CHAPTER A.III.

Access to data and information

Anne Schmidt, Chris van Swaay, Rene Henkens and Peter Verweij

III.1 Introduction

Biodiversity information is based on data that is gathered by a mixed, large group of people. Professionals and nature enthusiasts observe and record nature, either using protocols in field studies, remote sensing and monitoring schemes, or via opportunistic sightings. Despite this seeming abundance in data availability, decision- and policy-makers are constrained by the lack of targeted data and indicators, mostly as a result of barriers preventing existing data from being found and accessed, or by missing forms of presentation that answer questions of policy makers and practitioners (Verweij et al., 2019; Geijzendorffer et al., 2016; Addison, 2015; Wetzel et al., 2015; Proença et al., 2017).

III.1.3 Different types of data and information sources

There is a wide range of data and information sources available, including citizen-science data collections, monitoring data collections and networks, GIS-data repositories, research infrastructures for open data, synthesis of scientific knowledge and community interfacing platforms aspiring to bring the science and policy-making communities closer together. The variety of sources can be categorized in three main categories (see Box "Types of data and information sources").

III.1.4 Barriers to sharing of biodiversity data and information

The World Conservation Monitoring Centre (WCMC) of the United Nations Environmental Program (UNEP) conducted a review on the barriers to sharing of biodiversity data and information and made recommendations for eliminating them (*UNEP, 2012*). Although progress has been made since 2012, most of the barriers identified by the WCMC of UNEP still exist, namely:

- **Psychological and behavioural barriers**, which range from unwillingness to share for commercial reasons to barriers resulting from concerns over how data, information and knowledge might be used, as well as legal barriers.
- **Barriers related to describing information and data**, which range from a lack of widely agreed classification systems for some types of biodiversity, to insufficient use of contextual and explanatory information linked to datasets.
- **Practical barriers**, which range from knowing how to make data, information and knowledge you hold available in meaningful ways, to locating the information that you need from amongst plethora of data, information and knowledge available.

Citation

Chapter A.III: Schmidt, A.M., van Swaay, C.A.M., Henkens, R.J.H.G. & Verweij, P.J.F.M. (2021) In: 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.

The whole document can be downloaded under ecologic.eu/book/improving-the-availability-of-data-and-information

Definition of data, information and indicators

Biodiversity **data** are pieces of information collected through observations or generated via modelling. More technically, data is a set of numerical or qualitative values to describe variables about an individual, or object, including space and time. Data become **information** when the values get a meaning in some context for the receiver.

Indicators summarize or simplify relevant information and play an important role in communicating on the status and trends of nature in such a way that these are useful for decision making, e.g. by relating them to specific management goals and policy targets (*Gallopin, 1996*).

Types of data and information sources

There is a wide range of data and information sources available which can largely be grouped in **(1) data lakes** (contains raw, non-harmonised data), **(2) data platforms** (a system that enables integration of harmonised data in other similar datasets and uses a quality checked, sometimes open-access, data repository, to which, preferably, peer-reviewed articles are attached for proof of data quality) and **(3) indicator catalogues**. Data lakes and data platforms target data analysts. Indicators catalogues aim to provide condensed information in the form of indicators with accompanying narratives and references.

» **Inadequate strategies and resources** that result in data, information and knowledge often being made available in an opportunistic manner rather than being focused on need, often without sufficient resources being made available.

There are different types of solutions to remove these barriers and actions need to be taken by different stakeholders. Governments need to provide funding for information resources and maintenance of infrastructures and develop open data and research policies. Publishers should increase open access to publications and encourage the publication of data papers. Knowledge brokers should develop information infrastructures or repositories for ensuring long term access to data, information and knowledge and further promote the use of common vocabularies, classification systems and standards. The academic world should promote and create incentives to increase access to data and information. Donors and others providing support should ensure that each funded project provides appropriate access to the data and information and promote longer-term investment in the maintenance of data and information resources and funding of knowledge management and dissemination.

In some cases the access to data and information is not the problem, but the willingness to use the available data and information. There might be different reasons for this amongst others the scepticism towards using data collected by volunteers.

III.1.5 Data and information needed for the implementation of the Birds and Habitats Directive

For the implementation of the Birds and Habitats Directive data and information are needed on the species and the habitat types targeted by these directives. This concerns data and information on the distribution and population size of species, the area and quality of the habitat for species and, the distribution, area and structure and function (quality) of habitat types. In addition, data and information are needed on the impact of pressures and threats and the effects of mitigation and restoration measures [see chapter B.I. Guidance and tools for effective restoration measures for species and habitats].

The data and information serve different purposes, amongst others the selection and designation of Natura 2000 sites, the management of Natura 2000 sites, appropriate assessments for permitting procedures and conservation status assessments for reporting. This **means data and information is needed on different spatial scale levels ranging from local level to Natura site level, Natura 2000 network, biogeographical, national and European level**. The user requirements e.g. in terms of the spatial-temporal coverage and resolution of the data differ depending on the purpose. Where management plans need information in detailed maps almost at the square meter, the species and habitat distribution maps for the Article 17 reporting only needs to be done in squares of 10x10km. **The idea to collect data on multiple scale levels for multiple purposes seems logical, but in practice this is not always feasible as each monitoring objective requires a specific sampling strategy** [see chapter A.I. Monitoring]. Due to budget constraints priorities need to be set.

Opportunistic data collected by volunteers seem very attractive as the costs of collecting this type of data are low. Nevertheless, a lot of time and effort is spent on validating and harmonizing these data (*Dobson et al., 2016*). Even in successful online web portals, as iNaturalist.org and observation.org, recorders tend to go to the same places and sometimes it even gets crowded with volunteers at a well-known spot, where similar spots in the surroundings are missed. **It requires active participation from experts to try and direct ('lure') recorders into visiting unvisited places**. At the end this also requires time and money, which should not be ignored when setting up such systems or using existing ones.

III.2 Strategies, approaches and practical examples to improve data and information access

III.2.1 Frameworks, common vocabularies and classification systems

In order to facilitate the exchange of biodiversity data and information there should be a common understanding on the type of data and information that are needed by the different users (policy makers, practitioners and scientists). The Birds and Habitats Directives are important instruments to preserve and restore European biodiversity, but there is more to it than that. The Convention on Biological Diversity and the European Biodiversity Strategy have a broader perspective on biodiversity including for example ecosystem services. In the following paragraphs some examples are given of frameworks and classification systems to define and describe the data and information with this broader perspective in mind.

DPSIR framework: drivers, pressures, states, impacts and responses

The DPSIR model (see Figure III.1) adopted by the European Environmental Agency is a causal framework for describing the interactions between society and the environment. **The DPSIR framework serves as a starting point for the development of indicators to evaluate environmental policies such as the Birds and Habitats Directives.**

The way the conservation status of species and habitats is assessed fits into the DPSIR framework. Conservation status is being assessed based on several state variables (e.g. the distribution and population size of species), that are influenced by pressures resulting from different drivers (e.g. pollution from agriculture) and by policy and management responses acting upon them (e.g. measures to reduce pollution from agriculture). State indicators ideally are derived from observational data, whereas the impact of pressures and the effects of conservation measures – in most cases – are assessed based on directed research or expert judgement.

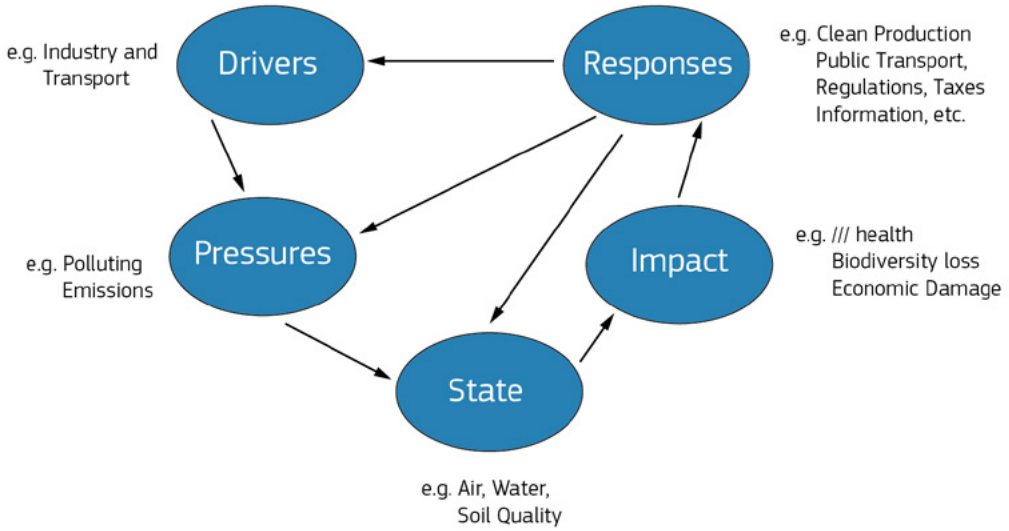

Figure III.1
DPSIR framework of the European Environmental Agency. Source: www.eea.europa.eu/publications/92-9167-059-6-sum/page002.html

The concept of biodiversity

In order to collect, exchange and/or integrate data from multiple sources it is important as well to develop a common vocabulary and unified classification systems, starting with the concept of biodiversity. *Noss (1990)* distinguishes different components (composition, structure and function) and different levels of biodiversity (genes, species populations, communities, ecosystems and landscapes), see Figure III.2. **The components and levels of biodiversity to be addressed depend on the research, policy or management questions that need to be answered**.

The Birds Directive and Habitats Directive are targeted on the level of ecosystems and communities (habitat types) and species populations (species). Different components are being addressed on these levels for example the population structure of species and the structure and function of habitat types. Nevertheless for the implementation of the directives the other levels of biodiversity are relevant as well, for example genetic diversity is important for setting favourable reference values on population size of species.

Essential Biodiversity Variables (EBVs)

The GEOBON network (https://geobon.org/) are developing the so called **Essential Biodiversity Variables** (EBVs), that to a large extent are based on the hierarchical approach of monitoring biodiversity proposed by *Noss (1990)*. **The EBVs provide the first level of abstraction between low-level primary observations and high-level indicators of biodiversity** (see Figure III.3). There are 6 EBV classes with 21 EBV candidates (see Figure III.4).

The EBVs serve different purposes. They are applied to integrate data coming from different sources e.g. in-situ (field surveys and monitoring schemes) and ex-situ (remote sensing) measurements and to transform these data into biodiversity indicators relevant for biodiversity assessments and reporting. They might become the window into the biodiversity observation systems upon which researchers, managers and decision makers at different levels can better interact while they do their jobs. As illustrated in Figure III.3 **EBVs concern state variables sensitive to change depending on drives, pressures and policy and management responses, that act upon them.**

The EBV classes that are relevant for the Birds and Habitat Directives are species populations (e.g. species distribution and population abundance), ecosystem function (e.g. disturbance regime) and ecosystem structure (habitat structure, ecosystem extent and fragmentation). Whereas the monitoring of trends in distribution and population size of species seems quite well developed, the monitoring of the distribution and area of habitat types is quite challenging and even more the monitoring and assessment of the 'quality of the habitat for species' and the 'structure and function of habitat types' [see chapter A.I. Monitoring]. **The further development of EBVs might be of help to harmonize the monitoring and assessment methods applied by different EU member states for the purpose of the implementation of the BD and HD**.

Identification and classification systems (code lists)

a. Taxonomy: species identification and classification

Taxonomy is a scientific discipline that has provided the universal naming and classification system of biodiversity for centuries and continues effectively to accommodate new knowledge (*Thomson et al., 2018*). The assumption that species are fixed entities underpins every international agreement on biodiversity conservation,

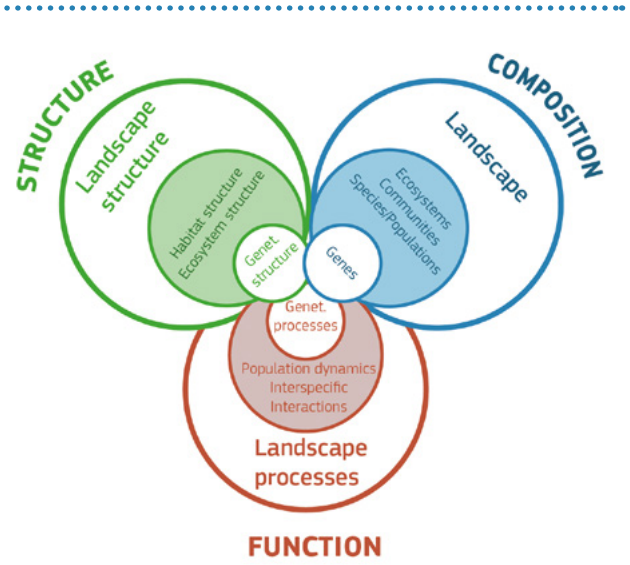

Figure III.2
Schematic visualisation of major biodiversity components (structure, composition, function) with hierarchical nested levels in each case (adapted after *Noss, 1990*). The coloured areas highlight the most feasible level, the level of diversity in species (species richness), within ecosystems and in population interactions.
Source: www.researchgate.net/figure/Schematic-visualisation-of-major-biodiversity-components-structure-composition_fig1_281586657

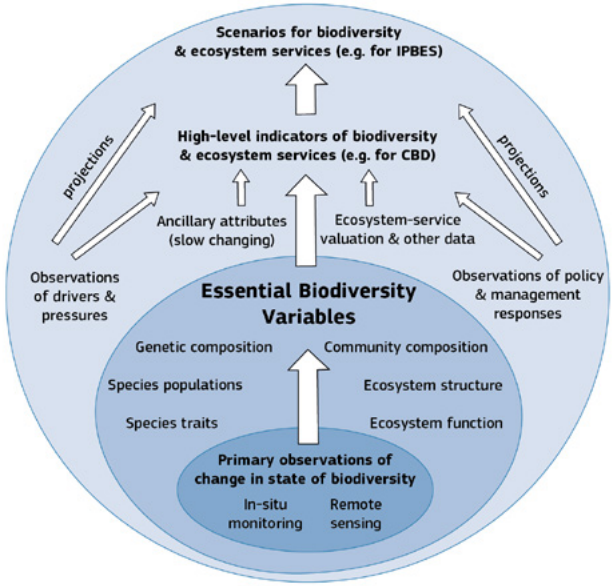

Figure III.3
Essential Biodiversity Variables.
Source: geobon.org/ebvs/what-are-ebvs

all national environmental legislation and the efforts of many individuals and organizations to safeguard plants and animals (*Garnett and Christidis, 2017*). **New knowledge, sometimes caused by new techniques, can lead to a change in taxonomy**. Because of this species get split, lumped with other species, or are moved to another genus. This also applies to the species in the Annexes of the Habitats Directive, where e.g. *Hypodryas maturna* (see Figure III.5) from the original list was moved to the genus *Euphypdryas*, and *Polyommatus eroides* is now considered a subspecies of the Alpine *Polyommatus eros*.

To keep legislation in line with new knowledge in taxonomy, a decent backbone is needed describing the most up-to-date taxonomy. Users need standardised and continuously harmonised taxonomic reference systems, as well as high-quality and complete taxonomic data sets (*De Jong et al. 2015*). Several initiatives have been launched to provide this:

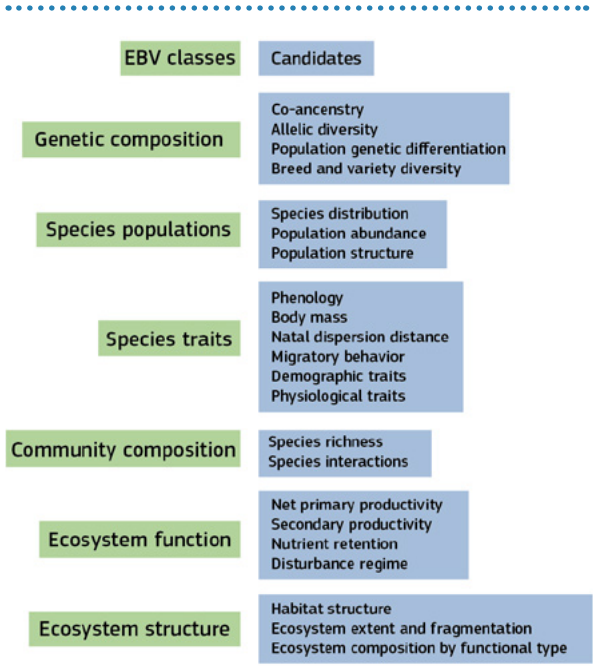

Figure III.4
EBV's classes and candidates.
Source: www.earthobservations.org/uploads/438_2_essential_biodiversity_variable_strategy_v1.pdf

- **The Pan-European Species-directories Infrastructure (PESI)** provides a mechanism to deliver an integrated, annotated checklist of the species occurring in 'geographic Europe', aiming to cover the Western Paleartic biogeographic region. At the core of EU-nomen are five community networks, with common nomenclatures or systems designations: Zoology, Botany, Marine Biota, Mycology and Phycology (*De Jong et al., 2015*). The present status of PESI is unclear, as recent searches on the website (www.eu-nomen.eu/pesi) did not give decent results to all queries, also not for Habitat Directive species.
- **EUNIS** (eunis.eea.europa.eu/species.jsp) provides a website with information targeted at accessing information about species in Europe, particularly species mentioned in legal texts. However many species names appear not to be updated to the latest taxonomy.
- **Fauna Europaea** (fauna-eu.org) was supposed to become Europe's main zoological taxonomic index, also feeding into PESI (see above). However, due to financial constraints the information is not up-to-date anymore.
- **Euromed Plantbase** (www.emplantbase.org/home.html): The Euro+Med PlantBase provides an on-line database and information system for the vascular plants of Europe and the Mediterranean region, against an up-to-date and critically evaluated consensus taxonomic core of the species concerned. The Euro+Med PlantBase is part of the Pan-European Species directories Infrastructure (PESI), funded by the European Union under the Framework 7 Capacities Work Programme.

Figure III.5
Euphydryas maturna. Photo: Chris van Swaay from the Dutch Butterfly Foundation.

- **WORMS** (World Register of Marine Species: the main taxonomic reference system for marine environment (www.marinespecies.org)

- **Catalogue of Life** (www.catalogueoflife.org): The Catalogue of Life is the most comprehensive and authoritative global index of species currently available. It consists of a single integrated species checklist and taxonomic hierarchy. The Catalogue holds essential information on the names, relationships and distributions of over 1.8 million species. This figure continues to rise as information is compiled from diverse sources around the world. For Catalogue of Life a new infrastructure is currently being developed in the CoL+ project (www.dissco.eu/catalogue-of-life).

It is obvious from the above mentioned initiatives, that users will find it difficult to find their way in all these websites.

The Darwin Core Standard **(DwC) offers a stable, straightforward and flexible framework for compiling biodiversity data from varied and variable sources**. Originally developed by the Biodiversity Information Standards (TDWG) community, Darwin Core is 'an evolving community-developed biodiversity data standard. It plays fundamental role in the sharing, use and reuse of open-access biodiversity data (www.gbif.org/darwin-core). **One of the cores is a Taxon core, which lists a set of species, typically coming from the same region or sharing common characteristics. This is an open-source way of standardizing taxa, used e.g. in GBIF (**gbif.org**)**.

b. Ecosystem typologies: habitat identification and classification

Many ecosystem and habitat typologies exist ranging from local to global level. In the following paragraph some of the main typologies used on EU level are shortly described to start with the EU Habitat Directive Annex 1 habitat types. Translations are being made between these different typologies.

Figure III.6
Slovenia, Osrednjeslovenska, Brezovica 5, *Saxifraga-Hans Dekker*. Source: www.freenatureimages.eu

EU Habitats Directive Annex I habitat types
The Habitat Directive Annex I lists today 233 European natural habitat types, including 71 priority (i.e. habitat types in danger of disappearance and whose natural range mainly falls within the territory of the European Union). Annex I was initially based on the hierarchical classification of European habitats developed by the CORINE Biotopes project since that was the only existing classification at European level. An Interpretation Manual describes the habitats but there is often variation between Member States in how they interpret the habitat types, sometimes there is variation between regions in the same country. There is a specific code list for identification of the habitat types, described as well for the Habitats Directive Article 17 reporting.

EUNIS habitat classification
The EUNIS habitat classification is a comprehensive pan-European system for habitat identification. **The EUNIS habitat classification covers both natural and artificial pan-European habitats and groups them into 11 broad categories**:

1. Marine habitats
2. Coastal habitats
3. Inland surface waters
4. Mires, bogs and fens
5. Grasslands and lands dominated by forbs, mosses or lichens
6. Heathland, shrub and tundra
7. Woodland, forest and other wooded land
8. Inland unvegetated or sparsely vegetated habitats
9. Regularly or recently cultivated agricultural, horticultural and domestic habitats
10. Constructed, industrial and other artificial habitats
11. Habitat complexes

The habitat types are identified by specific codes, names and descriptions.

The MAES ecosystem typology
The MAES project (MAES: Mapping and Assessment of Ecosystem and their Services) has proposed a typology that distinguishes 12 main ecosystem types based on the higher levels of the EUNIS Habitat Classification.

The interpretation of ecosystem typologies is often complicated and even more so the mapping and monitoring of habitats [see chapter A.I Monitoring of species and habitats]. **Member States may use the same codes, but the interpretation and the mapping / monitoring and assessment methods differ leading to inconsistencies in the data and information being reported**.

c. Classification systems for drivers, pressures, impact and responses

For the purpose of reporting the EC proposes classification systems and code lists are prescribed for the identification of pressures and threats and conservation measures. These classification systems are based on former classification systems such as proposed by *Salafsky et al. (2007)*. Differences exist between the classification systems and code lists of different directives, such as the Birds and Habitats Directives, the Water Framework Directive and Marine Strategy Framework Directive.

Although unified classification systems for drivers, pressures, impact and responses (e.g. mitigation and conservation measures) exist, data and information are often lacking or inaccessible. The reporting formats of the Birds and Habitats Directives don't request evidence on pressures and threats in terms of quantitative data (e.g. trends).

III.2.2 Data portals and services

A data portal on the internet acts as a 'gateway' to a series of other websites that deal with the same subject. In some countries, national level web portals exist, which provide the ability to customise local projects to suit the needs and interests of key stakeholders at the same time as feeding into larger databases using standardised data collection and curation protocols. Examples include Artportalen in Sweden, the Norwegian Biodiversity Information Centre, waarneming.nl and telmee.nl in the Netherlands and the National Biodiversity Network in the UK. These portals create a bridge between the needs of large Biodiversity Observation Networks and the needs of local stakeholders by reducing many of the barriers that hinder data flows. These portals provide many of the tools, systems access to expertise, feedback and other resources that otherwise make connecting local projects to global programs challenging (Chandler et al., 2017).

Next to these national gateways, iNaturalist.org and observation.org provide international data portals, making it possible for everyone in the world to enter any living organism in the world. Part of this data is uploaded to GBIF.

In the following paragraphs some examples are presented of global and European data portals and services, that are or might become of importance for the implementation of the Birds and Habitats Directives.

GBIF – Global Biodiversity Information Facility

GBIF (www.gbif.org) is an **international network and research infrastructure** funded by the world's governments and aimed at providing anyone, anywhere, open access to data about all types of life on Earth.

The GBIF network of participating countries and organizations, provides data-holding institutions around the world with common standards and open-source tools that enable them to share information about where and when species have been recorded. This knowledge derives from many sources, including everything from museum specimens collected in the 18th and 19th century to geotagged smartphone photos shared by amateur naturalists in recent days and weeks.

The GBIF network draws all these sources together through the use of data standards, such as Darwin Core (DwC is meant to provide a stable standard reference for sharing information on biological diversity, *Wieczorek et al., 2012*), which forms the basis for the bulk of GBIF.org's index of 1,5 billion of species occurrence records. GBIF covers for instance over 500 million species occurrences for the participating countries in Europe. Publishers provide open access to their datasets using machine-readable Creative Commons licence designations, allowing scientists, researchers and others to apply the data in hundreds of peer-reviewed publications and policy papers each year. Many of these analyses—which cover topics from the impacts of climate change and the spread of invasive and alien pests to priorities for conservation and protected areas, food security and human health—would not be possible without this. Currently, more than two peer-reviewed articles that use data discovered and accessed through GBIF are published every day of the year (www.gbif.org/literature-tracking).

The National Biodiversity Network UK

The National Biodiversity Network NBN (nbn.org.uk) is a collaborative partnership created to exchange biodiversity information (see Figure III.7). The NBN Trust, the charity which oversees and facilitates the development of the Network, has a membership including many UK wildlife conservation organisations, government, country agencies, environmental agencies, local environmental records centres and many voluntary groups. Different tools are made available to record, share and explore data.

Figure III.7
NBN Data Flow Pathway. Source: nbn.org.uk/wp-content/uploads/2015/10/Data-flow-pathway-headings-only.jpg.

EVA – European Vegetation Archive

The European Vegetation Archive (EVA – euroveg.org/eva-database) is **an initiative of European Vegetation Survey aimed at establishing and maintaining a single data repository of vegetation-plot observations** (i.e. records of plant taxon co-occurrence at particular sites, also called phytosociological relevés) from Europe and adjacent areas and to facilitate the use of these data for non-commercial purposes, mainly academic research and applications in nature conservation and ecological restoration. The initiative follows the EVA Data Property and Governance Rules. It closely cooperates with the Global Index of Vegetation-Plot Databases (GIVD), the Global Vegetation Database (sPlot) and the Plant Trait Database (TRY).

EVA stores copies of national and regional vegetation-plot databases on a single software platform. By 30 June 2015, 61 databases from all European regions have joined EVA, contributing in total 1.027.376 vegetation plots, 82% of them with geographic coordinates, from 57 countries. EVA provides a unique data source for large-scale analyses of European vegetation diversity both for fundamental research and nature conservation applications (*Chytrý et al., 2016*).

Copernicus

Copernicus (www.copernicus.eu/en/services) is the largest space data provider in the world, currently producing 12 terabytes per day. Copernicus is a **European Union Programme aimed at developing European information services based on satellite Earth Observation and in situ (non-space) data**. The Programme is coordinated and managed by the European Commission and implemented in partnership with the Member States, the European Space Agency (ESA), the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), the European Centre for Medium Range Weather Forecasts (ECMWF), EU Agencies and Mercator Océan.

Vast amounts of global data from satellites and from ground based, airborne and seaborne measurement systems are being used to provide information to help service providers, public authorities and international organisations. The vast majority of data and information delivered by Copernicus are made available and accessible to any citizen and any organisation around the world on a free, full and open access basis.

Copernicus analyses the data in a way that generates indicators useful for policy makers and end users, providing information on past, present and future trends. They can analyse, for example, the air quality in our cities and detect visible and noticeable increases in air pollution (smoke, dust, smog) or analyse the rise in global sea levels.

Monitoring portals

With the monitoring of more and more taxa spreading over Europe, there are now portals bringing together data and results for use at a higher level. So far the main portals are for birds (Pan-European Common Bird Monitoring Scheme: pecbms.info) and butterflies (European Butterfly Monitoring Scheme: butterfly-monitoring.net). They summarize pan-European as well as EU-trends and indicators, providing a background for trends in Member States. In most cases the underlying data is also used by the member states for biodiversity reporting.

III.2.3 Open data principles, policies and practices

As described by the WCMC some people and organisations are unwilling to share biodiversity data for various reasons, but there is a rising awareness that sharing data helps to improve the knowledge on the environment and may increase as well the effectiveness of human interventions to protect and preserve the environment. From the academic world there are different initiatives – often community driven – to improve access to data. Governments are developing and implementing policies for open data and research whereas the funding organisations demand the appropriate access to the data being collected in research projects. These initiatives and policies are contributing as well to improve the access to data and information (and knowledge) for the implementation of the Birds and Habitats Directives. In the next paragraphs some of these initiatives are presented.

GO FAIR

GO FAIR is a bottom-up, stakeholder-driven and self-governed initiative that aims to implement the FAIR data principles (www.go-fair.org/fair-principles)**, making data Findable, Accessible, Interoperable and Reusable (FAIR)**. It offers an open and inclusive ecosystem for individuals, institutions and organisations working together through Implementation Networks (INs). The INs are active in three activity pillars: GO CHANGE, GO TRAIN and GO BUILD. The principles emphasise **machine-actionability (i.e., the capacity of computational systems to find, access, interoperate, and reuse data with none or minimal human intervention)** because humans increasingly rely on computational support to deal with data as a result of the increase in volume, complexity, and creation speed of data (*Wilkinson et al., 2016*).

Research Data Alliance (RDA)

The Research Data Alliance (www.rd-alliance.org**) was launched as a community-driven initiative in 2013 by the European Commission, the US Government's National Science Foundation and National Institute of Standards and Technology, and the Australian Government's Department of Innovation with the goal of building the social and technical infrastructure to enable open sharing and re-use of data**.

RDA wants researchers and innovators to openly share data across technologies, disciplines, and countries to address the grand challenges of society. RDA's mission is to build the social and technical bridges that enable open sharing and re-use of data.

Open Data Directive

The Directive on open data and the re-use of public sector information, also known as the 'Open Data Directive' (Directive (EU) 2019/1024) entered into force on 16 July 2019. Once fully transposed on the national level, the new rules will:

- Stimulate the publishing of dynamic data and the uptake of **Application Programme Interfaces (APIs)**.

Network coherence is often addressed on the basis of:

- assessment of landscape fragmentation, through indices
- assessment of functionality of the landscape for particular species or ecosystems
- assessment of corridors

- Limit the exceptions which currently allow public bodies to charge more than the marginal costs of dissemination for the re-use of their data.
- Enlarge the scope of the Directive to:
  - → **data held by public undertakings**, under a specific set of rules. In principle, the Directive will only apply to data which the undertakings make available for re-use. Charges for the re-use of such data can be above marginal costs for dissemination;
  - → **research data resulting from public funding** – Member States will be asked to develop policies for open access to publicly funded research data. New rules will also facilitate the re-usability of research data that is already contained in open repositories.
- Strengthen the transparency requirements for public–private agreements involving public sector information, avoiding exclusive arrangements.

In addition, the Open Data Directive requires the adoption by the Commission (via a future implementing act) of a **list of high-value datasets to be provided free of charge**. These datasets, to be identified within a thematic range described in the Annex to the Directive, have a high commercial potential and can speed up the emergence of value-added EU-wide information products. They will also serve as key data sources for the development of Artificial Intelligence. Member States have to transpose Directive (EU) 2019/1024 by 16 July 2021.

III.2.4 Information systems

Information systems bring together data and information from different sources and disseminate this information in a structured way for different types of users. They are oriented to a specific domain such as biodiversity and organised around certain user communities (governmental officials and/or scientists). In the next paragraphs some examples on global and European level are described.

EUNIS – European Nature Information System

The European Nature information System, EUNIS (eunis.eea.europa.eu/index.jsp), **brings together European data from several databases and organisations into three interlinked modules on sites, species and habitat types**. The EUNIS information system is part of the European Biodiversity Centre and it is a contribution to the knowledge base for implementing the EU and global biodiversity strategies and the 7th Action Programme. **The EUNIS information system provides access to the publicly available data in the EUNIS database**.

BISE – Biodiversity Information System of Europe

Biodiversity Information System of Europe, BISE (biodiversity.europa.eu) is a **single entry point for data and information on biodiversity supporting the implementation of the EU strategy and the Aichi targets in Europe**. Bringing together facts and figures on biodiversity

A number of examples based on LIFE or Interreg projects are presented on how measures were prepared for improvement of the coherence of habitats, as well as for specific species:

- Boreal Baltic coastal meadows (1630*)
- Alpine rivers and their ligneous vegetation with Myricaria germanica (3230)
- Temporary Mediterranean ponds (3170*)
- European sturgeon/Beluga (Huso Huso) (HD App. V)
- Large copper (Lycaena dispar) (HD App. II, IV)
- Eurasian lynx (Lynx lynx) (HD App. II, IV)
- Stag beetle (Lucanus cervus) (HD App. II)

The flora of Baltic coastal meadows is very rich, e.g. in Estonia a total of 390 plants species have been found, which is 26% of all Estonian species. More than 20 protected species grow on coastal meadows, including many orchids: *Dactylorhiza ruthei*, Frog orchid (*Coeloglossum viride*), Fen orchid (*Liparis loeselii*), Baltic orchid (*Dactylorhiza baltica*), Blood-red dactylorhiza (*Dactylorhiza incarnata ssp. cruenta*), Early marsh orchid (*Dactylorhiza incarnata*), Musk orchid (*Herminium monorchis*), Marsh helleborine (*Epipactis palustris*), Early-purple orchid (*Orchis mascula*), Common spotted orchid (*Dactylorhiza fuchsii*), Military orchid (*Orchis militaris*), Fly orchid (*Ophrys insectifera*) and Fragrant orchid (*Gymnadenia conopsea*).

Other decorative species in coastal meadows are: *Gladiolus imbricatus*, *Armeria maritima*, *Tetragonolobus maritimus*, large pink *Dianthus superbus* and Red kidney vetch *Anthyllis vulneraria var. coccinea* (*Anonymous, 2011*).

and ecosystem services, it links to related policies, environmental data centres, assessments and research findings from various sources. **It is being developed to strengthen the knowledge base in support of the implementation of the EU biodiversity strategy e.g. Birds and Habitats Directives** and the assessment of progress in achieving the 2020 targets.

OBIS – Ocean Biographic Information System

OBIS (www.obis.org) is a **global alliance that collaborates with scientific communities to facilitate free and open access to, and application of, biodiversity and biogeographic data and information on marine life**. To date more than 20 OBIS nodes around the world have been established, which facilitate the connection of data sources in their region to the master OBIS data network and also increasingly provide specialised services or views of OBIS data to users in their particular region. The OBIS nodes connect over 500 institutions from 56 countries. Collectively, they have provided over 45 million observations of nearly 120.000 marine species, from Bacteria to Whales, from the surface to 10.900 meters depth, and from the Tropics to the Poles. The datasets are integrated so you can search and map them all seamlessly by species name, higher taxonomic level, geographic area, depth, time and environmental parameters.

III.2.5 Knowledge networks

Knowledge networks are collections of individuals and teams who come together across organizational, spatial and disciplinary boundaries to invent and share a body of knowledge. The focus of such networks is usually on **developing, distributing** and **applying knowledge**. Just as information systems knowledge networks are often focussed on certain domains. In the next paragraphs some good examples are presented.

The Natura 2000 Biogeographical Process

The EU Biodiversity Strategy calls for significant improvements in the conservation status of species and habitats protected under the EU Birds and Habitats Directives by 2020. To help meeting this target, the European Commission launched in 2012 the Natura 2000 Biogeographical Process, a **multi-stakeholders' co-operation process at the biogeographical level**, including seminars, workshops and cooperation activities **to enhance effective implementation, management, monitoring, financing and reporting of the Natura 2000 network**.

OBN network

In The Netherlands there is a knowledge network called ‘OBN’ with researchers, conservation site managers, universities, consultancies, NGO’s and governmental bodies, such as provinces and water boards, closely cooperating to restore ecosystems and nature reserves. In this network, knowledge and practice intermingle, and science and nature management jointly look for the most effective approaches to enhance sustainable conservation of important ecosystems in the Dutch landscapes [see chapter B.I. Guidance and tools for effective restoration measures for species and habitats].

III.3 Key findings and recommendations

There are many initiatives to improve access to data and information on different scale levels (from local to global level), but often with a much broader scope than the implementation of the Bird and Habitat Directives. The challenge is to explore/exploit these initiatives for the purpose of a better implementation of the Birds and Habitats Directives. Obviously a combination of different approaches is needed to remove the barriers as identified by the WCMC.

III.3.1 Frameworks, common vocabulary and classification systems

A broader perspective than the Birds and Habitats Directives is needed to improve access to biodiversity data and information

When defining the data and information needs and developing classification systems for the purpose of streamlining data flows, it is important to look from a broader perspective than just the Birds and Habitats Directives, as there is a strong relation and overlap with other EU directives (e.g. the Water Framework Directive, the Marine Strategy Framework Directive), biodiversity conventions and agreements (e.g. the Convention on Biological Diversity). Harmonisation of classification systems used by these directives is recommendable.

The DPSIR framework is a good starting point for defining common indicators

The DPSIR framework is useful as a starting point to define the data and information needs and develop indicators. The assessments for the purpose of the implementation of the Birds and Habitats Directives (e.g. conservation status assessment and proper assessments) fit into this framework. State indicators such as (trends in) population size of species form the basis of these assessments, but indicators for drivers, pressures, impacts and responses are important as well, specifically when addressing the impact of transitions of economic sectors on biodiversity.

The Essential Biodiversity Variables are a useful concept for harmonising monitoring and assessments

The EBVs offer opportunities to harmonise (not necessarily standardise) the monitoring and assessment methods of different Member States as they can serve as a window for observation networks and facilitate the integration of data coming from different sources. The challenge will be to define common state indicators – useful for the implementation of the Birds and Habitats Directives – based on the EBVs, and to operationalise these indicators with the help of observation data coming from different sources. In addition to state indicators other type of indicators of the DPSIR framework (drivers, pressures, impacts and responses etc.) should be defined.

Identification and classification systems need to be maintained

There is obviously a need for unified identification and classification systems, that are maintained on the long term. Many initiatives such as PESI are no longer maintained and therefore not useful anymore.

III.3.2 Data portals and services

Linking data portals on different scale levels

There are several good examples of data portals and services making data accessible for different stakeholders and for multiple purposes operating on different scales (from local to global). The challenge is to have more and more organisations and networks contributing to these portals and to streamline the data flows from local to global and vice versa. Available funding on a long term basis and the contribution of certain communities (often out of idealistic motives) determines the success of these portals. In Figure III.8 the number records of the observations on macro moths from GBIF are presented to illustrate that there is quite some difference between the Member States in terms of data availability.

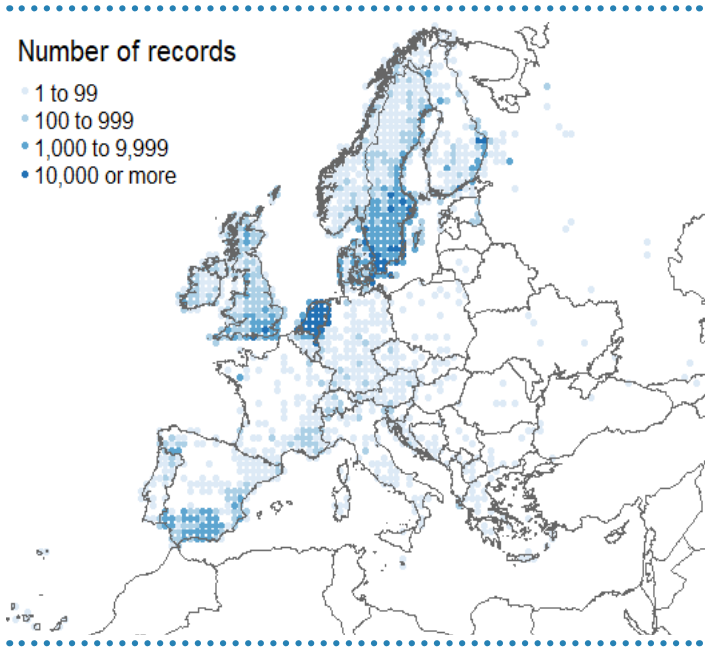

Figure III.8
Number of records of observations on macro moths from GBIF data, 10th of March 2020, doi.org10.15468dl.w1aafk

Better use of the potential of opportunistic data

The efficient use of the widely collected opportunistic data requires active participation of leading scientists and conservationists. They can bind volunteer recorders and steer them to active investigation of 'empty' areas.

Better use of the potential of remote sensing data

The use of remote sensing has not yet been fully assimilated into standard biodiversity conservation practices. The remote sensing community needs to continue to reach out to the broader conservation community and to simplify access to images and the derived products that the broader community need (link with remote sensing chapter). These actions will facilitate greater use and integration and increase the return on the huge investment in remote sensing infrastructure. As more and different types of sensors become available and as coordination with that broader community continues to increase, remote sensing will play an ever-increasing role, providing global, periodic data that can improve our understanding of change as well as how society responds (*Geller et al., 2017*).

III.3.3 Open data and research principles, policies and practices

The FAIR principles are important to improve data and information access. By means of open data policies these principles can be put in practice. Data portals play an important role, making it easier for data custodians to register their data.

III.3.4 Information systems

Many information systems are being developed that serve different purposes. The maintenance of these systems can be problematic due to lack of long-term funding and governance.

III.3.5 Knowledge networks

Knowledge networks of e.g. scientists and practitioners are very valuable as long as they stay in place for a long period of time.

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Acknowledgements and contributions

Thanks to DG-Environment for the input and comments on earlier drafts of the Handbook. In particular Ute Goerres and Angelika Rubin that directed the study, but also Micheal O'Briain and Bruno Combal that provided input at various stages.

Events and forums on which the project was presented:

- 4th NATURA 2000 monitoring workshop: remote sensing group (Doñana, 9–11th of April 2019): Carlos Sunyer, Clive Hurford, Alan Brown, Kristijan Civic, Bruno Combal, Sander Mucher, Ellen Meulman, and all other participants.
- ESP-Conference, science-policy interface (Hannover, Leibniz University Hannover, 21st of October 2019): EBIND – The contribution of Ecosystem Services science to policy: are we addressing the right questions? Marta Perez-Soba, Leon Braat, Theo van der Sluis.
- E-BIND Focus Group meeting 'Evidence-based improvements in the Birds and Habitats Directives (BHD) implementation: systematic review' (Brussels, June 2019).

Complete list of organizations consulted along the project

European Environment Agency- Natural capital and Ecosystems, Helmholtz-Centre for Environmental Research (Germany), Spanish Ministry for Ecological Transition, European Bird Census Council (EuroBird Portal), German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Foundation for the research on Ethology and Biodiversity (Spain), European Commission: DG Environment, DG Research and Innovation & Joint Research Centre, Swedish University of Agricultural Sciences, University of Cantabria: Environmental Hydraulics Institute (Spain), Technical University of Denmark: National Institute of Aquatic Resources, EUROSITE, University of Twente (Netherlands), Justus-Liebig University Gießen, Universiteit Antwerp (Belgium), Natuurmonumenten (Netherlands), Bulgarian Biodiversity Foundation, University of Patras: Department of Environmental And Natural Resources Management (Greece), Infrastructure and Ecology Network Europe, IMMERSE H2020 Project (Improving Models for Marine Environment Services), Catalan Ornithological Institute (Spain), BirdLife Europe, EURAC Research Centre (Italy), Flora & Fauna International, Conservatoires D´Espaces Naturels (France), Research Institute for Nature & Forest (Belgium).

Other people consulted or contributed (by authors): Dolf de Groot, Carla Grashof-Bokdam, Walter van Wingerden (†), Chris van Swaay.