiversity monitoring scheme (and frequency)**	B **Relevant policy or management action at national or local level**	C **Relevant indicator & spatial resolution**	D **How exactly does this data lead to action (decision making, planning, management)? Please describe**	E **Weblink URL to monitoring scheme**
Monitoring of habitats and species according to the Habitats Directive obligations	*Art. 17 Habitats Directive*	*Conservation status per site/per biogeographical region*	*Data is sent to the EU for international reporting, used for national policy making, preparation of national biodiversity strategy and action plan (NBSAP), National Action plan for Wetlands, Prioritised Action Framework For Natura 2000, in process of management planning for Natura 2000 sites + also other relevant policies, such as the Common Agricultural Policy, Common Fisheries Policy, etc.*	www.biomonitoring.sk
Monitoring of birds according to the Birds Directive	*Art. 12 Birds Directive*	*Population size and trends on national level*	*Data is sent to the EU for international reporting, used for national policy making, preparation of national biodiversity strategy and action plan (NBSAP), National Action Plan for Wetlands, Prioritised Action Framework For Natura 2000in process of management planning for Natura 2000 sites + also other relevant policies, such as the Common Agricultural Policy, Common Fisheries Policy, etc...*	www.biomonitoring.sk
There are also several other monitoring activities, but they are rather scattered among different organizations and institutions, so we will have to harmonize them slowly…			*Data are used for different purposes, which will need to be also harmonized.*	

Mapping and monitoring of invasive alien species	Art. 14 REGULATION (EU) No 1143/2014, acc. to the law of 150/2019 on IAS	Cumulative numbers of invasive alien species in Slovakia, Rate of Invasive Alien Species Spread	Data is sent to the EU for international reporting, national policy making, planning management of invasive alien species, management plans for protected areas, etc.	www.biomonitoring.sk
Mapping of ecosystems and their services	RRP, National Restoration Plan	Various, ecosystem –based	Mapping of ecosystems and their services in combination with the data from the Habitats and Birds Directive monitoring fit into the completion of some tasks from the Recovery and Resilience Plan and will provide a basis for National Restoration Plan.	
Monitoring of pollinators	European Pollinators Initiative	List of priority species & spatial resolution based on the chosen methodology	Due to a rapid decline in pollinator species, SK needs to strengthen monitoring capacities at the national and local level. The Habitats Directive does not cover their protection enough. With the help of the universities and the agri-sector we are preparing the analysis of the current state of pollinators monitoring in Slovakia and will create a framework to build on this.	

2. Please expand your answer given in Table 1 by providing one or several concrete examples: How are biodiversity data used to identify biodiversity problems and trigger policy formulation in your country (figure 1, parts 1-2)?

At the moment, biodiversity data are used especially in relation to N2000 reporting purposes, setting out and update the objectives and protective measures for habitats and species of Community interest and to inform national biodiversity strategy. According the data we formulate and streamline the measures in national action plans – Biodiversity National Action Plan, National Action Plan for Wetlands etc. In relation to implementation of the Convention on Biological Diversity (CBD) a set of 64 indicators exists, but their usage is limited (there are significant differences between the quality of data, cooperation with relevant institutions, etc.) – Ministry of Environment of the Slovak Republic together with the Slovak Environment Agency are slowly updating this system together to make it useful for all relevant (not only biodiversity related)

purposes.

3. Please expand your answer given in Table 1 by providing one or several concrete examples: How have biodiversity data informed national and local action in your country (e.g. establishment of new protected areas, triggering land use change, more sustainable forest management) (figure 1, parts 3-4)?

Biodiversity data are partially used for example in relation to the status of the protected areas, establishment of new protected areas, realization of management measures in protected areas and elaborating rescue programme for species. There is much more potential to use biodiversity monitoring data such as in the field of sustainable forest management, biodiversity in agricultural landscape, land cover change assessment, environmental criminality, protection and management of wetlands – this should be feasible especially when the exchange of data among different national and local organizations and institutions will be enhanced.

4. Please expand your answer given in Table 1 by providing one or several concrete examples: Does your country integrate biodiversity data in models and scenarios, e.g. modelling distribution of habitat suitability, future trends or the consequences of interventions (figure 1, parts 5-6)?

Biodiversity data in models and scenarios are used, but only partially – their use could be significantly improved.
Institute on environmental policy (IEP) - an independent analytical unit of Ministry of Environment of the Slovak Republic, provide reliable analyzes and forecasts in the field of environment for the Slovak government and the public, whereas biodiversity data provides part of the input where necessary (this could increase significantly in the future). IEP evaluates the economic effectiveness of the measures, provides evaluation and proposal of new policies. The IEP also provides strategic insight and direction for the ministry (Envirostrategy 2030). However, IEP is mostly focused on the economical side of the environment. Example of covered topics so far: monitoring of logging, expansion of non-intervention protected areas, green fiscal reforms, etc.
There are two others publications elaborated by Slovak experts 1. "Environmental Scenarios 2020+ Sustainable Growth, Biodiversity and Climate Change" (2018)
https://www.researchgate.net/publication/326128303_ENVIRONMENTAL_SCENARIOS_2020_SUSTAINABLE_GROWTH_BIODIVERSITY_AND_CLIMATE_CHANGE_SUMMARY;
2. "Nature Outlook 2050 – Scenarios for Nature in Slovakia and implications for public policies" (2020)
https://www.researchgate.net/publication/343306281_Nature_Outlook_2050_Scenarios_for_nature_in_Slovakia_and_implications_for_public_policies.

5. Please provide one or several concrete examples: If biodiversity data is currently not (sufficiently) used for policymaking or for informing action in your country, what would be needed for this to happen?

First of all, what we see as the most important step is to make the exchange of data within the country more effective – then we could identify the gaps and see what kind of data is missing. This would also improve setup of financial allocations and human expertise. However, the data across different environmentally related sectors are scattered between organisations and widely fragmented, thus harmonisation and more coordinated access is needed.

Survey respondent 18 (Estonia)

1. How are biodiversity monitoring data currently used for national and local policy making in your country?

A **Current biodiversity monitoring scheme (and frequency)**	**B** **Relevant policy or management action at national or local level**	**C** **Relevant indicator & spatial resolution**	**D** **How exactly does this data lead to action (decision making, planning, management)? Please describe**	**E** **Weblink URL to monitoring scheme**
Beached Bird Survey	*HELCOM*		Data is used for international reporting.	Monitoring data, reports and descriptions of methods are available https://kese.envir.ee/ (only in Estonian)
National breeding bird survey (annually) -several different surveys for different habitats (e.g. forest birds, wetland birds, coastal	EU Habitats directive, *Birds Directive, national biodiversity strategies and action*	*Number of breeding pairs, number of specimens, indicators for*	Data is used for international reporting. Data is nationally used for making policy decisions, planning protective measures, assessing effectiveness of protection measures etc.	Monitoring data, reports and descriptions of methods are available

meadows, small islands etc.)	*plans*	*assessing habitat quality*		https://kese.envir.ee/ (only in Estonian)
Monitoring of birds of prey and + black stork (Ciconia nigra) (annually)- includes several different surveys dedicated for certain species	EU Habitats directive, *Birds Directive, national biodiversity strategies and action plans*	*Number of breeding pairs, number of specimens, number of offspring*	Data is used for international reporting. Data is nationally used for making policy decisions, planning protective measures, assessing effectiveness of protection measures etc.	Monitoring data, reports and descriptions of methods are available https://kese.envir.ee/ (only in Estonian)
Monitoring important sites for migratory birds (geese, Grus grus, swans (each group once in 3 years)	EU Habitats directive, *Birds Directive, national biodiversity strategies and action plans*	*Number of specimens*	Data is used for international reporting. Data is nationally used for making policy decisions, planning protective measures, assessing effectiveness of protection measures etc.	Monitoring data, reports and descriptions of methods are available https://kese.envir.ee/ (only in Estonian)
National wintering bird survey (annually) – forest birds, birds of prey, seabirds	*Birds Directive, national biodiversity strategies and action plans*	*Number of specimens*	Data is used for international reporting. Data is nationally used for making policy decisions, planning protective measures, assessing effectiveness of protection measures etc.	Monitoring data, reports and descriptions of methods are available https://kese.envir.ee/ (only in Estonian)
Bird migration monitoring in Kabli and Pulgoja Bird Centre – (annually in autumn) bird ringing		*Number of specimens*		Monitoring data, reports and descriptions of methods are available https://kese.envir.ee/ (only in Estonian)
National amphibian survey + citizen science project in	EU Habitats directive*, national*	*Number of specimens/egs/spa*	Data is used for international reporting. Data is nationally used for making policy decisions,	Monitoring data, reports and

last 3 years + specialize survey for Bufo calamita (annually)	*biodiversity strategies and action plans*	*wn/, indicators for assessing habitat quality*	planning protective measures, assessing effectiveness of protection measures etc.	descriptions of methods are available https://kese.envir.ee/ (only in Estonian)
Monitoring of European mink (Mustela lutreola) restored population	EU Habitats directive*, national biodiversity strategies and action plans*		Data is used for international reporting. Data is nationally used for making policy decisions, planning protective measures, assessing effectiveness of protection measures etc.	Monitoring data, reports and descriptions of methods are available https://kese.envir.ee/ (only in Estonian)
National Siberian flying squirrel (Pteromys volans) survey (annually)	EU Habitats directive*, national biodiversity strategies and action plans*	Number of inhabited habitats	Data is used for international reporting. Data is nationally used for making policy decisions, planning protective measures, assessing effectiveness of protection measures etc.	Monitoring data, reports and descriptions of methods are available https://kese.envir.ee/ (only in Estonian)
National grey seal survey (annually)	EU Habitats directive, HELCOM*, national biodiversity strategies and action plans*	*Number of specimens*	HELCOM	Monitoring data, reports and descriptions of methods are available https://kese.envir.ee/ (only in Estonian)
National ringed seal survey (every 3. year)	HELCOM*, national biodiversity strategies and action plans*	*Number of specimens*	HELCOM	Monitoring data, reports and descriptions of methods are available https://kese.envir.ee/

				(only in Estonian)
National bat survey (annually)	EU Habitats directive, EUROBATS, *national biodiversity strategies and action plans*		Data is used for international reporting. Data is nationally used for making policy decisions, planning protective measures, assessing effectiveness of protection measures etc.	Monitoring data, reports and descriptions of methods are available https://kese.envir.ee/ (only in Estonian)
National bat hibernation site survey (annually)	EU Habitats directive, EUROBATS, *national biodiversity strategies and action plans*	*Number of specimens per site*	Data is used for international reporting. Data is nationally used for making policy decisions, planning protective measures, assessing effectiveness of protection measures etc.	Monitoring data, reports and descriptions of methods are available https://kese.envir.ee/ (only in Estonian)
National Eurasian otter (Lutra lutra) survey	EU Habitats directive, *national biodiversity strategies and action plans*	Number of inhabited habitats	Data is used for international reporting. Data is nationally used for making policy decisions, planning protective measures, assessing effectiveness of protection measures etc.	Monitoring data, reports and descriptions of methods are available https://kese.envir.ee/ (only in Estonian)
National sand lizard (Lacerta agilis) survey	EU Habitats directive, *national biodiversity strategies and action plans*	Number of specimens	Data is used for international reporting. Data is nationally used for making policy decisions, planning protective measures, assessing effectiveness of protection measures etc.	Monitoring data, reports and descriptions of methods are available https://kese.envir.ee/ (only in Estonian)
National European crayfish (*Astacus astacus*) survey (annual)	EU Habitats directive, *national biodiversity*	CPUE (catch per unit effort) per site	Data is used for international reporting. Data is nationally used for making policy decisions, planning protective measures, assessing	Monitoring data, reports and descriptions of

	strategies and action plans		effectiveness of protection measures etc.	methods are available https://kese.envir.ee/ (only in Estonian)
National freshwater pearl mussel (*Margaritifera margaritifera*)survey (every third year)	EU Habitats directive*, national biodiversity strategies and action plans*	Number of alive/dead specimens	Data is used for international reporting. Data is nationally used for making policy decisions, planning protective measures, assessing effectiveness of protection measures etc.	Monitoring data, reports and descriptions of methods are available https://kese.envir.ee/ (only in Estonian)
National snail species survey (annually) – focus in on protected species	EU Habitats directive*, national biodiversity strategies and action plans*	Number of alive/dead specimens	Data is used for international reporting. Data is nationally used for making policy decisions, planning protective measures, assessing effectiveness of protection measures etc.	Monitoring data, reports and descriptions of methods are available https://kese.envir.ee/ (only in Estonian)
National butterfly survey (annually) – separate work for day and night species	EU Habitats directive*, national biodiversity strategies and action plans*	Number of species, number of specimens	Data is used for international reporting. Data is nationally used for making policy decisions, planning protective measures, assessing effectiveness of protection measures etc.	Monitoring data, reports and descriptions of methods are available https://kese.envir.ee/ (only in Estonian)
National bumblebee survey – (frequency is still under debate	*national biodiversity strategies and action plans*	Number of species, number of specimens	Data is nationally used for making policy decisions, planning protective measures, assessing effectiveness of protection measures etc.	Monitoring data, reports and descriptions of methods are available https://kese.envir.ee/ (only in Estonian)

National European medicinal leech survey (annually)	EU Habitats directive*, national biodiversity strategies and action plans*	Number of specimens	Data is nationally used for making policy decisions, planning protective measures, assessing effectiveness of protection measures etc.	Monitoring data, reports and descriptions of methods are available https://kese.envir.ee/ (only in Estonian)
National protected plant species monitoring (annually)	EU Habitats directive*, national biodiversity strategies and action plans*	Status of habitata, number on speciments	Data is nationally used for making policy decisions, planning protective measures, assessing effectiveness of protection measures etc.	Monitoring data, reports and descriptions of methods are available https://kese.envir.ee/ (only in Estonian)
National protected moss species monitoring (annually)	EU Habitats directive*, national biodiversity strategies and action plans*	Status of habitata, number on speciments	Data is nationally used for making policy decisions, planning protective measures, assessing effectiveness of protection measures etc.	Monitoring data, reports and descriptions of methods are available https://kese.envir.ee/ (only in Estonian)
National protected fungi species monitoring (annually)	*national biodiversity strategies and action plans*	Conformation weather the species is present	Data is nationally used for making policy decisions, planning protective measures, assessing effectiveness of protection measures etc.	Monitoring data, reports and descriptions of methods are available https://kese.envir.ee/ (only in Estonian)
Monitoring on EU directive habitats annually	EU Habitats directive*, national biodiversity strategies and action*	Different indicators to detect the status of the habitat	Data is nationally used for making policy decisions, planning protective measures, assessing effectiveness of protection measures etc.	Monitoring data, reports and descriptions of methods are

	plans			available https://kese.envir.ee/ (only in Estonian)
Monitoring of ungulates (annually)		Number of speciments	According to the results and suggestions by Environment Agency, Environmental Board decides every year how many hunting permits will be issued to regulate the no of the hunting species	
Monitoring of bears (annually)	Derogation Reports under Article 9 of the Birds Directive and Article 16 of the Habitats Directive; protection and control plan for large carnivores	number of speciments	According to the results and suggestions by Environment Agency, Environmental Board decides every year how many hunting permits will be issued to regulate the no of the bears	
Monitoring of lynx (annually)	Derogation Reports under Article 9 of the Birds Directive and Article 16 of the Habitats Directive; protection and control plan for large carnivores	number of speciments	According to the results and suggestions by Environment Agency, Environmental Board decides every year how many hunting permits will be issued to regulate the no of the lynx (in recent years the no has been 0)	
Monitoring of the wolves (annually)	Derogation Reports under Article 9 of the Birds Directive and Article 16 of the Habitats Directive; protection and control plan for large carnivores	number of pacts and speciments	According to the results and suggestions by Environment Agency, Environmental Board decides every year how many hunting permits will be issued to regulate the no of the wolves	

Monitoring of the beavers	Derogation Reports under Article 9 of the Birds Directive and Article 16 of the Habitats Directive; protection and control plan for the beavers	number of speciments	According to the results and suggestions by Environment Agency, Environmental Board decides every year how many hunting permits will be issued to regulate the no of the beavers	

2. Please expand your answer given in Table 1 by providing one or several concrete examples: How are biodiversity data used to identify biodiversity problems and trigger policy formulation in your country (figure 1, parts 1-2)?

In Estonia Environmental Board is using monitoring data to prepare management plans for the protected areas and protected species (e.g eagles, beavers etc.) Also we monitor game species and this data is used for issuing hunting permits.

3. Please expand your answer given in Table 1 by providing one or several concrete examples: How have biodiversity data informed national and local action in your country (e.g. establishment of new protected areas, triggering land use change, more sustainable forest management) (figure 1, parts 3-4)?

Data from National Siberian flying squirrel (Pteromys volans) survey is actively used to make forest management decisions. State Forest Management Centre is checking suitable forests before clear-cuts to determine presence of the species. Monitoring data is also considered by Estonian Environmental Board before granting forest management permits to private forest managers. Clearcutting in species habitats is prohibited.

4. Please expand your answer given in Table 1 by providing one or several concrete examples: Does your country integrate biodiversity data in models and scenarios, e.g. modelling distribution of habitat suitability, future trends or the consequences of interventions (figure 1, parts 5-6)?

We have habitat models for several species and survey sites are in many cases selected using habitat models. Flying squirrel example was mentioned before.

5. Please provide one or several concrete examples: If biodiversity data is currently not (sufficiently) used for policymaking or for informing action in your country, what would be needed for this to happen?

Many wildlife groups, habitat types or some certain species would benefit from bigger sample size. For example ringed seal monitoring is carried out on every third year, although HELCOM advises us to do it on yearly bases. We have rare species that are not sampled enough because of too small monitoring sample or what would even need specialized monitoring scheme.

Survey respondent 19 (Latvia)

1. How are biodiversity monitoring data currently used for national and local policy making in your country?

A **Current biodiversity monitoring scheme (and frequency)**	B **Relevant policy or management action at national or local level**	C **Relevant indicator & spatial resolution**	D **How exactly does this data lead to action (decision making, planning, management)? Please describe**	E **Weblink URL to monitoring scheme**
Countrywide monitoring of the common birds. Annual, non-specific census of breeding birds (all breeding species are recorded)	*Art. 12 Birds Directive/ The National Development Plan 2021-2027/ Latvia's environmental policy concept*	*Population trends data for ~106 most common breeding bird species in Latvia.*	*Data are sent to the Pan-European Common Bird Monitoring Scheme for international reporting. Nationally, negative trends trigger species specific action programmes in the case of some species. OECD Index of population trends of forest birds and Index of population trends of farmland birds. Data taken into account in developing the Priority Action Framework for Natura 2000 network in Latvia*	https://www.daba.gov.lv/lv/media/3793/download
Countrywide monitoring of the night active birds in farmland. The main target species of this monitoring is	*Art. 12 Birds Directive/ The National Development Plan*	*Population trends data for ~12 most common night active breeding*	*Nationally, the data are considered in the national common agricultural policy (Lauku attīstības programma). Data taken into account in developing the Priority Action Framework for*	https://www.daba.gov.lv/lv/media/11662/download

Corncrake (Crex crex), but data are collected for ~10 other bird species active at night. Annual, non-specific census of breeding birds (all night active breeding species are recorded)	*2021-2027/ Latvia's environmental policy concept*	*bird species in Latvia.*	*Natura 2000 network in Latvia*	
Countrywide monitoring scheme for Birds of Prey and Owls. This monitoring collects data on the 18 species of Birds of Prey and 9 owl species. Annual, specific census of birds of prey and owls.	*Art. 12 Birds Directive/ The National Development Plan 2021-2027/ Latvia's environmental policy concept*	*Population trends data for 27 breeding bird species in Latvia.*	*Nationally, negative trends trigger species specific action programmes in the case of some species. Data taken into account in developing the Priority Action Framework for Natura 2000 network in Latvia*	https://www.daba.gov.lv/lv/media/7953/download
Counts of wintering waterfowl at the seacoast and in the inland water bodies. Annual, within the framework of Wetlands International Waterbird Census.	*Art. 12 Birds Directive/ The National Development Plan 2021-2027/ Latvia's environmental policy concept*	*Total number of wintering birds on the coast. Population trends data for ~22 wintering bird species/species groups in Latvia.*	*Data are sent to the Wetlands International for international reporting and used to calculate the HELCOM indicators.*	https://www.daba.gov.lv/lv/media/8387/download
Aerial (plane based) line transect surveys of wintering waterfowl in the Baltic Sea. Annual "index" counts and total counts every six years.	*Art. 12 Birds Directive/ The National Development Plan 2021-2027/ Latvia's environmental policy concept*	*Distribution and density of ~15 wintering bird species/species groups in Latvia.*	*Data are used in HELCOM-OSPAR-ICES Joint Working Group on seabirds and AEWA to calculate the indicators for whole Baltic sea region.*	https://www.daba.gov.lv/lv/media/3792/download
Coastal breeding bird monitoring. Annual, specific	*Art. 12 Birds Directive/ The*	*Population trends data for ~10*	*Nationally, negative trends trigger species specific action programmes in the case of some species.*	https://www.daba.gov.lv/lv/media/1110

census of coastal breeding birds all along the coast of Latvia.	*National Development Plan 2021-2027/ Latvia's environmental policy concept*	*coastal breeding bird species in Latvia.*		5/download
Latvian Breeding Bird Atlas. Distribution of 212 breeding bird species. Once every 20 years. Current project period 2020.-2024.	*Art. 12 Birds Directive/ The National Development Plan 2021-2027/ Latvia's environmental policy concept*	*Distribution of 212 breeding bird species in 5 x 5 km square resolution.*	*Nationally, negative trends trigger species specific action programmes in the case of some species. Data taken into account in developing the Priority Action Framework for Natura 2000 network in Latvia*	https://www.daba.gov.lv/lv/media/3796/download
Monitoring of breeding birds in biologically valuable grasslands. Annual, specific census of breeding birds in the grasslands with a special status in the national common agricultural policy - biologically valuable grasslands.	*/ The National Development Plan 2021-2027/ Latvia's environmental policy concept /National common agricultural policy.*	*Distribution and density of 28 grassland breeding bird species in 20 randomly selected plots.*	*Nationally, the data are considered in the national common agricultural policy (Lauku attīstības programma). Data taken into account in developing the Priority Action Framework for Natura 2000 network in Latvia*	https://www.zm.gov.lv/public/ck/files/ZM/TP%20petijumi/20131121_BVZ_kartesanas_metodika.pdf (pages 25-36)
Black stork Ciconia nigra monitoring. Annual, specific monitoring of black stork nesting success.	*Art. 12 Birds Directive/ The National Development Plan 2021-2027/ Latvia's environmental policy concept*	*Black stork nesting success in 100 nests.*	*An analysis of the factors influencing the success of black stork nesting is performed. The findings are used in the environmental impact assessment process. Data taken into account in developing the Priority Action Framework for Natura 2000 network in Latvia*	https://www.daba.gov.lv/lv/media/4240/download
Monitoring of invasive alien plant species. Planed once in 4 years.	*EU regulation on invasive alien species/ The National*	*Occurrence of species and population size dynamics.*	*Data is sent to the EU for international reporting. Nationally. Overall trends. Data will be used for national and regional programmes that target*	https://www.daba.gov.lv/lv/media/4399/download

Not fully implemented at present. The methodology should be adjusted according to the results obtained and their assessment	Development Plan 2021-2027/ Latvia's environmental policy concept	400 sample plots (5x 5 km)	the removal of invasive alien species (planning of resources, actions for removing IAS)	
Monitoring of invasive alien insect species. Annually.	EU regulation on invasive alien species/ The National Development Plan 2021-2027/ Latvia's environmental policy concept	Occurrence and distribution of species. Inspection of known localities and monitoring in 15 plots of national monitoring of invertebrates.	Data is sent to the EU for international reporting. Nationally. Overall trends. Data will be used for national and regional programmes that target the removal of invasive alien species (planning of resources, actions for removing IAS)	https://www.daba.gov.lv/lv/media/4399/download
Monitoring of invasive alien snail's species. Planed once in 5 years	EU regulation on invasive alien species/ The National Development Plan 2021-2027/ Latvia's environmental policy concept	Occurrence of species and number of	Data is sent to the EU for international reporting. Nationally. Overall trends. Data will be used for national and regional programmes that target the removal of invasive alien species (planning of resources, actions for removing IAS)	https://www.daba.gov.lv/lv/media/4399/download
Monitoring of invasive alien snail's species. Planed once in 5 years.	EU regulation on invasive alien species	Occurrence of species and number of individuals identified for each species. Inspection of known localities (15 in one year)	Data is sent to the EU for international reporting. Nationally. Overall trends. Data will be used for national and regional programmes that target the removal of invasive alien species (planning of resources, actions for removing IAS)	https://www.daba.gov.lv/lv/media/4399/download

Countrywide Acoustic monitoring of bats (annually)	*Art. 17 Habitat Directive / The National Development Plan 2021-2027/ Latvia's environmental policy concept / EUROBATS*	*Species occurrence (presence) and number of individuals found for each species. 25x25 km*	*Monitoring started only 2020. The data will be sent to the EU for international reporting and will be used for reporting – Art 17, Natura 2000 SDF, EURBATS*	*https://www.daba.gov.lv/lv/media/3798/download*
Myotis dasycneme inventory in colony headquarters (annually). Visual record of flying bats at the colony	*Art. 17 Habitat Directive / The National Development Plan 2021-2027/ Latvia's environmental policy concept / EUROBATS*	*Number of adult females. 20 colonies*	*Data is sent to the EU for international reporting (Art 17, EUROBATS). Nationally. Overall trends. Data taken into account in developing the Priority Action Framework for Natura 2000 network in Latvia*	https://www.daba.gov.lv/lv/media/3799/download
Countrywide Monitoring of wintering bats. Species occurrence (presence) and number of individuals found for each species	*Art. 17 Habitat Directive / The National Development Plan 2021-2027/ Latvia's environmental policy concept / EUROBATS*	*148 large headquarters and systematically deployed small basement monitoring plots (25x25 km)*	*Data is sent to the EU for international reporting (Art 17, EUROBATS). Nationally. Overall trends. Data taken into account in developing the Priority Action Framework for Natura 2000 network in Latvia*	https://www.daba.gov.lv/lv/media/3800/download
Countrywide monitoring of Eurasian otter Lutra lutra. Once in 6 years.	*Art. 17 Habitat Directive / The National Development Plan 2021-2027/ Latvia's environmental policy concept*	*Relative occurrence, in 10x 10 km 4 monitoring points/places*	*Data is sent to the EU for international reporting (Art 17). Nationally. Overall trends. Data taken into account in developing the Priority Action Framework for Natura 2000 network in Latvia*	https://www.daba.gov.lv/lv/media/3808/download
Countrywide monitoring of Brown bear Ursus arctos. Annually.	*Art. 17 Habitat Directive / The National Development Plan*	*Systematic accumulation of occurrence observations. Molecular genetic*	*Data is sent to the EU for international reporting (Art 17). Nationally. Overall trends. Data taken into account in developing the Priority Action Framework for Natura 2000 network in Latvia*	https://www.daba.gov.lv/lv/media/8109/download and https://www.daba.g

	2021-2027/ Latvia's environmental policy concept	*methods*		ov.lv/lv/media/11090/download
Countrywide and Natura 2000 sites Monitoring of fish. Annually. At monitoring also collected data about invasive fish and cancer species.	*Art. 17 Habitat Directive / The National Development Plan 2021-2027/ Latvia's environmental policy concept EU regulation on invasive alien species*	*Species occurrence (presence) and number of individuals found for each species. 50x50 km*	*Data is sent to the EU for international reporting (Art 17). Nationally. Overall trends. Data is also used in developing Natura 2000 site management plans. Data taken into account in developing the Priority Action Framework for Natura 2000 network in Latvia*	https://www.daba.gov.lv/lv/media/3776/download
Countrywide Monitoring of invertebrates (including monitoring of night and day butterflies, dragonflies and beetle (overhead fauna). Annually.	*Art. 17 Habitat Directive / The National Development Plan 2021-2027/ Latvia's environmental policy concept*	*Species occurrence (presence) and number of individuals found for each species. 50x50 km*	*Data is sent to the EU for international reporting (Art 17). Nationally. Overall trends*	https://www.daba.gov.lv/lv/media/3780/download
Countrywide Monitoring of amphibians and reptiles (including monitoring of all amphibians, Tritus cristatus, Emys orbicularis, Lacerta agilis). Once in 3 years.	*Art. 17 Habitat Directive / The National Development Plan 2021-2027/ Latvia's environmental policy concept*	*Relevant indicators amphibians and Tritus cristatus - occurrence of species and population size; Emys orbicularis - population size; Lacerta agilis - relative density of the population.*	*Data is sent to the EU for international reporting (Art 17). Nationally. Overall trends. Data taken into account in developing the Priority Action Framework for Natura 2000 network in Latvia*	https://www.daba.gov.lv/lv/media/8025/download
Monitoring of plants (Habitat directive Annex II	*Art. 17 Habitat Directive / The*	*Number of localities,*	*Data is sent to the EU for international reporting (Art 17, Natura 2000 SDF). Nationally. Overall*	https://www.daba.gov.lv/lv/media/1144

species). Countrywide and Natura 2000 site monitoring. Once in 6 years, exude Cypripedium calceolus – 3 times in 6 years.	*National Development Plan 2021-2027/ Latvia's environmental policy concept*	*population size. Survey of known localities.*	*trends. Data is also used in developing Natura 2000 site management plans. Data taken into account in developing the Priority Action Framework for Natura 2000 network in Latvia*	1/download
Monitoring of habitat areas. Countrywide and Natura 2000 site. Annually.	*Art. 17 Habitat Directive / The National Development Plan 2021-2027/ Latvia's environmental policy concept*	*Changes of area. Use national register data and will planed use remote sensing*	*Data is sent to the EU for international reporting (Art 17, Natura 2000 SDF). Nationally. Overall trends. Data is also used in developing Natura 2000 site management plans*	https://www.daba.gov.lv/lv/media/3775/download
Monitoring of migrant bats. Annually.	*Art. 17 Habitat Directive / The National Development Plan 2021-2027/ Latvia's environmental policy concept /EUROBATS*	*Number of migrating bats, population demographics (gender, age). One station in country - Pape*	*Data is sent to the EU for international reporting (Art 17, EUROBATS). Nationally. Overall trends*	https://www.daba.gov.lv/lv/media/4234/download
Monitoring of migrant birds. Annually.	*Art. 12 Birds Directive / The National Development Plan 2021-2027/ Latvia's environmental policy concept*	*Number of migrating birds, population demographics (gender, age). One station in country - Pape*	*Nationally, negative trends trigger species specific action programmes.*	https://www.daba.gov.lv/lv/media/4239/download
Monitoring of large predators (Canis lupus, Lynx lynx). Annually.	*Art. 17 Habitat Directive / The National Development Plan 2021-2027/ Latvia's*	*Population demography.*	*Data is sent to the EU for international reporting (Art 17). Nationally. Overall trends. Effects on farm animals. Compensation issues and policy planning. Setting hunting limits.*	https://www.daba.gov.lv/lv/media/4233/download

	environmental policy concept			
Monitoring of Dryomys nitedula. Annually.	*Art. 17 Habitat Directive / The National Development Plan 2021-2027/ Latvia's environmental policy concept*	*Distribution, population size, dynamics, structure*	*Data is sent to the EU for international reporting (Art 17). Nationally. Overall trends.*	https://www.daba.gov.lv/lv/media/4235/download
Monitoring of Muscardinus avellanarius. Annually.	*Art. 17 Habitat Directive / The National Development Plan 2021-2027/ Latvia's environmental policy concept*	*Distribution, population size, dynamics, structure*	*Data is sent to the EU for international reporting (Art 17). Nationally. Overall trends.*	https://www.daba.gov.lv/lv/media/4236/download
Monitoring of marine costal habitats. Planed annually, but, uncommon.	*Art. 17 Habitat Directive / The National Development Plan 2021-2027/ Latvia's environmental policy concept*	*Measurements of the dynamic processes of the seacoast, soil pollution, vegetation structure, species composition*	*Data is sent to the EU for international reporting (Art 17). Nationally. Overall trends.*	https://www.daba.gov.lv/lv/media/4409/download
Natura 2000 site monitoring of bats (Myotis dasycneme). Inventory in colony headquarters (annually) and Visual and acoustic observation of bats above water reservoirs (lakes) once in 2 years.	*Art. 17 Habitat Directive / The National Development Plan 2021-2027/ Latvia's environmental policy concept / EUROBATS*	*Population size. 33 Natura 2000 sites*	*Data is sent to the EU for international reporting (Art 17, EUROBATS). Nationally. Overall trends. Data is also used in developing Natura 2000 site management plans. Data taken into account in developing the Priority Action Framework for Natura 2000 network in Latvia*	https://www.daba.gov.lv/lv/media/8103/download

Natura 2000 site monitoring of Eurasian otter Lutra lutra. Once in 6 years.	*Art. 17 Habitat Directive / The National Development Plan 2021-2027/ Latvia's environmental policy concept*	*Population size. 70 Natura 2000 sites, 10x 10 km*	*Data is sent to the EU for international reporting (Art 17, Natura 200 SDF). Nationally. Overall trends. Data is also used in developing Natura 2000 site management plans. Data taken into account in developing the Priority Action Framework for Natura 2000 network in Latvia*	https://www.daba.gov.lv/lv/media/8105/download
Natura 2000 site monitoring of Brown bear Ursus arctos. Annually.	*Art. 17 Habitat Directive / The National Development Plan 2021-2027/ Latvia's environmental policy concept*	*Population size. Molecular genetic methods. 5 Natura 2000 sites,*	*Data is sent to the EU for international reporting (Art 17, Natura 200 SDF). Nationally. Overall trends. Data is also used in developing Natura 2000 site management plans. Data taken into account in developing the Priority Action Framework for Natura 2000 network in Latvia*	https://www.daba.gov.lv/lv/media/8109/download and https://www.daba.gov.lv/lv/media/11090/download
Natura 2000 site Monitoring of amphibians and reptiles (including monitoring of all amphibians and Bombina bombina, Tritus cristatus, Emys orbicularis, Coronella austriaca). Frequency: Bombina bombina, Tritus cristatus, Emys orbicularis - annually; Coronella austriaca -once in 3 years.	*Art. 17 Habitat Directive / The National Development Plan 2021-2027/ Latvia's environmental policy concept*	*Relevant indicators Bombina bombina and - Emys orbicularis - population size; Tritus cristatus and Coronella austriaca - relative density of the population.*	*Data is sent to the EU for international reporting (Art 17, Natura 200 SDF). Nationally. Overall trends. Data is also used in developing Natura 2000 site management plans. Data taken into account in developing the Priority Action Framework for Natura 2000 network in Latvia*	https://www.daba.gov.lv/lv/media/8025/download
Natura 2000 site Monitoring of invertebrates (including monitoring of night and day butterflies, dragonflies and beetle (overhead fauna). Once in 6 years	*Art. 17 Habitat Directive / The National Development Plan 2021-2027/ Latvia's environmental policy concept*	*Number of localities, population size. Natura 2000 sites and known localities*	*Data is sent to the EU for international reporting (Art 17, Natura 200 SDF). Nationally. Overall trends. Data is also used in developing Natura 2000 site management plans. Data taken into account in developing the Priority Action Framework for Natura 2000 network in Latvia*	https://www.daba.gov.lv/lv/media/8031/download; https://www.daba.gov.lv/lv/media/8035/download; https://www.daba.gov.lv/lv/media/8039/

				download; https://www.daba.gov.lv/lv/media/8043/download; https://www.daba.gov.lv/lv/media/8049/download; https://www.daba.gov.lv/lv/media/8053/download; https://www.daba.gov.lv/lv/media/8057/download; https://www.daba.gov.lv/lv/media/8061/download; https://www.daba.gov.lv/lv/media/8071/download; https://www.daba.gov.lv/lv/media/8075/download

2. Please expand your answer given in Table 1 by providing one or several concrete examples: How are biodiversity data used to identify biodiversity problems and trigger policy formulation in your country (figure 1, parts 1-2)?

Biodiversity data are used and evaluated in the development of the Latvia's environmental policy concept and formally also in the development of Latvia's Forest Policy concept. Data also used in the development of the Priority Action Framework for Natura 2000 network in Latvia, where defining priorities for management for which funding is to be diverted

3. Please expand your answer given in Table 1 by providing one or several concrete examples: How have biodiversity data informed national and local action in your country (e.g. establishment of new protected areas, triggering land use change, more sustainable forest management) (figure 1, parts 3-4)?

The data are considered in the national common agricultural policy - Index of population trends of farmland birds is viewed in the context of support schemes for farmers

4. Please expand your answer given in Table 1 by providing one or several concrete examples: Does your country integrate biodiversity data in models and scenarios, e.g. modelling distribution of habitat suitability, future trends or the consequences of interventions (figure 1, parts 5-6)?

In 2021 Latvia has started the implementation of the LIFE integrated project LIFE 19 IPE/LV/000010 "Optimising the Governance and Management of the Natura 2000 Protected Areas Network in Latvia ". The project will develop FRV for all habitat types of the EU importance, including the management plan / action plan for achievement of the FRV. Action plan may include provisions for connectivity, establishment of new protected areas, enhancement of the existing ones, as well as necessary management activities for achieving FRV. All these aspects will be taken into account in the analysis of the results of the country-wide habitat mapping.
In 2021 Latvia has also started the implementation of the LIFE project LIFE19 GIE/LV/000857 "Threatened species in Latvia: improved knowledge, capacity, data and awareness ". The project will update the list of endangered species and carry out an assessment of their degree of vulnerability in accordance with the criteria developed by the IUCN.
Three multi- species management plans have been developed for species groups – owls and woodpeckers. For woodpeckers and owls specific research and modelling to indicate most vulnerable sites for species protection has been conducted. The developed models shall be viewed by providing certified expert opinions, etc.

5. Please provide one or several concrete examples: If biodiversity data is currently not (sufficiently) used for policymaking or for informing action in your country, what would be needed for this to happen?

The data obtained should be complete, reliable, representative, with longer time trends, comparable with data obtained in other years.
Greater political will to take decisions - could affect economic activity and reduce the impact of economic development on natural resources

Survey respondent 20 (DG agri)

1. How are biodiversity monitoring data currently used for national and local policy making in your country?

A **Current biodiversity monitoring scheme (and frequency)**	B **Relevant policy or management action at national or EU level**	C **Relevant indicator & spatial resolution**	D **How exactly does this data lead to action (decision making, planning, management)? Please describe**	E **Weblink URL to monitoring scheme**
In the context of the CAP CMEF (PMEF in next CAP)	*Common Agricultural Policy*	*Most relevant to biodiversity are:* *C.31 Land cover* *C.32 LFA - ANC* *C.33 Farming intensity* *C.34 Natura 2000 area* *C.35 Farmland birds index* *C.36 Conservation status of agricultural habitats* *C.37 HNV farming* *C.38 Protected forest* *C.39 Water abstraction in agriculture* *C.40 Water quality* *C.41 Soil organic matter in arable land* *C.42 Soil erosion by water*	*CAP Context indicators are used to analyze the context and baseline situation of the agricultural sector. MS base their SWOT analysis and needs assessment on these data to build the CAP strategy at national level.* *Impact indicators coincide normally with context indicators and are used during CAP evaluations to assess if the policy has reached its objectives.*	At EU level, the CAP indicators are published in the agri food data portal in thematic and context indicators dashboards: https://agridata.ec.europa.eu/extensions/DataPortal/cmef_indicators.html Within the dashboards, one is dedicated to biodiversity: https://agridata.ec.europa.eu/extensions/DashboardIndicators/Biodiversity.html?select=EU27_FLAG,1

2. Please expand your answer given in Table 1 by providing one or several concrete examples: How are biodiversity data used to identify biodiversity problems and trigger policy formulation in your organisation/directorate (figure 1, parts 1-2)?

The Performance Monitoring and Evaluation Framework (PMEF) is the framework for CAP indicators in the next programming period 2021 – 2027. It takes over from the current Common Monitoring and Evaluation Framework (CMEF) used in the current period 2014-2020.
At the moment of compiling this questionnaire (September 2021), DG AGRI is still using the CMEF framework to monitor the period 2014-2020 which have been extended in terms of policy implementation until 2022.
Context – impact PMEF indicators have updated the list of indicators, and includes two new related to biodiversity: one on trends of species and habitats of Community interest related to agriculture, and one on landscape features.. For example, indicators on pesticides and antimicrobials are not included in the CMEF framework but are present in the Some new indicators on biodiversity, are not yet available or operational.
Member States use the same framework to program and measure national and regional implementation of the policy.
implementation in terms of financed realizations is followed annually through output and result indicators
All indicators are used on an ongoing basis to evaluate the results of the policy and reaching its objectives.

3. Please expand your answer given in Table 1 by providing one or several concrete examples: How have biodiversity data informed action at national or EU level (e.g. establishment of new protected areas, triggering land use change, more sustainable forest management) (figure 1, parts 3-4)?

Trends in the main context indicators for biodiversity indicated in table 1 were used at national level to establish recommendations to Member States, aimed at ensuring that needs on biodiversity will be taken in account in CAP strategic plans.
Analytical factsheets with context – impact indicators analyzed by objectives are available here (biodiversity is addressed in objective 6):
https://ec.europa.eu/info/food-farming-fisheries/farming/facts-and-figures/performance-agricultural-policy/agriculture-country/cap-specific-objectives-country_en
Recommendations to Member States are available here:
https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/cap-strategic-plans_en

4. Please expand your answer given in Table 1 by providing one or several concrete examples: Does your organisation/directorate integrate biodiversity data in models and scenarios, e.g. modelling distribution of habitat suitability, future trends or the consequences of interventions (figure 1, parts 5-6)?

Several models are used to analyze the CAP for outlook estimations and impact assessments, mostly for economic and market developments. CAPRI is the main model used for environmental forecasts based on the outcomes of CAP environmental measures and schemes, providing for the moment estimations on emissions and nutrients. The farmland bird index indicator is currently introduced in CAPRI as a new development, still under construction.

5. Please provide one or several concrete examples: If biodiversity data is currently not (sufficiently) used for policymaking or for informing action in your organisation/directorate, what would be needed for this to happen?

They are used but they are actually patchy or insufficient. A consistent indicators system considering all dimensions of biodiversity would be needed. Often difficult link between the indicators and the policy. Such a system would facilitate progress assessment in wider perspective. Biodiversity is very local – need to build a system of indicators that properly accounts for and builds on this variation in diversity, ecosystems, landscapes, etc. Data from monitoring schemes on protected habitats and species linked to Natura 2000 implementation are available only every 6 years, which does not fit with the CAP policy cycle of 7 years and its annual implementation/reporting. Need for clarity of concepts: Unclear meaning of certain concepts e.g. conservation status as defined in habitats Directive Data at EU and national level are often not enough In situ monitoring is limited by lack of capacity and resources, and will always be. Need to identify right proxies rather than aspire to monitor every dimension of biodiversity across the EU Remote sensing information could be further used to improve some indicators/monitoring schemes

Survey respondent 21 (Italy)

1. How are biodiversity monitoring data currently used for national and local policy making in your country?

A **Current biodiversity monitoring scheme (and frequency)**	B **Relevant policy or management action at national or local level**	C **Relevant indicator & spatial resolution**	D **How exactly does this data lead to action (decision making, planning, management)? Please describe**	E **Weblink URL to monitoring scheme**
Monitoring biotic elements	Art. 8 WFD	Fish, diatom, macrophytes, macroinvertebrate	Data is used to protect water bodies in good or high quality status and to restore water and aquatic ecosystems quality within 2027	

Monitoring pollinators in National Parks	European Pollinators Initiative COM (2018) 395 final & COM(2021) 261 final	Number of pollinators along a fix transect, in Pan Trap, in	Data are used to have the baseline data to monitoring the status and the trend of pollinators populations	
National Natural Capital Monitoring (e.g. Crop Pollination, habitat suitability)	The National Law 221/2015.	Pollinated crops and recreational tourism based on biophysical and monetary model by ARIES technology; habitat quality and degradation based on INVEST model	The Italian Natural Capital Committee, every year, sends to the Italian Parliament the Report on the State of the Natural Capital. Four Reports are published. Accounting for ecosystem services can be used as an assessment tool for calibrating the socio-economic needs within the limits imposed by the sustainable use of ecosystems, thus providing useful information to the policy maker who must preserve the natural system	https://www.mite.gov.it/pagina/il-rapporto-sullo-stato-del-capitale-naturale-italia
National Monitoring Plan on Habitats Directive	*Art. 17 Habitats Directive (HD)*	Parameters according european guidelines for monitoring activities under the art 17 of the Habitats Directive , standardized at national level . For Habitat types georeferenced vegetation plots are requested both to validate distribution that	By homogenization of local (regional districts) data gathering and standardized aggregation criteria, following a statistical design for sampling, more powerful results in terms of efficiency will be produced, enhancing data-informed decision on the topic (including conservation measures)	http://www.reportingdirettivahabitat.isprambiente.it/

		to assess Structure and Function.		
National census, mapping and monitoring of Funga (in particular macromycetes)	None at national level. A communication from IUCN and the Global Fungal Red List Initiative	Census and mapping of fungal species based on a network of voluntary observations; monitoring programme of fungal species at risk	The data is collected by a voluntary network of expert citizens (such as mycologists, universities and mycological associations) throughout the country according to the principles of Open Science. The data, collected with shared standard methodologies, flow into a permanent national database available to politics and citizens. The data are organized to help the identification of elective habitat for rare species, use of mycological key species to analyze habitats value and conditions in diacronic analyses for natural habitats, post-operam analyses in environmental restoration interventions, statistical analyses for species and habitat at various geographic level for conservation tools.	Network for the study of Mycological Diversity: https://www.isprambiente.gov.it/en/activities/biodiversity/network-for-the-study-of-mycological-diversity/network-for-the-study-of-mycological-diversity?set_language=en Informative System for mycological biodiversity: https://sinacloud.isprambiente.it/portal/apps/sites/#/data
FBIproject *(annual monitoring)*	*Art. 12 Birds Directive / national biodiversity strategy*	*Common farmland bird population and FBI Index trends for Rete Rurale Nazionale 2020 (MIPAAF, Ministry of Agricultural, Food and*	*Dataset is sent to the EU for national reporting. National trend data are involved in the management of hunting pressure on huntable species (in term of population to preserve or duration of hunting season, hunting bags).*	https://www.reterurale.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/22311

		Forestry Policies (Italy)		
IWC International Waterfowl Winter Census. *(annual monitoring)*	*Art. 12 Birds Directive / national biodiversity strategy / Ramsar sites*	*Trends of wintering waterfowl bird populations. All the wetlands and relevant coastal sites for wintering are monitored annualy.*	*Dataset is sent to the EU for national reporting. National trend data are involved in the management of hunting pressure on huntable waterfowl (in term of population to preserve or duration of hunting season, hunting bags).*	http://www.infs-acquatici.it/index%20iwcItalia.html https://www.wetlands.org/
MonitRing *(annual monitoring)*	*Art. 12 Birds Directive / national biodiversity strategy /*	*Trends of bird populations and arrival dates of migratory species*	*Phenology of migratory passerines data have employed for the management of hunting pressure on huntable waterfowl (in term of population to preserve or duration of hunting season, hunting bags).*	
Progetto Alpi *(annual monitoring)*	*Art. 12 Birds Directive / national biodiversity strategy*	*Trend of populations of wintering and migratory passerines during the fall migration across the Alps (10-20 ringing stations)*	*Development of conservation policies*	http://progetto-alpi.muse.it/it/
Progetto Piccole Isole	*Art. 12 Birds Directive*	*Trend of bird*		

(annual monitoring)	*/ national biodiversity strategy*	*populations and arrival dates of migratory species during spring migration across che Mediterranean sea (9 ringing stations)*		
Sea Birds selected for the Marine Strategy Framework *(annual monitoring)*	*Art. 12 Birds Directive / national biodiversity strategy / Ramsar sites*	*Number of breeding pairs in selected coastal sites*	*Data is sent to the EU for national reporting. Dataset was employed to support the proposal to establish new Special Protection areas*	http://www.strategiamarina.isprambiente.it/accesso-ai-dati-di-monitoraggio-sic-2013-sistema-informativo-centralizzato https://cdr.eionet.europa.eu/it/eu/msfd_art17/2018reporting/textreport/envxbdazg/ http://groupware.sinanet.isprambiente.it/strategia-marina/library/d1 http://www.infs-acquatici.it/index%20iwcItalia.html

Heronries Censuses *(annual monitoring)*	*Art. 12 Birds Directive*	*Number of breeding pairs of herons, ibis and cormorants*	*Data is sent to the EU for national reporting.*	
Migratory Raptors *(annual monitoring)*	*Art. 12 Birds Directive*	*Number and trends of individuals of migratory raptor crossing the main bottle-necks of the country*	*Data is sent to the EU for national reporting.*	https://www.areeprotettealpimarittime.it/ente-di-gestione-aree-protette-alpi-marittime/pubblicazioni/infomigrans
Monumental trees	National Law 10/2013	List indicating species, main features and position of monumental trees	Information and data in the list aim to promote protection and knowledge of monumental trees and biodiversity they support at national, sub-national and local level	https://www.politicheagricole.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/11260
Urban and peri-urban trees and forests	National Law 10/2013	- Green spaces in built-up areas covered by woodlands – Tree assets in main national municipalities (number and kmq) from a	Data and information could provide technical guidance on urban greening and assistance to mobilise funding and capacity building for national, sub-national and local authorities, including the development of Urban Greening Plans	https://www.reterurale.it/flex/cm/pages/ServeAttachment.php/L/IT/D/8%252F4%252F1%252FD.f8bffe877b6ff2584b21/P/BLOB%3AID%3D19231/E/pdf

		survey on voluntary basis		
Sustainable Forest Management Certification	EU Regulation 995/2010 COM (2013) 659 COM(2021) 572 National Decree 34/2018	Forest area certified according to the two international systems of certification: the Forest Stewardship Council (FSC) and the Program for Endorsement of Forest Certification schemes (PEFC)	Forest certification is crucial in providing evidence of sustainable forest management. It enables forest owners and managers to demonstrate that the practices they apply in the forest today are sustainable and that their forests meet both our needs and those of future generations. .	https://annuario.isprambiente.it/sys_ind/470
National Forest Inventory	National Law 353/2000	Field surveys and photointerpretation of variables, features and attributes for the points of "National Inventory of Forests and forest Carbon pools - INFC "	The National Inventory of Forests and forest Carbon pools - INFC represents a comprehensive, reliable, large-scale monitoring system.	https://www.inventarioforestale.org/en

Organic farming area	COM(2020) 381 COM(2020) 380 Ministry of Agriculture Decree 6793/2018	Agricultural land under organic farming management and agro-ecological practices	Monitoring organic farming will support authorities to achieve the key commitment of reaching at least 25% of agricultural land managed under organic farming, and increasing significantly the uptake of agro-ecological practices by 2030 as requested in the EU Nature Restoration Plan.	https://annuario.isprambiente.it/sys_ind/472
Monitoring of invasive alien species of union concern	Regulation (EU) 1143/2014 on invasive alien species Decree n. 230/17	Distribution of the specie (maps with grid 10x10km according with the guidelines under art.24 Reg 1143/14 and COMMISSION IMPLEMENTING REGULATION (EU) 2017/1454)	Data is used for the national management plans of invasive alien species of union concern with focus at regional level.	
DIAS (Database of Italian Alien Species		Presence of alien specie in Italy	Database, constantly updated by ISPRA, reported the presence and some other data (occurrence, pathways, management…) for all the alien species detected in Italy (at national and regional level and the data are available online. The data are mainly collected from literature, from regional administration responsible of the monitoring and management of the alien species.	https://www.specieinvasive.it/index.php/it/ricerca-db-italia

2. Please expand your answer given in Table 1 by providing one or several concrete examples: How are biodiversity data used to identify biodiversity problems and trigger policy formulation in your country (figure 1, parts 1-2)?

HABITAT'S VEGETATION PLOTS: can be used *per se* to record indicator species and assemblages and as response variables (if georeferenced) to calibrate and process remote images and environmental data in environmental modelling. Thus boosting capabilities of automated or semi-automated system to detect changes and impacts in ecosystems.

FUNGA: The data collected on mycological diversity are made public in order to identify any changes and alterations, such as the disappearance of species, the presence of alien species and/or the displacement of species in unusual habitats. Collect information on the connections between species and habitats for the monitoring and assessment of habitats and species of Community, national or regional interest and for the post-operational survey of environmental recovery activities
The data are public and allow to stimulate the formulation of specific regulations in defense of mycological diversity and of their specific habitats.

MONUMENTAL TREES: Listing and monitoring Monumental trees allows reporting about ecosystems and landscapes state and trends; furthermore a monumental tree supports biodiversity providing micro-habitats to a variety of living organisms. Data and information about Monumental trees are needed to support conservation policies.
URBAN AND PERI-URBAN TREES AND FORESTS: Assessing area and trends of forest coverage in urban and peri-urban areas and the ecosystem services they provide could support interest in maintaining and even enhancing biodiversity within urban landscapes not only for the inherent value of biodiversity conservation itself, but also because of the tangible societal benefits (e.g., environmental awareness, and the mental health and well-being); furthermore implementing an assessment of the city's local tree heritage is fundamental in defining and enforcing a set of rules for managing the urban forest, to develop long-term management plans and allocating a sufficient budget for urban forest management.
SUSTAINABLE FOREST MANAGEMENT CERTIFICATION: It is a prerequisite for doing business and certified forest materials are requested more and more in procurement policies around the world. It also acts as an enabler of sustainability, empowering consumers and companies to choose sustainably-sourced products, rewarding responsible forest owners and creating an incentive for uncertified forest owners to obtain certification.
NATIONAL FOREST INVENTORY: NFI could support decision makers in a broad range of forest related policies. It could also promote new knowledge and enhanced methods and support forest policies with harmonised forest information and adapt data collection to new emerging policy needs.
ORGANIC FARMING AREA: It could support decision maker in the implementation of the EU-wide agro-ecological targets set out in the Biodiversity Strategy for 2030, in the Farm to Fork Strategy and the new CAP

BIRDS: Population numbers and trends of highly threatened species have supported several Nature Life Project proposals with the aim to restore populations or improve their status by the application of conservation measures.

ALIEN SPECIES: In relation to the surveillance system provided for in art. 14 of the regulation, the general framework of the national system and the competent authorities for monitoring the soil, inland waters and territorial seas are described in detail in art. 18 of Legislative Decree 230/2017. The system is coordinated by the Ministry of the Environment, with the support of ISPRA. The Regions and Autonomous Provinces carry out monitoring, with the support of ISPRA, using the same structures responsible for monitoring pursuant to the Habitat, Water and Marine Strategy directives. Legislative Decree 230/2017 also provides that the Ministry draws up, with the support of ISPRA, after consulting the Regions and Autonomous Provinces, the guidelines for setting up the regional monitoring systems and programs of the IAS of Union and national significance, which to date have yet to be enacted. In the meantime, a simplified procedure was put in place, consistent with the general scheme proposed at European level, to detect the presence or introduction of IAS of Union or national significance.
The first element of the simplified procedure is the timely notification of new observations by IAS or other invasive species at risk of significant impact. For this purpose, the Ministry makes use of the Forestry Corps of the Carabinieri and the regional or provincial Forestry Corps. To date, notifications from the Forestry Corps are forwarded directly to the Ministry and ISPRA through a dedicated e-mail address (specieinvasive@isprambiente.it) and to the Regions / Autonomous Provinces concerned. ISPRA provides technical support to the Regions / Autonomous Provinces for the effective management of the IAS of Union relevance identified in different contexts.
In order to facilitate the identification of IAS of Union relevance by the staff of the competent authorities and citizens, ISPRA has produced numerous documents and materials (with regional distribution maps), making them available on a dedicated website (www.specieinvasive.it), created by the Institute with the financial support of the Ministry. In addition, ISPRA has produced a document with the description of the IAS of Union relevance that was distributed at events and meetings, and was circulated to stakeholders, teachers, public administration staff, etc. Since February 2018, the website www.specieinvasive.it has a dedicated e-mail address to be able to communicate the observations of IAS of Union relevance or of invasive alien species detected in Italy. In the future, the site will be integrated with a system that will allow all observations of invasive alien species to be reported. The ISPRA, which manages the site, for each report received through the site, carries out an initial verification of the veracity of the observation, with the support of a network of experts. If the report is confirmed as truthful, ISPRA informs the Regions / Autonomous Provinces concerned that they proceed with the validation through inspections, interviews, analyzes or other types of checks on the territory to confirm the presence of the species in the identified area. Once the presence has been confirmed, the Regions / Autonomous Provinces must immediately notify the Ministry and ISPRA. The Ministry, with the support of ISPRA, arranges the specific eradication or management measures. In the event that there is a risk of spread to a neighboring country, the Ministry notifies the neighboring country concerned and the European Commission, and informs the Ministry of Foreign Affairs.
In addition to the national system, some Italian regions have set up their own regional surveillance systems, characterized by different levels of complexity and monitoring objectives.
Sicily The Region has officially requested all municipalities to report the presence of IAS of Union significance
Liguria, Piedmont and other Regions As part of LIFE STOPVESPA (LIFE14 / NAT / IT / 001128) a rapid alert system has been set up for reporting new Vespa velutina nigrithorax nests
Friuli Venezia Giulia The region has set up a regional rapid alert system, coordinated by the Biodiversity Service, which includes staff from the regional forestry bodies, the hunting and fishing service, ARPA, the phytosanitary service (ERSA) and the fish heritage protection body (ETPI). (https://www.regione.fvg.it/rafvg/cms/RAFVG/ambiente-territorio/tutela-ambiente-gestione-risorse-naturali/FOGLIA01/FOGLIA2/#id4)
Piedmont To ensure the monitoring of Myriophyllum aquaticum, an official note was sent to the irrigation consortia, rice growers and agricultural associations on the risks and threats caused by the Miriofillo and to create a monitoring network.

Emilia Romagna An interdepartmental working group has been set up in the Region which includes the Protected Areas, Forests and Mountain Development Service, the Wildlife-Hunting Service, the Regional Phytosanitary Service and other structures. The phytosanitary service takes care of monitoring for the Vespa velutina (followed by CONAPI), which involves the installation of attractive traps at beekeeper companies.
Liguria As part of the ALIEM project, ARPAL has started the creation of a surveillance network, made up of institutional and non-institutional subjects who, on a voluntary basis, carry out surveys of alien and invasive alien species and send them to the Ligurian Biodiversity Observatory - LiBiOss , in order to guarantee an early warning in case of new introductions in the regional territory.
Valle d'Aosta In the Region, the eradication of Trachemys scripta takes place through reports to the Forestry Corps of the Aosta Valley, which proceeds with the recovery or capture carried out directly by the agents in the region. The captured specimens are transferred to the CRAS VDA, in a controlled and fenced environment, where the reproduction of the specimens is prevented.
Veneto The SBI of Veneto has started a data collection work on invasive plant species to be published by 2020. An interregional database (FVG, Veneto, PAT) is being created for the floristic and faunal datasets, primarily Rete Natura 2000 and also for data concerning alien species. Management actions for invasive alien species are also included in the PAF being developed.
Lazio As part of the routine activities of the Regional Environment Directorate and the system of regional protected areas, the Lazio Region has activated the regional monitoring network for allochthonous tortoises since 2010.

3. Please expand your answer given in Table 1 by providing one or several concrete examples: How have biodiversity data informed national and local action in your country (e.g. establishment of new protected areas, triggering land use change, more sustainable forest management) (figure 1, parts 3-4)?

FUNGA: At the moment there are data available not for all Italian regions but the database is growing.
The database will allow policy makers to choose specific monitoring areas for the study and conservation of Funga. Furthermore, political action can be taken to prevent any changes in land use and for more sustainable forest management.

MONUMENTAL TREES: It supports promotion of initiatives to implement educational programmes fostering student to discover, experience and value local biodiversity, and to dedicate a day to celebrate the city's tree heritage.

URBAN AND PERI-URBAN TREES AND FORESTS: It promotes development of political agendas that empower green spaces and urban forests. It also supports developing and using technical guidelines to plan, design and manage urban forests and trees; creating and promoting green jobs and economic opportunities; and monitoring the "heat island effect" in cities to advance strategic planning of urban forests.

SUSTAINABLE FOREST MANAGEMENT CERTIFICATION: Public procurement is one area where certification schemes are often relied upon to guarantee that the goods purchased comply with the environmental criteria set by public authorities.

NATIONAL FOREST INVENTORY: NFI could serve decision makers as reliable, sound, and timely relevant forest information. It fosters developing

and broadening the knowledge base and support a broad range of forest related policies.

ORGANIC FARMING AREA: It is used to provide incentives in order to improve percentage of Utilized Agricultural Area under organic farming and achieving European and Global Biodiversity and Sustainability Goals

BIRDS: *The trends of many bird species should guide local and national actions, especially in the management of agricultural environments, wetlands and hunting activities. Unfortunately, environmental policies take this information into account to a very small extent*

4. Please expand your answer given in Table 1 by providing one or several concrete examples: Does your country integrate biodiversity data in models and scenarios, e.g. modelling distribution of habitat suitability, future trends or the consequences of interventions (figure 1, parts 5-6)?

NATURAL CAPITAL: The importance of Ecosystem Services modeling is widely recognised in the scientific and policy push to understand ecosystem services and using information about them in environmental policy . While economic valuation methods for ecosystem services and biophysical models of natural processes exist since decades, the rise of dedicated modelling platforms is a more recent development This notably followed the release of the Millennium Ecosystem Assessment in 2005 (MA 2005) and, shortly after, the launch of systematic and sustained ecosystem services modeling approaches, such as the Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST, Sharp et al. 2014) and Artificial Intelligence for Environment & Sustainability (ARIES[2]) (Villa et al. 2014).
The Italian Fourth Report on the State of Natural Capital analyzed 12 ecosystem services (woody biomass supply, agricultural, fish, water availability, pollination, flood risk regulation, erosion protection, hydrological regime regulation, water purification by soils, habitat quality, carbon sequestration and storage, and recreational tourism) and their change between 2012 and 2018. The biophysical valuation with these models is translated into monetary units using valuation methods consistent with the System of National Accounts. Data on biodiversity have been used mainly in the modeling of crop pollination and habitat suitability but also in the model on recreational tourism

FUNGA: Data on mycological diversity are integrated with data on the diversity of terrestrial ecosystems

BIRDS: *For birds, only descriptive distribution data were modeled (rough range maps). The distribution data provided by volunteers for the Italian Breeding Bird Atlas 2013-2018 (Ornitho.it) were used for habitat-species models and altitude-species models.*

MONUMENTAL TREES, URBAN AND PERI-URBAN TREES AND FORESTS, SUSTAINABLE FOREST MANAGEMENT CERTIFICATION; NATIONAL FOREST INVENTORY and ORGANIC FARMING AREA: Data, statistics and information are used in National Reporting and Assessment on Biodiversity, Sustainability and Environmental issues

5. Please provide one or several concrete examples: If biodiversity data is currently not (sufficiently) used for policymaking or for informing action in your country, what would be needed for this to happen?

FUNGA: To ensure that biodiversity data is used for policy making or to inform action in the country, it is necessary to: - involve the reference scientific network (research centers, universities and mycological associations); - guarantee a homogenous distribution of data at national level - define standard census and mapping rules shared at national level; - address directly interested and passionate citizens to convey the message of the importance of Funga conservation. BIRDS: *Bird dataset should be provided or be available for institutional agencies. Alternatively, a new national monitoring scheme has to be designed and funded, foreseeing the coordination of regional administration and ornithological associations.*

Survey respondent 22 (Spain)

1. How are biodiversity monitoring data currently used for national and local policy making in your country?

A **Current biodiversity monitoring scheme (and frequency)**	B **Relevant policy or management action at national or local level**	C **Relevant indicator & spatial resolution**	D **How exactly does this data lead to action (decision making, planning, management)? Please describe**	E **Weblink URL to monitoring scheme**
Monitoring of endangered species; species of european interest; invasive alien species; inventory of protected areas, sites of geological importance and wetlands; forest ecosystems mapping and statistics; status of habitats	When available, the corresponding data is harmonized, standardized and covers the whole national territory. It is included in the Spanish Inventory of the Natural Heritage	Indicators of the Spanish Inventory of the Natural Heritage and Biodiversity (IEPNB); harmonized at the national level (https://www.mite	These data are used for national reporting (https://www.miteco.gob.es/es/biodiversidad/temas/inventarios-nacionales/inventario-espanol-patrimonio-natural-biodiv/informe_anual_IEPNB.aspx), as well to fulfill european and international reporting obligations. They are used for plans and strategies for conservation of the natural heritage and biodiversity in Spain	https://www.miteco.gob.es/es/biodiversidad/temas/inventarios-nacionales/

of european interest; genetic diversity of trees; desertification; land use	and Biodiversity (IEPNB)	co.gob.es/es/biodiversidad/temas/inventarios-nacionales/inventario-espanol-patrimonio-natural-biodiv/sistema-indicadores/default.aspx).		
EIDOS database of wild species in Spain		This database includes all the information needed for the indicators about species of the IEPNB at national level	There has been done a great effort on harmonization of data, as main example it has been developed a controlled list of wild species (Listas patrón: https://www.miteco.gob.es/es/biodiversidad/servicios/banco-datos-naturaleza/informacion-disponible/BDN_listas_patron.aspx). For instance, it allows to integrate information about species from different sources within EIDOS. It also facilitates information exchange across regional, national and european institutions.	https://www.miteco.gob.es/es/biodiversidad/servicios/banco-datos-naturaleza/Eidos_acceso.aspx
National Forest inventory, every 10 years	*National forest law*	*Populations of woody plants, especially forest trees. 25-m radius plots*	*Forest management planning*	https://www.miteco.gob.es/es/biodiversidad/temas/inventarios-nacionales/inventario-forestal-nacional/default.aspx
Bird surveys, yearly	*Birds Directive*	*Counts of common birds in 5-min point counts,*	*Point counts of common birds during breeding are used to compute the common bird indices requested by Eurostat*	http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=en

		carried out by volunteers coordinated by SEO/BirdLife Interantional		v_bio2&lang=en; https://seo.org/wp-content/uploads/2021/06/Boletin-Seguimiento-2020_Def.pdf
Birds and habitat directives surveys, irregular time intervals	*EU Birds and Habitats Directives*	*Monitoring programs for species listed in the Directives, usually carried out at the regional level (regions are the administrative level of responsibility for environmental issues in Spain), carried out by either volunteers or professionals at several spatial and temporal scales*	*Data is used for national and regional programmes and for sexenal reports to the EU*	https://www.miteco.gob.es/es/biodiversidad/temas/conservacion-de-la-biodiversidad/

2. Please expand your answer given in Table 1 by providing one or several concrete examples: How are biodiversity data used to identify biodiversity problems and trigger policy formulation in your country (figure 1, parts 1-2)?

Specially endangered species are legally protected and the corresponding conservation plan needs to be developed (Ley 42/2007, de 13 de diciembre, del Patrimonio Natural y de la Biodiversidad). Population size and trends data for some species, mostly birds, have been used by NGOs to force governments (regional and national) to create and update lists of endangered and invasive species and to establish protected sites. Governments are usually not proactive at updating biodiversity policies.

3. Please expand your answer given in Table 1 by providing one or several concrete examples: How have biodiversity data informed national and local action in your country (e.g. establishment of new protected areas, triggering land use change, more sustainable forest management) (figure 1, parts 3-4)?

Data from the IEPNB is used for the preliminary analysis conducted for the development of the Spanish Biodiversity Strategy.

Biodiversity data has led to several technical and scientific work to inform biodiversity policies at several levels, but these work has not been generally used by authorities to date. For instance, there is a Scientific Committee named by the national authorities to evaluate requests to include or exclude species in the official lists of endangered and invasive species (https://www.miteco.gob.es/es/biodiversidad/temas/conservacion-de-especies/especies-proteccion-especial/ce-comite.aspx), but the authorities sometimes do not follow recommendations of the Committee unless forced by NGOs and court. This is occurring now with some game birds (e.g., the European dove Streptopelia turtur, which is endangered according to technical data and recommendations but Spanish authorities refuse to protect it) and with some invasive species of commercial interest (such as eucalypts and Phytophthora ooomicetes, which are not declared invasive in spite of overwhelming scientific evidence.

4. Please expand your answer given in Table 1 by providing one or several concrete examples: Does your country integrate biodiversity data in models and scenarios, e.g. modelling distribution of habitat suitability, future trends or the consequences of interventions (figure 1, parts 5-6)?

Species distributions are based on EIDOS data model (based on Plinian Core).

Future predictions of distributions have also been done in the past, but need to be updated.
E.g. https://www.miteco.gob.es/es/biodiversidad/temas/inventarios-nacionales/inventario-especies-terrestres/ieet_efectos_cambio_climatico.aspx

As outlined above, there are several recent studies, some even supported by administrative authorities, on relevant aspects of biodiversity conservation (e.g. https://www.miteco.gob.es/es/biodiversidad/temas/conservacion-de-especies/especies-proteccion-especial/ce-comite.aspx for invasive or endangered species). However, conclusions of these studies are seldom applied to conservation action.

5. Please provide one or several concrete examples: If biodiversity data is currently not (sufficiently) used for policymaking or for informing action in your country, what would be needed for this to happen?

In order to provide solid evidence for policymaking, it would be needed a better harmonization and coordination of robust and enough data from national and regional monitoring schemes, as well as from research institutions and ONGs, with access to raw data on time so that the combination of all this information can provide the most udpated information about the whole territory. This can be a very challenging task due

to the Spanish administrative structure. It is important to record as well the spatial component of the data instead of getting just statistical data.

In my opinion, monitoring responsibilities should be properly supported by means of stable monitoring programs supervised by well-trained professionals. The quality of official reports should be strictly supervised by independent scientists and their results be compulsory according to environmental law. Examples include strict supervision of sexenal reports on the Birds and Habitats Directives, that are usually incomplete and even wrong since there are not sexenal monitoring programs for most species an habitats covered by the Directives; establishment of a monitoring program of the environmental effects of the application of the Common Agricultural Policy at proper spatial and temporal scales and properly linked to declared environmental goals; and a proper use of the official Scientific Committees supervising the lists of endangered and invasive species.

Survey respondent 23 (Ireland)

1. How are biodiversity monitoring data currently used for national and local policy making in your country?

A **Current biodiversity monitoring scheme (and frequency)**	B **Relevant policy or management action at national or local level**	C **Relevant indicator & spatial resolution**	D **How exactly does this data lead to action (decision making, planning, management)? Please describe**	E **Weblink URL to monitoring scheme**
Art 17 Species Monitoring Programmes (varies from yearly to c5 yearly)	*National Biodiversity Action Plan*	*Distribution varies from 1, 10, 50 km Indicators: population trend As a higher level programme: number/% of species green/amber/red Number/% of species with declining or*	*Data feeds into conservation objective setting for Natura sites and determination of measures required. High level data used as part of Prioritised Action Framework which influences accessibility of EU funding mechanisms and negotiations across sectors for biodiversity related expenditure. Data is available for national planning and decision making around this species which is listed on Annex II of the EU Habitats Directive. Data used as part of national biodiversity indicators, various EU and UN reporting streams.*	https://www.npws.ie/sites/default/files/publications/pdf/NPWS_2019_Vol3_Species_Article17.pdf Lists relevant monitoring manuals by species

		improving trends *Number/% species impacted by various pressure categories* *etc*		https://www.eea.europa.eu/themes/biodiversity/state-of-nature-in- the-eu/article-17-national-summary-dashboards www.inlandfisheries.ie
Art 17 Habitat Monitoring Programmes (varies from yearly to c5 yearly)	*National Biodiversity Action Plan*	*Distribution 10 km* *Indicators: area trend* *As a higher level programme: number/% of habitats green/amber/red* *Number/% of habitats with declining or improving trends* *Number/% habitats impacted by various pressure categories* *etc*	*Data feeds into conservation objective setting for Natura sites and determination of measures required. High level data used as part of Prioritised Action Framework which influences accessibility of EU funding mechanisms and negotiations across sectors for biodiversity related expenditure.* *Data is available for national planning and decision making around this species which is listed on Annex II of the EU Habitats Directive.* *Data used as part of national biodiversity indicators, various EU and UN reporting streams.*	https://www.npws.ie/sites/default/files/publications/pdf/NPWS_2019_Vol2_Habitats_Article17.pdf Lists relevant monitoring manuals by habitat https://www.eea.europa.eu/themes/biodiversity/state-of-nature-in-the-eu/article-17-national-summary-dashboards
Art 12 Bird Monitoring (varies from yearly to c10yearly)	*National Biodiversity Action Plan*	*Distribution 10 km* *Population trends* *Trends in breeding birds*	*Data feeds into conservation objective setting for Natura sites and determination of measures required. High level data used as part of Prioritised Action Framework which influences*	https://www.eea.europa.eu/themes/biodiversity/state-of-nature-in-the-

		Trends in migrating birds Number/% species impacted by various pressure categories etc	*accessibility of EU funding mechanisms and negotiations across sectors for biodiversity related expenditure. Data is available for national planning and decision making around this species which is listed on Annex II of the EU Habitats Directive. Data used as part of national biodiversity indicators, various EU and UN reporting streams.*	eu/article-12-national-summary-dashboards
Butterfly Monitoring Scheme: 2008-current (weekly counts annually)	*National Biodiversity Action Plan/Regional Red List*	*Multi-species index, derived from tracking changes in the populations of 15 common species (~100 sites nationally)*	*Used to measure the health of butterfly populations. Data is available for future Red List revisions. It is also used to assess the impact of climate change on biodiversity. Data is provided to the EU Butterfly Monitoring Scheme. This allows pan-European butterfly trends to be detected and provides the data to enable the European Grassland Butterfly Indicator to be generated.*	*www. biodiversityireland.ie*
Marsh Fritillary Monitoring Scheme: 2015-current (annually)	*Art. 17 reporting*	*Annual habitat condition survey and larval web count at key sites*	*Data is available for national planning and decision making around this species which is listed on Annex II of the EU Habitats Directive.*	*www. biodiversityireland.ie*
All-Ireland Bumblebee Monitoring Scheme: 2012 - current (monthly counts annually)	*National Biodiversity Strategy/Regional Red List*	*Multi-species index, derived from tracking changes in the populations of 8 common species (~70 sites nationally)*	*Used to measure the health of bumblebee populations. Data is available for future Red List revisions. It is used to measure the impact of the All-Ireland Pollinator Plan. It also drives local level management actions within the Plan.*	*www. biodiversityireland.ie*
Rare Plant Monitoring Scheme: 2017 - current (annually)	*National Biodiversity Strategy/Regional Red List*	*Annual population count (~200 populations monitored)*	*Used to measure the health of rare plant populations. Data is available for future Red List revisions. Data provided to Local Authorities for planning around species protection.*	*www. biodiversityireland.ie*

National Pollinator Monitoring Scheme: 2022 onwards - (annually across the field season)	*National Biodiversity Strategy/Regional Red List*	*Range of standardised sampling methodologies employed to generate a national pollinator index (50 sites nationally)*	*Will be used to measure the health of pollinator populations. Will be used to measure the impact of the All-Ireland Pollinator Plan. Will allow development and revision of National Red List for all pollinating insects. Data will be sent to the EU for international reporting (EU Pollinator Monitoring Scheme - in development).*	*www. biodiversityireland.ie*
E.g. National breeding bird survey (annually)	*Art. 12 Birds Directive / national biodiversity strategy / Ramsar sites*	*Number of breeding pairs of each bird species per km² (or per site or per district)*	*Data is sent to the EU for international reporting. Nationally, negative trends trigger restoration action of e.g. Ramsar wetland sites and species specific action programmes*	
E.g. Monitoring the impact of air pollution on ecosystems	*Air quality policy, reporting under Art. 9 of the National Emissions Ceiling directive*	*Ozone foliar damage to trees and crops (200 sites in the country)*	*Data is sent to the EU for international reporting. The data is used for monitoring the health of forests.*	NECD Ecosystem programmes being developed for Ireland at the moment
The National Crayfish Plague Surveillance Programme The surveillance programme is based on eDNA samples from water. Annually from June to November – during moulting season	*Pressure for Habitats Directive Annex 2 species*	The surveillance programme is based on eDNA samples from water.	*Data is used to inform presence of plague which would instigate a suite of mitigation measures*	
Water Framework Directive Fish Sampling rivers (annually)	Water Framework Directive Assessments	No. fish species present & density	Data is used to assess the status of waterbodies. Information is used to direct resources to areas rated low and poor	www.wfdfish.ie

Water Framework Directive Fish Sampling lakes (annually)	Water Framework Directive Assessments	No. fish species present & density/cpue	Data is used to assess the status of waterbodies. Information is used to direct resources to areas rated low and poor	www.wfdfish.ie
Water Framework Directive Fish Sampling transitional waters (annually)	Water Framework Directive Assessments	No. fish species present & density/cpue	Data is used to assess the status of waterbodies. Information is used to direct resources to areas rated low and poor	www.wfdfish.ie
Water Framework Directive Biodindicators: Macroinvetebates, aquatic plants, micro algae, phytoplankton, phytobenthos Every 3 years	Water Framework Directive Assessments	National	To determine whether ecological status is impacted by water quality or altered hydromorphology. Results fed into programme of measures where appropriate	https://www.epa.ie/publications/monitoring--assessment/freshwater--marine/EPA_WFD_MonitoringProgramme_2019_2021-(1).pdf
Eel Monitoring Programme	Eel Regulation 1100/2007	National	Programme targeting the different lifestages of the endangered european eel. Used in reporting to EU under regulation	www.inlandfisheries.ie
National Salmon Monitoring	Various ByeLaws	National	Programme uses a combination of monitoring tools to model population estimates. Annual bye-laws created based on information gathered under this project. Data used at national and international level.	www.inlandfisheries.ie

2. Please expand your answer given in Table 1 by providing one or several concrete examples: How are biodiversity data used to identify biodiversity problems and trigger policy formulation in your country (figure 1, parts 1-2)?

The results of the Art 17/12 monitoring programmes support the setting of site based conservation objectives in Natura sites. Results also underpin the Priortised Action Framework Declines in certain habitat/species have led to focussed action on the ground e.g. Natterjack toad pond creation scheme, Curlew task force,

development of score sheets for selected habitats and species that feed into results based payments schemes, e.g. Pearl mussel, species rich grassland. Bidding for EU funding mechanisms are also based on assessments with unfavourable status and/or declining trends.

Fish presence/absence and growth, condition along with the presence of invasive species is used to highlights areas where there are problems, this impacts on national legislation and bye-laws. Fish biodiversity surveys are used to highlight the impact of barriers on fish migration and indicate when barriers need to be mitigated or removed.

3. Please expand your answer given in Table 1 by providing one or several concrete examples: How have biodiversity data informed national and local action in your country (e.g. establishment of new protected areas, triggering land use change, more sustainable forest management) (figure 1, parts 3-4)?

The data have been used to support cross-sectoral negotiations relating to forestry, water, agriculture, climate and sustainable development policy.

Special Areas of Conservation have been set up for the different lamprey species, salmon, shad and pollan based on information gathered in the different surveys carried out by IFI. Information from the salmon monitoring resulted in the creation of a tagging and logbook system for commercial and recreational salmon (and seatrout >40cm) caught in Ireland.

4. Please expand your answer given in Table 1 by providing one or several concrete examples: Does your country integrate biodiversity data in models and scenarios, e.g. modelling distribution of habitat suitability, future trends or the consequences of interventions (figure 1, parts 5-6)?

Habitat suitability analysis has been undertaken for bats, Natterjack toad and Irish hare. More tenuous links have been made for cetaceans. Climate change modelling has been undertaken for habitats and selected species. Please see the publication lists as part of the Art 17 and 12 audit trails.

5. Please provide one or several concrete examples: If biodiversity data is currently not (sufficiently) used for policymaking or for informing action in your country, what would be needed for this to happen?

Strategic development of data architecture to enable academics to undertake big data analysis of existing datasets and make targeted policy recommendations.
A more coordinated approach between stakeholders at the national level to identify conservation measures that would benefit multiple species/habitats based on trend data from existing monitoring programmes and with a focus on conservation measures that have evidence-

based benefits

Survey respondent 24 (Serbia)

1. How are biodiversity monitoring data currently used for national and local policy making in your country?

A **Current biodiversity monitoring scheme (and frequency)**	B **Relevant policy or management action at national or local level**	C **Relevant indicator & spatial resolution**	D **How exactly does this data lead to action (decision making, planning, management)? Please describe**	E **Weblink URL to monitoring scheme**
E.g. National breeding bird survey (annually)	*Art. 12 Birds Directive / national biodiversity strategy / Ramsar sites*	*Number of breeding pairs of each bird species per km² (or per site or per district)*	*Does not exist. Only sparse information is collected from time to time. There is no funding for proper monitoring*	https://pticesrbije.rs/programi/
International Waterbird Count	*Art. 12 Birds Directive / national biodiversity strategy / Ramsar sites*	*Number of targeted species and trends of their wintering populations*	*Data is shared with the Wetlands International and it needed for conservation planning on international and regional scale.*	https://pticesrbije.rs/programi/
E.g. Monitoring of invasive insects species and some invasive alien plant species	*Strategy of biodiversity protection, Programme of Nature Conservation*	*Monitoring programme based on a network of voluntary observations of invasive alien species and targeted species*	*data used for determining national policies on nature protection and environmental reports. Data is used for national and regional programmes that target the removal of invasive alien plant species (planning of resources, actions for removing IAPS).*	https://bioindicators.sepa.gov.rs/indicator-name-invasive-insect-species-trend/

		monitoring in areas under high risk.		
Benthic invertebrates (annually)	Regulation on the parameters of ecological and chemical status of surface waters and parameters of chemical status and quantitative status of groundwaters (Official Gazette of the RS 74/2011)	Depending on waterbody type: -Zelinka & Marvan Saprobic Index -BMWP Score - ASPT Score -Shannon-Weaver Diversity Index -EPT Taxa -number of families -total number of taxa -percentage participation of Oligochaeta/Tubificidae -number of bivalve species -number of gastropod species number of sensitive taxa (Austrian list)	Data obtained on proposed BQE metrics (not taxonomy and composition) are published in annual National reports on Water Quality, and periodically in Ecological Status Assessment reports. Some data from same watercourses are compared in bilateral cooperation with Hungary]	Water Quality reports http://www.sepa.gov.rs/index.php?menu=5000&id=1304&akcija=showDocuments&tema=Vode Ecological status and other reports http://www.sepa.gov.rs/index.php?menu=5005&id=1303&akcija=showDocuments&tema=Vode
Phytobenthos (annually	[Regulation on the parameters of ecological and chemical status of surface waters and parameters of chemical status and	*-IPS (Coste in Cemagref, 1982) "Indice de pollutio-sensibilite"* *-CEE (Descy & Coste,1990)* *-EPI-D (Dell'Uomo,*	Data obtained on proposed BQE metrics (not taxonomy and composition) are published in annual National reports on Water Quality, and periodically in Ecological Status Assessment reports. Some data from same watercourses are compared in bilateral cooperation with Hungary	Water Quality reports http://www.sepa.gov.rs/index.php?menu=5000&id=1304&akcija=showDocuments&tema=Vode

	quantitative status of groundwaters (Official Gazette of the RS 74/2011)	*1999) "Diatom-based Eutrophication/Pollution Index*		Ecological status and other reports http://www.sepa.gov.rs/index.php?menu=5005&id=1303&akcija=showDocuments&tema=Vode
Phytoplankton (6 times per year)	[Regulation on the parameters of ecological and chemical status of surface waters and parameters of chemical status and quantitative status of groundwaters (Official Gazette of the RS 74/2011)	-phytoplankton abundance (cells mL-1) -percentage participation of Cyanobacteria and Euglenophyta in the total phytoplankton community -biomass (chlorophyll-a concentration)	Data obtained on proposed BQE metrics (not taxonomy and composition) are published in annual National reports on Water Quality, and periodically in Ecological Status Assessment reports. Some data from same watercourses are compared in bilateral cooperation with Hungary	Water Quality reports http://www.sepa.gov.rs/index.php?menu=5000&id=1304&akcija=showDocuments&tema=Vode Ecological status and other reports http://www.sepa.gov.rs/index.php?menu=5005&id=1303&akcija=showDocuments&tema=Vode
Monitoring of butterflies	Strategy of biodiversity protection, Programme of Nature Conservation	Diversity of species: butterfly population trends	Monitoring programme based on a network of voluntary observations. Necessary elements: date, species, location (inaccuracy <100m).We supplied data on certain species (mostly N2000 species) to bodies that organized gathering data for determining national policies on nature protection and environmental reports	https://bioindicators.sepa.gov.rs/indicator-name-diversity-of-species-butterfly-population-trend/ http://www.sepa.go

				v.rs/download/lzvestaj2018.pdf
Monitoring the impact of soil pollution on ecosystems	Management of natural areas; EU regulation on soil	Monitoring programme based on a network of scientific observations of soil	Data is sent to the EU for international reporting. The data is used for soil monitoring. Nationally, make maps of areas of devastated and degraded soils and implement plans for their protection, revitalization and remediation.	
Monitoring of selected (cca 15) strictly protected plant and animal species (annually) in Vojvodina Province	Law on nature conservation	Depending on taxa, size or spatial distribution of selected species	Data are used for defining of restrictions in process of issuing permits for all types of works in natural areas. It is also used in defining and establishing new protected ares, as well as for defining management plans or practical conservation measures.	http://www.pzzp.rs/rs/sr/
Monitoring the impact of water pollution on ecosystems based on vascular plant	Management of natural areas; EU regulation on vascular plant	Monitoring programme based on a network of scientific observations of vascular plant species	Data is sent to the EU for international reporting. The data is used for monitoring especially endangered and protected vascular plants.	https://bioindicators.sepa.gov.rs/indicator-name-aquatic-macrophytes-water-pollution-biomonitoring-aqmwb/
Monitoring the impact of air pollution on forest ecosystems	ICP Forests Programm Air quality policy, reporting under Art. 9 of the National Emissions Ceiling directive	Forest health condition	Forest condition monitoring is integrated into the state forestry system, state environmental reporting system and state nature conservation reporting system.	https://bioindicators.sepa.gov.rs/indicator-name-forest-health-conditions/ http://www.sepa.gov.rs/download/lzvestaj_2019.pdf

				https://www.forest.org.rs/?icp-forests-srbija

2. Please expand your answer given in Table 1 by providing one or several concrete examples: How are biodiversity data used to identify biodiversity problems and trigger policy formulation in your country (figure 1, parts 1-2)?

The bird population sizes and trends data are used for conservation planning. This data is supplied to national nature conservation bodies such as Institute for Nature Conservation of Serbia, Institute for Nature Conservation of Vojvodina Province and Ministry of Environmental Protection. Via Bird Protection and Study Society of Serbia (BirdLife Serbia) all relevant bird population and trend data is supplied to the BirdLife International and Wetlands International, which is then used for assessing global and regional red lists. Mentioned data is also used for proclamation of nationally protected areas, Ramsar sites, EMERALD sites and future SPA/NATURA2000 sites.
Data from monitoring on distribution of strictly protected species Saker falcon (Falco cherrug) is crucial in issuing permits for establishing wind farms, e.g. restrictions of building of wind turbines are related to territories of Saker falcon (Falco cherrug)

3. Please expand your answer given in Table 1 by providing one or several concrete examples: How have biodiversity data informed national and local action in your country (e.g. establishment of new protected areas, triggering land use change, more sustainable forest management) (figure 1, parts 3-4)?

Bird population and trend data is used for the Red List and Red Book of birds of Serbia. The same data is used for different rule books on official protection of species on national level. Mentioned data is also used for proclamation of nationally protected areas, Ramsar sites, EMERALD sites and future SPA/NATURA2000 sites.
Data from monitoring on distribution of strictly protected species, e.g. Autumn Lilly (Scilla autumnalis), Eastern Imperial Eagle (Aquila heliaca), Souslik (Spermophillus citellus) and Long-nosed Locust (Acrida ungarica) were used in defining borders of recently established protected areas in Pannonian part of Serbia.
All relevant created indicators have been used for national and international reporting, and strategic planning documents..
Monitoring the state of population and the distribution of important species and habitats, as well as the presence of endangered species of plants, animals and fungi is especially used in the management of protected areas in Serbia. However, it is generally used through a spatial overlap of registered values during monitoring, to design/redefine boundaries and apply protection regimes in protected assets as well as sustainable use of natural resources. Also, biodiversity data are used for taking in situ and ex situ activities in the country.
Monitoring of flora and endangered plant species including their distribution in protected areas “Lalinačka slatina”, Monitoring of amphibian

species distribution and amphibian breeding sites in protected area “Vlasina”, Monitoring of reptile species distribution in protected area “Vlasina”, Monitoring of Testudo hermanni in protected area “Sićevo Gorge”, Monitoring of Vipera ammodytes and other reptiles in protected area “Sićevo Gorge” , Creating network of important areas (ecological network and corridors) and places of high species diversity within the protected area Lalinačka slatina.

4. Please expand your answer given in Table 1 by providing one or several concrete examples: Does your country integrate biodiversity data in models and scenarios, e.g. modelling distribution of habitat suitability, future trends or the consequences of interventions (figure 1, parts 5-6)?

https://bioindicators.sepa.gov.rs http://www.sepa.gov.rs/download/Izvestaj_2019.pdf

5. Please provide one or several concrete examples: If biodiversity data is currently not (sufficiently) used for policymaking or for informing action in your country, what would be needed for this to happen?

More detailed Biodiversity Strategy, Law of Nature Conservation and sublow which clearly defines monitoring protocols and its use for policymaking

Survey respondent 25 (Slovenia)

1. How are biodiversity monitoring data currently used for national and local policy making in your country?

A **Current biodiversity monitoring scheme (and frequency)**	B **Relevant policy or management action at national or local level**	C **Relevant indicator & spatial resolution**	D **How exactly does this data lead to action (decision making, planning, management)? Please describe**	E **Weblink URL to monitoring scheme**
E.g. National breeding bird	*Art. 12 Birds Directive*	*Number of*	*Data is sent to the EU for international reporting.*	

survey (annually)	*/ national biodiversity strategy / Ramsar sites*	*breeding pairs of each bird species per km² (or per site or per district)*	*Nationally, negative trends trigger restoration action of e.g. Ramsar wetland sites and species specific action programmes*	
E.g. Monitoring the impact of air pollution on ecosystems	*Air quality policy, reporting under Art. 9 of the National Emissions Ceiling directive*	*Ozone foliar damage to trees and crops (200 sites in the country)*	*Data is sent to the EU for international reporting. The data is used for monitoring the health of forests.*	
E.g. Monitoring of invasive alien species	*Management of natural areas, rivers and forests; EU regulation on invasive alien species*	*Monitoring programme based on a network of voluntary observations of invasive alien species and targeted species monitoring in areas under high risk.*	*Data is used for national and regional programmes that target the removal of invasive alien species (planning of resources, actions for removing IAS)*	
Farmland bird index (annualy)	*Art. 12 Birds Directive; CAP*	Trend per species	Data are used for reporting for Birds directive and reporting of goals of Rural development plan	http://kazalci.arso.gov.si/sl/content/ptice-kmetijske-krajine-3; https://www.ptice.si/naravovarstvo-in-raziskave/monitoringi/sipkk/
Monitoring of most important species of crayfish, fish, lamprey, butterflies, beetles, breading birds, bats, large	*Art. 12 Birds Directive; Art. 7 and 12. Habitats directive, CAP, Natura 2000 management*	Number of animals or/and trend per site	Data are used for reporting for Birds and Habitats directive and reporting of reach of goals of Rural development plan, Natura 2000 management program, plans for management of forests, fishery plans, water management	http://www.natura2000.si/natura-2000/natura-2000-v-sloveniji/monitoring/

carnivores (regularly; different intervals for different species)	*programme, planning in forestry, and fishery*		plans and development of new and renovation of existing management operations	
Monitoring of most important species of amphibious, dragon flies, molluscs, reptiles, plants (not regularly or just started; different intervals for different species)	*Art. 7 Habitats directive, Natura 2000 management programme, planning in forestry and fishery*	Number of animals or/and trend per site	Data are used for reporting for Birds and Habitats directive and reporting of reach of goals of Rural development plan, Natura 2000 management program, plans for management of forests, fishery plans, water management plans and development of new and renovation of existing management operations	http://www.natura2000.si/natura-2000/natura-2000-v-sloveniji/monitoring/
Maping of non forest habitat types (first taking down)	*Art. 7 Habitats directive, CAP, Natura 2000 management*	Name of habitat type per polygon on the map	Data are used for reporting for Birds and Habitats directive and reporting of reach of goals of Rural development plan, Natura 2000 management program Approand development of new and renovation of existing management operations	https://zrsvn-varstvonarave.si/informacije-za-uporabnike/katalog-informacij-javnega-znacaja/habitatni-tipi/

2. Please expand your answer given in Table 1 by providing one or several concrete examples: How are biodiversity data used to identify biodiversity problems and trigger policy formulation in your country (figure 1, parts 1-2)?

Biodiversity data does not trigger final political decisions sufficiently. Their strength point out mainly in processes supported by habitats and Birds Directive.

3. Please expand your answer given in Table 1 by providing one or several concrete examples: How have biodiversity data informed national and local action in your country (e.g. establishment of new protected areas, triggering land use change, more sustainable forest management) (figure 1, parts 3-4)?

There are some most important examples of actions performed on biodiversity data:
- Designation of Mura River UNESCO MaB
- Development of new operations for biodiversity in CAP Strategic plan in preparation
- Programming of Natura 2000 sites goals and measures for next perspective

- Incorporation of biodiversity data in nature protection guidelines for spatial plans and plans for use of natural resources and adjustments of plans

4. Please expand your answer given in Table 1 by providing one or several concrete examples: Does your country integrate biodiversity data in models and scenarios, e.g. modelling distribution of habitat suitability, future trends or the consequences of interventions (figure 1, parts 5-6)?

A few models were prepared, predominantly for large carnivores, birds and beetles. For instance:

Model of distribution and habitat of Canis aureus was used in decision making process about legal status and management of species. https://drive.google.com/file/d/1yu8upFh6lQOd4KODtBa6CGBvkfFiqTe1/view

Distribution of some bird species were modeled for designation of Natura 2000. https://www.ptice.si/wp-content/uploads/2014/03/201110_denac_revizija_iba_porocilo_28102011_dopolnjena_verzija.pdf

5. Please provide one or several concrete examples: If biodiversity data is currently not (sufficiently) used for policymaking or for informing action in your country, what would be needed for this to happen?

Nature conservation should gain better acceptance in society. Society should be more aware how dependent it is from nature. Ecosystem services are there even more important as biodiversity data. Society does not understand its relation to nature.

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