Deliverable 5.2 (D5.2)

Recommendations and strategies for building and sustaining a network of EU BON sites

M50

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Authors:	Mathias Kuemmerlen, Peter Haase, Jonas Jourdan (SGN, Senckenberg Gesellschaft für Naturforschung, Germany) Anke Hoffmann, Vanessa Dörries, Florian Wetzel, Christoph Häuser, Johannes Penner (MfN, Museum für Naturkunde - Leibniz Institute for Research on Evolution and Biodiversity, Germany) Carlos Rodriguez (CSIC, Estación Biológica de Doñana, Spain)

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Dissemination Level

PU	Public	✓
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
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1. Executive Summary

1.1 Introduction

The main objective of the EU BON project is to build the European component of the Group on Earth Observation Biodiversity Observation Network (GEO BON). The purpose of such a network is to provide reliable scientific knowledge that is accessible and applicable to the needs of society, in order to facilitate the sustainable governance of our biological resources. Beside the EU BON network, several other biodiversity observation systems are already established, however, environmental datasets are heterogeneous in their methods, unbalanced in their spatial and taxonomic coverage and poorly integrated, urging for a framework that standardizes, homogeneously distributes and effectively links biodiversity observation across Europe and the globe.

1.2 Progress towards objectives

The goal of this deliverable is to provide recommendations and strategies for building and sustaining a network of EU BON sites. Thus, a guide is proposed to set up, operate and continuously develop a biodiversity observation network. It is subdivided into three sections. A) *Biodiversity observation: sites and schemes*: This section addresses different approaches in monitoring: those driven by particular locations or sites, including existing networks of sites, and those based on a particular monitoring strategy, or scheme, with varying locations. *B) Biodiversity data: standards, analyses and communication of results:* Biodiversity monitoring data has to be collected consistently across a large-scale area and for a diverse range of organisms. For this, data has to be processed into relevant information such as Environmental Biodiversity Variables (EBVs), which follow specific standards, are homogenous and comparable. *C) European Biodiversity Network: implementation strategy:* Existing elements of biodiversity monitoring and the results are brought together to propose a path for the implementation of the European Biodiversity Network. Concrete steps are suggested to achieve a sustainable network that evolves through time, adapting to new requirements and insights.

1.3 Achievements and current status

The current report analyzes the situation of biodiversity monitoring in Europe and provides a plan for building and sustaining a network of EU BON sites. There is currently no network spanning all of Europe, focusing on all taxa and covering all regions. However, there are several biodiversity observation systems available but were not harmonised with one another. We establish a list of potential partner networks, including those approached in the course of EU BON and beyond. Further we propose a general strategy to bind these networks into a single, consolidated biodiversity observation network for Europe.

1.4 Future developments

Based on the existing networks, the challenge consists in merging efforts from these networks into a wider network that collaborates to establish an overarching biodiversity observation network. The ultimate goal is to monitor biodiversity both extensively and intensively, but in an efficient way. A specific strategy is outlined in the current report to meet the demands of biodiversity data required to adequately monitor the current status of populations and ecosystems, while allowing to make predictions anticipating possible changes. Existing observation sites will therefore require modifications to fit the new objectives, while new sites should be set up where geographical gaps exist.

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2. Introduction

2.1 Background

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Current biodiversity observation systems and environmental datasets are heterogeneous in their methods, unbalanced in their spatial and taxonomic coverage and poorly integrated, urging for a framework that standardizes, homogeneously distributes and effectively links biodiversity observation across Europe and the globe. Moreover, the resulting data should be easily accessible and channelled to the relevant stakeholders.

EU BON proposes an integrative approach including biodiversity information from on-site research, remote sensing data, analysis tools and e-science infrastructure. Furthermore, novel ways to portray and deliver the knowledge generated are addressed by joining social networks of science and policy with technological networks of interoperating IT infrastructures.

2.2 Objective

A biodiversity observation network (BON) can be built on existing components, such as the infrastructure of GBIF or LifeWatch, as well as the framework of national biodiversity data centres. EU BON's 31 partners from 18 countries are already members of various networks of biodiversity data-holders, monitoring organisations, and leading scientific institutions. The expertise of the partners has been harnessed and combined with those of other organizations which have been identified during this project. The goal of this deliverable is to provide recommendations and strategies for building and sustaining a network of EU BON sites. Thus, a guide is proposed to set up, operate and continuously develop a biodiversity observation network. It is subdivided into three sections:

a) **Biodiversity observation: sites and schemes**. This section addresses different approaches in monitoring: those driven by particular locations or sites, including existing networks of sites, and those based on a particular monitoring strategy, or scheme, with varying locations. In this context we summarize efforts of biodiversity monitoring that are already part of the EU BON network, those that have been approached already and those with a high potential to be approached in the near future.

b) **Biodiversity data: standards, analyses and communication of results**. Biodiversity monitoring data has to be collected consistently across a large-scale area and for a diverse range of organisms. For this, data have to be processed into relevant information such as EBVs (Pereira *et al*. 2013), which follow specific standards, are homogenous and comparable.

c) **European Biodiversity Network: implementation strategy**. Existing elements of biodiversity monitoring and the results are brought together to propose a path for the implementation of the European Biodiversity Network. Concrete steps are suggested to achieve a sustainable network that evolves through time, adapting to new requirements and insights.

3. Biodiversity observation: sites and schemes

A network is built by linking single elements in a way that they facilitate the process of interest. Here we link diverse elements that will lead to a structure and workflow that produces reliable data on biodiversity observations (**Fig. 1**). The well-founded placement of individual elements in a logical sequence within the network should maximize their effectiveness of the network to produce useful biodiversity observation data. We rely on efforts made within the diverse work packages of the

EU BON project addressing particular components, such as recommendations to set up biodiversity observation sites, improve their operation and their monitoring activities (EU BON 2015a, b). Moreover, we draw upon different elements that already exist in other contexts and have been developed for similar purposes. This is the case of a toolbox which has been created to support the establishment and operation of biodiversity observation sites within GEO BON. The toolbox has been named BON in a Box (https://boninabox.geobon.org) and should help kick-start new efforts and guide existing ones by providing information on monitoring methods and analysis tools.

The basic purpose of observing biodiversity is to deliver near-real-time relevant data to various stakeholders and end users, ranging from local to global levels. For this purpose, it is necessary to set up a collaborative network that can deliver such data. This, however, is no trivial task as it needs to provide accurate information, efficiently spanning many different types of ecosystems and with short time lags.

In the following, the biodiversity observation network established during the EU BON project is summarized. In the first part, an overview is given, subdivided into *3.1.1*) initial EU BON test sites, *3.1.2*) Large scale site networks, as well as *3.1.3*) national monitoring schemes. The second part enumerates a selection of further networks of biodiversity observation (*3.2.1-3.2.3*), as well as additional monitoring schemes (*3.2.4-3.2.6*), which would be valuable additions to a European Biodiversity Network.

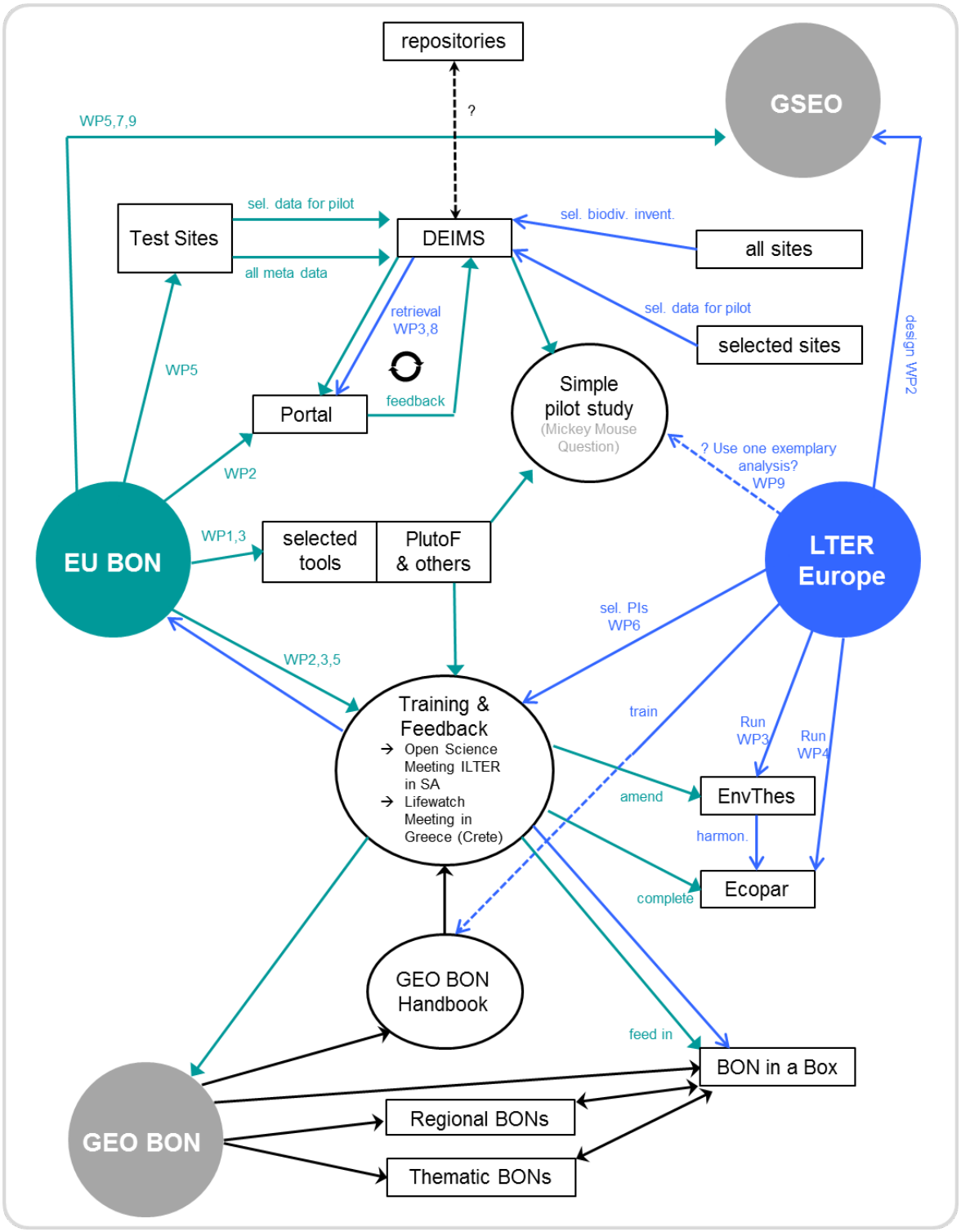

Figure 1: Conceptual map of the support structure for a European Biodiversity Observation Network, integrating all existing elements.

3.1 Biodiversity observation network established in the EU BON project

Within the EU BON project, the first step in establishing a network of biodiversity observation sites was to start with those operated by project partners (see detailed descriptions in EU BON 2015a). However, the number of such sites is relatively low among partners, mostly because of high operation costs and limited funding possibilities.

3.1.1 EU BON test sites

Three of the original partners in the EU BON consortium operate field stations where the monitoring of biodiversity is part of the regular activities: the Spanish Consejo Superior de Investigaciones Científicas (CSIC) runs the Doñana Biological Station (EBD), with a focus on terrestrial ecosystems; in Greece the Hellenic Centre for Marine Research (HCMR) carries out much of their marine research in the Amvrakikos Wetland; and finally, in Germany, Senckenberg (SGN) studies freshwater ecosystems within the Rhine-Main-Observatory (RMO).

i. Doñana Biological Station

Protected since 1968, Doñana National Park (537 km^2) is a UNESCO Biosphere Reserve, a Ramsar Site, a Natural World Heritage Site and it is integrated in the Natura 2000 network. Environmental monitoring started in the mid 60's, with a very local perspective of monitoring that mainly focused on the surroundings of the main field station (EBD). At that time, the main goal was to make the high species richness of the site visible to the world to help preserving the area and finally declare it as National Park. Afterwards, different monitoring protocols started being conducted under the helm of the Spanish Council for Scientific Research (EBD-CSIC). In 2006, Doñana joined ALTERNet (A Long-Term Biodiversity, Ecosystem and Awareness Research Network) that aims to establish a lasting infrastructure for integrated ecosystem research and since 2007 is LTER site.

ii. Rhine-Main-Observatory

The Rhine-Main-Observatory comprises the catchment of the river Kinzig (~1000km^2), situated on the Eastern boundary of the Rhine-Main agglomeration area in Central Germany, between the Vogelsberg and the Spessart mountains. It was established in the year 2007 and has been continuously operated by the Senckenberg Gesellschaft für Naturforschung (SGN) since then. At the Rhine-Main-Observatory, the long-term impacts of changes in land use, climate and other environmental variables on animal and plant communities in anthropogenically used habitats are investigated. The monitoring program focuses on habitats in streams and their floodplains, including areas with natural vegetation, agricultural and settlement areas. The Rhine-Main-Observatory is part of the Long-Term Ecological Research network (LTER). Senckenberg carries out a range of biodiversity research projects at the Rhine-Main-Observatory.

iii. Amvrakikos Wetland

Amvrakikos Wetlands site (West Greece) has been characterized as a National Park since 2008 and is protected through several Conventions (Ramsar, Barcelona, Bern and Bonn Conventions). Amvrakikos is also a Natura 2000 SCI and SPA site. Several diverse habitats are present in the Amvrakikos wetlands site, such as coastal lagoons, estuaries, salt meadows, marshlands, halophilus scrubs, sandbanks and mudflats, swamps and delta formations, whereas many of them are defined as priority habitats according to the Habitats Directive. Amvrakikos Gulf is one of the most important routes of migratory birds with more than 254 bird species. The Hellenic Centre for Marine Research (HCMR) is a public research centre that has collaborated with the Managing Body of Amvrakikos Wetlands for several years now and has participated in many research projects in the area.

Two additional partner sites were added to the EU BON project after it started and served as an additional test site for EU BON partners. This adds further ecosystems into the portfolio of the project. In particular the engagement with diverse stakeholders is of great importance as a testbed for project partners.

iv. Sierra Nevada Observatory

The Sierra Nevada Global-Change Observatory is intended to put together useful and relevant information regarding the ecological systems and the socioeconomics in a protected area that covers 171.000 ha. The design of the Global Change Monitoring Programme in the Sierra Nevada is based on the conceptual and thematic frameworks proposed by the GLOCHAMORE strategy (GLObal CHAnge in MOuntain REgions http://mri.scnatweb.ch/ projects/glochamore), sponsored by UNESCO. The local implementation of the global initiative first required the exhaustive compilation of monitoring protocols that were previously used in the Sierra Nevada. Thus, many of the monitoring protocols for wild fauna (Spanish ibex and wild boar) and flora (threatened species endemic to the high peaks) have been incorporated into the current programme. The result provides 48 methodologies related to data collection on various aspects of the composition, structure, and function of the Sierra Nevada ecological system and encompasses a total of 130 different variables. Links with other international networks and projects (LTER, NEON, etc.) have been established, during which difficulties in harmonization of data could be identified. Citizen science projects are promoted to obtain information about the impacts of global change in Sierra Nevada. Current challenges include reinforce the relationships of the Observatory with major projects (EU BON, LifeWatch, NEON, LTER, etc.).

v. European Natural Park Mercantour/Alpi Marittime

Located at the western end of the Alps, overlapping France and Italy, the Argentera-Mercantour massif is comprised of nearly 250,000 hectares. The Mercantour massif is the lowest southern promontory of the Alps, before its chain dips sharply into the Mediterranean Sea, boasting a steep altitudinal gradient. This Massif is protected on the French side by the Parc National du Mercantour, created in 1979, and on the Italian side by the Parco Naturale Alpi Marittime, created in 1995. Together, these two parks are home to a unique natural and cultural heritage of Europe. To protect this common heritage, both natural areas have been twinned since 1987, with the common ambition of enhancing territorial continuity that ignores any border. This strong collaboration, probably one of the most successful among European contiguous parks, has allowed them to become, in 2011, the first real European Park. For the protection and conservation, research is recognized as essential. This area was selected as a pilot area for the first All Taxa Biodiversity Inventory + Monitoring (ATBI+M) in Europe. Up to date, more than 12,000 species have been inventoried. Some monitoring protocols have also been implemented, in some cases for over 20 years.

Experiences from these sites have in common that they show how establishing a monitoring program is an ongoing process, which can be continuously improved through time. The Doñana Biological Station, for instance, started biodiversity monitoring by aerial counts of waterbirds in the 1970's. Nonetheless, standardized monitoring protocols on Doñana biological diversity were not properly established until the 2000's. Similarly, the Rhine-Main-Observatory started the annual monitoring of benthic macroinvertebrates at 3 sites, expanding later to 16 sites and finally to 22 sites. Furthermore, the Sierra Nevada Observatory is in the process of harmonizing monitoring protocols with those from other networks.

In terms of data sharing and mobilization, the first steps were taken when joining ALTER-Net and LTER networks in the Doñana Biological Station and in the Rhine-Main- Observatory. Further data sharing and mobilization continued during the participation in European projects such as ECOPOTENTIAL (www.ecopotential-project.eu/) and EU BON (www.eubon.eu). Despite of these first efforts, the bulk of the information on biodiversity is not yet fully available as electronic datasets. However, this is also due to the increasing amount of data recorded as instrumentation efforts in the last years have made available more and new biological as well as environmental data, requiring improved storage and sharing platforms.

3.1.2 Large scale site networks

i. LTER-Europe

This network has accumulated experience for over 10 years in which significant progress has been made towards a large scale, homogenized monitoring program, as described in the website LTER Europe (http://www.lter-europe.net/). This is an important step towards understanding the complexity and persistence of environmental problems, but new approaches to nature conservation and management need to refer to interdisciplinary, long-term, and multi-scale research, incorporating traditional knowledge and modern technologies to achieve sustainability. They also need to address a variety of drivers to environmental change and provide tangible results that could be implemented through regional consultancy and local participation. The first LTER networks were established in the seventies and focused mainly on ecological phenomena that could be investigated at the local level (site-level), but supported the interpretation of larger scale processes. To support fundamental research on ecosystem processes, the selection of sites favoured natural or semi-natural ecosystems with core study topics being primary production, population ecology, biogeochemical cycles, organic matter dynamics, disturbances and biodiversity. The recent shifts in the ecological research and management paradigms were considered and incorporated in the design of the emerging LTER-Europe as a "next-generation network", which consists of traditional LTER sites (local level) and LTSER platforms (sub-regional and landscape level). LTSER platforms are intended to serve as hot spot regions for socio-ecological research, to *inter alia* improve the knowledge base for efficient nature conservation and management.

The development of LTER-Europe owes much to the European Commission's Framework 6 project, ALTER-Net (A Long-Term Biodiversity, Ecosystem and Awareness Research Network; 2004-2009) which aimed to integrate European biodiversity research capacity. The development of a single European LTER network was one of the main objectives of ALTER-Net. The project was the main driver for the development of key elements such as: criteria for sites, the LTSER platform concept, the governance structure of LTER-Europe, recommended variables for harmonized monitoring and integrated data management.

The long-term mission of LTER-Europe is to track and understand the effects of global, regional and local changes on socio-ecological systems and their feedbacks to environment and society, as well as to provide recommendations and support for solving current and future environmental problems. LTER-Europe is actually a regional network of ILTER, the international Long-Term Ecological Research Network. LTER-Europe helps to coordinate ILTER activities in Europe and represents European-level interests in ILTER (https://www.ilternet.edu/). There are also 20 European national networks in ILTER.

3.1.3 National monitoring schemes

In the course of the EU BON project, monitoring schemes at the national level were added as partners (a detailed list of programs is available here: http://eumon.ckff.si/monitoring). Such schemes represent a different, top down approach in acquiring biodiversity observation data. The monitoring itself stands in the focus of the effort, rather than a particular site. Such efforts can then be replicated where, and as often as needed.

i. Brazilian Research Program in Biodiversity

Brazilian Research Program in Biodiversity - PPBio was developed in line with the Convention on Biological Diversity and the Brazilian National Biodiversity Policy. Created in 2004, it has the mission to articulate regional and national competence to expand and disseminate biodiversity information in a planned and coordinated form. To achieve this, PPBio adopted a model of decentralized logistic management associated with a system of standardized sampling design and a centralized data management. Conversely, the data management is centralized and uses the Metacat system that is used by the International Long-Term Ecological Research (ILTER) sites throughout the world. The system is based on the Ecological Metadata Language (EML;

http://knb.ecoinformatics.org/software/eml/), augmented with extra metadata tables to allow evaluation of sampling effort (http://ppbio.inpa.gov.br/repositorio/dados). The PPBio program is now functioning in all of Brazil, with regional hubs in Amazônia, the north-eastern semi-arid, the Atlantic forest, the Pantanal, the central savannas and the southern grasslands. The same system has been replicated in Eucalypt forests and deserts in Australia and in woodlands and grasslands in Nepal´s Chitwan National Park (http://ppbio.inpa.gov.br/ppbiointer). The basic sampling design follows the RAPELD, which allows rapid inventories (RAPs) to assess the biotic complementarity keeping the data fully integrated among areas with more detailed information (LTER sites). The system has been adopted as standard by many environmental agencies and is the default for the Rainforest Standard for REDD++ projects. There is a need to train personnel in matters relating to field collection, identification, data management and analysis, collection of auxiliary data on biochemistry and genetics by taxonomists and ecologists, and implementation of automatic recording devices for environmental data in many sites. There is also a need for training of participants in integrated analyses to link the physical environment, micro-organisms, invertebrates, vertebrates and plants in functioning systems. However, the biggest challenge is to convince participants of the need for strict spatial standardization and the need to make data, together with appropriate metadata, available shortly after it is collected. It can be difficult to find leaders interested in both advancing scientific questions and promoting capacity building in local institutions. It is sometimes difficult to find financing for integrated studies that transcend state and national boundaries.

ii. Israel's National Biodiversity Monitoring Program

The objective of the monitoring program is to conduct a quantitative and qualitative evaluation of key ecosystems in Israel. The so called HaMaarag program (http://www.hamaarag.org.il/en) conducts the monitoring in a systematic manner over time, enabling an assessment of the state of nature in the country and identification of significant changes, mainly those that reflect deterioration of and damage to ecosystems and to the biological diversity and functioning of their populations. Based on these insights, it will be possible to propose ways of halting this decline. The monitoring program included 4 major stages: (i) defining the monitoring units; (ii) defining threats and processes; (iii) selection of indicators/indices; (iv) selection of methods.

3.2 Biodiversity observation beyond EU BON

Several other biodiversity observation initiatives exist, congregating members that belong to particular regions or have specific scientific interests. Such organized groups can be approached in order to rapidly increase the number of members in a BON. This process has proven to be much more efficient to gain members and to establish new links. For this purpose, an agreement in the form of a MoUs is useful as a first step, as it was done with the Tropical Ecology Assessment and Monitoring (TEAM) and the Long-Term Ecosystem Research of Europe (LTER-Europe) networks. The following outlines networks and monitoring schemes which collect biodiversity data across different geographic scales.

3.2.1 Large scale monitoring networks

Several large scale monitoring programs and networks operate at the continental or at the global scale. These are particularly interesting because they cover large areas and provide extensive datasets within a single network. Their thematic specificity (e.g. tropical, marine or polar ecosystems) often incorporates systems that have much less scientific attention than temperate zones. Some examples are:

- Global Lake Ecological Observatory Network (GLEON)
- Caucasus Biodiversity Monitoring Network (CBMN)
- Tropical Ecology Assessment and Monitoring (TEAM)
- Network Circumpolar Biodiversity Monitoring Programme (CBMP)
- Marine Biodiversity Observation Network (MBON)
- Arctic BON

3.2.2 National monitoring networks

Several countries have already established biodiversity monitoring programs at the national level consolidating data from various sources. The level of organization is also diverse, ranging from monitoring according to an established framework (national BONs), to simple data collection from individual efforts.

- Biodiversity Monitoring in Switzerland (BDM)
- National Biodiversity Network of the United Kingdom (NBN)
- Colombia BON
- France BON
- China BON (Sino-BON)

3.2.3 Regional monitoring networks

Several monitoring initiatives have formed regional networks, particularly in large countries such as the USA and Spain.

- Biodiversity monitoring network of the Ecological and Forestry Applications Research Centre (CREAF) in Catalonia
- Eco-regional Biodiversity Monitoring (EBM) of the California Department of Fish and Wildlife (CDFW)
- Environmental Information Network of Andalusia (REDIAM)

3.2.4 Policy driven monitoring schemes

Through particular laws, policy makers establish binding monitoring networks at the national or regional levels, to assure particular laws are followed. These networks have the property of being homogenized and tested to a great extent, in order to provide comparable results, which are later interpreted in the light of particular requirements. A good example is the European Water Framework Directive (WFD). It requires that aquatic ecosystems reach a particular ecological status in a specified timeframe. The only way to assess the progress towards this goal is to monitor lakes and rivers continuously and homogeneously throughout the European partner countries. The resulting data is extremely valuable from the perspective of a biodiversity observation network; although the specific aims of the monitoring diverge slightly. Another good example is the Natura 2000 network, which includes a series of sites where threatened species and habitats are protected and should be monitored regularly.

- EU Water Framework Directive (WFD)
- EU Marine Strategy Framework Directive
- European Natura 2000 network
- European Habitats Directive

3.2.5 Project based monitoring schemes

For finite time periods, large research projects are funded to pursue particular scientific questions at large spatial scales. The recording of data and some regular monitoring, use a similar framework to a biodiversity monitoring network. The data is restricted in the temporal scale, but frequently offers much more detail in terms of taxonomic groups and spatial resolution.

- Biodiversity Exploratories, a project funded by the German Research Foundation (DFG)
- Ecopotential (2015-2019)
- EBONE (2008 - 2012)
- EuMon (2005 – 2008)

3.2.6 Other monitoring efforts: Citizen science

Diverse initiatives have recently emerged where citizen science efforts are collected and made publicly available for further data analysis purposes. These initiatives are very variable, some focusing on particular regions and other on specific taxonomic groups. A complete overview of the numerous resources is difficult as many continue to be developed and most evolve through time. However, the potential of citizen science data is undeniable, as it harnesses the effort of volunteers across the globe, complementing the effort from scientists. Future developments in biodiversity monitoring will increasingly draw upon citizen science data as an alternative source of information. Just a few examples are mentioned here, but a more exhaustive list can be found in the citizen science section of the EU BON Biodiversity Portal (http://biodiversity.eubon.eu).

- Audubon Christmas Bird Count
- German Butterfly Monitoring
- Yellowhammer Dialects Project
- iNaturalist
- eBird

4. Biodiversity data: standards, analyses and communication of results

4.1 Data standards and data collection

The main challenge of biodiversity monitoring is to consistently collect large amounts of data across a vast area and for a diverse range of organisms, so that data is applicable at continent-wide scale of the network. To achieve this goal, relevant and coherent information on biodiversity of defined spatial and temporal contexts are necessary. A number of recommendations were formulated in EU BON D5.1 to which monitoring sites should adhere to. Those recommendations focused on four key elements of a monitoring schema:

4.1.1 What to measure

Relevant data include biotic, but also abiotic and socio-economic variables. The measurement objective should follow a clear goal, such as the Essential Biodiversity Variables (EBVs) approach, which aims to harmonize existing monitoring schemes. Pereira *et al*. (2013) identified six classes of EBVs to operationalize biodiversity assessments. There are different ways to measure EBVs; some are typically measured through local species sampling (human assessment or sensor-based), others can also be measured through remote sensing while others were obtained by characterizing genotypes of selected species and observe changes in allelic richness. A minimum sampling of at least 6 different essential biodiversity variables (for details see Pereira *et al*. 2013) in 2 EBV classes is recommended, as well as the measurement of associated relevant environmental pressures.

4.1.2 Where to measure

The selection of suitable monitoring sites, is not a trivial decision as it should be representative of the main habitats and land-use categories of the studied region. Additionally, the spatial context of sites has to be considered. This means that measurement sites should be located across environmental gradients. Furthermore, appropriate spatial resolution and extent is necessary, to match biodiversity elements and the environmental pressures that are expected to affect biodiversity. Various approaches are possible, but differ largely depending on ecosystem, taxonomical group and research question. Recommendations for improvements regarding conceptual, strategic and methodological approaches were described in EU BON (2015b).

4.1.3 How to measure

Methods and guidelines during data collection are central to homogenous data production. A consistent methodology needs to be used to allow spatial and temporal comparability of samples within site (and preferably within network). At least annual sampling should be performed, i.e. data series should contain at least one measurement per year (multiple sampling a year is preferred, to also cover intra-annual variability). A time series of at least five consecutive years should be covered. Voucher specimens should be collected and stored appropriately at least for some of the biodiversity monitoring series, i.e. not only data are stored but also raw materials such as photographs, alcohol samples, faeces, feathers, tissue samples, etc. (at least occasional, preferably systematically & extensive).

4.1.4 How to manage the information collected

A data management plan is essential, that covers digital storage of data and quality checks. The metadata should be available online, with specific data sharing principles (see also EU BON 2013a). All sites should store their data according to international standards of data security and dedicate staff are assigned to data management. Harmonized and systematically integrated data are a prerequisite to provide scientifically sound and useful knowledge on the status and development of biodiversity for different stakeholders, including decision-makers. Compliance with our recommendations and active co-operation in the biodiversity observation network will enhance the visibility and availability of data. Ultimately, this will increase the chances of the network attracting long-term funding, which is the greatest challenge in the biodiversity monitoring sites that have joined EU BON so far.

Decisions on how to structure data collection require significant time to plan accordingly. Sufficient resources are available for biodiversity monitoring in different taxonomic groups or ecosystems and these continue to be developed constantly. The GEO Handbook on Biodiversity Observation Networks and the online resource BON in a box (https://boninabox.geobon.org/) are just two examples. Moreover, if the data is to be used for a specific purpose, such as to serve in a particular policy driven network (i.e. WFD) established methods exist and should be followed.

4.2 Common analyses and indicators

The effective communication of biodiversity knowledge requires that monitoring data gets processed beyond the original observations. For this purpose, multiple tools exist to analyse, evaluate and model particular indicators from the monitoring data. The development of such tools is an ongoing process in itself, which is driven by novel technologies as well as by new requirements from conservation practitioners, landscapes managers and policy makers (Urban 2016).

4.2.1 Tools

During the EU BON Project many tools have been developed and tested in the project's own test sites. Tools are diverse, ranging from remote sensing and spatial scaling, to distribution and abundance modelling. Detailed reports on the development of these tools have been presented in various reports: e.g., EU BON (2015c, 2016a). In the beta version of the EU BON biodiversity portal (http://biodiversity.eubon.eu) many tools are listed and can be seen in detail, next to special online interactive tools such as the species richness viewer. In addition, from the testing procedures several manuscripts were prepared and submitted to scientific journals. Some are already published (Kuemmerlen *et al.* 2016), but most are still under review.

4.2.1 Indicators

Basic biodiversity indicators such as abundance and richness of species have traditionally been used to describe ecosystems. However, current requirements of scientists and also of landscape managers

and policy makers, call for much more and more detailed information. For example, the occurrence of a species does not indicate whether its distribution is highly fragmented and thus under high pressure. Or, a particular species' abundance cannot disclose if the existing population is stable in time and successfully reproducing. Such more elaborate indicators can help convey critical information on biodiversity much more effectively. Many new sets and sub-sets of indicators under discussion currently, seek to adhere to present indicators, such as those from the originally published EBVs by Pereira *et al*. (2013) as well as those from the CBD.

Several groups of indicators have been developed in the recent years. The essential biodiversity variables (EBVs) have been widely accepted since their proposition (Pereira *et al.* 2013), because they cover a wide range of aspects which are crucial to evaluate the state of conservation of biodiversity at different levels of system organization. From these, additional thematic are now under development (Turak *et al.* in press), to cater the particular needs of specialist groups, but also assuring interoperability with other EBVs. Within the EU BON project, EBVs were an important crosscutting topic that was incorporated into many discussions regarding monitoring and tool development. Publications regarding these discussions have been prepared and are now in the review process.

In parallel, a European initiative has elaborated indicators lists based on particular regional needs, based on the Kiev Resolution on Biodiversity in 2003, aiming at reinforcing Europe's objective to halt the loss of biological diversity at all levels by the year 2010. This process was coined Streamlining European Biodiversity Indicators (SEBI) and foresees a further development of the indicators, to learn from previous experiences and improve the current set of indicators.

As part of the Convention on Biological Diversity (CBD) within the Conference of the Parties (COP), indicators have also been developed and focus also on many socio-economic aspects of biodiversity, such as traditional knowledge, sustainable use and ecosystems services. These indicators adhere to the CBD goals and are also a working progress, which has included several working group assessments, as well as questionnaires. As these indicators are developed by different international parties, partners and a broad conservation community, they have a strong potential to become a global standard, once the process of selection defines a fixed set.

5. European Biodiversity Network: implementation strategy

5.1 Current Status

There is currently no network spanning all of Europe, focusing on all taxa and covering all regions. However, there are several existing networks which fall into at least one of these categories. The challenge consists in merging efforts from these networks into a wider network that collaborates to establish an overarching biodiversity observation network. For this purpose, new partners can be associated to the network, as described below. The ultimate goal is to monitor biodiversity both extensively and intensively, but in an efficient way. A specific strategy is outlined in the following to meet the demands of biodiversity data required to adequately monitor the current status of populations and ecosystems, while allowing to make predictions anticipating possible changes. Existing observation sites will therefore require modifications to fit the new objectives, while new sites should be set up where geographical gaps exist. This will entail a process of homogenizing current networks and to identify the existing gaps, such as those identified by Geijzendorffer *et al*. (2015). A preliminary strategy is outlined.

5.2 Associating partners

To gain additional partners in the network, these can be approached and incorporated if the interest of both parties exists. A formal process was developed to facilitate the association of such new partners. From the beginning, the EU BON consortium intended to strengthen its network by involving/including other projects and institutions from different areas, ranging from data provision to Citizen Science activities. A **Memorandum of Understanding** (**MoU**) **for associated partners** (**Annex 1**) was developed that describes the advantages of a close partnership with the EU BON consortium/network, the goals and principles of EU BON as well as the roles, responsibilities and benefits for the associates and EU BON. The association has been characterized as voluntary and based on common interests towards achieving the objectives of the network. It should be stated that the MoU is not a legally binding agreement nor does it obligate any of the parties to any financial commitments or expenditures. However, the EU BON consortium anticipated from such extended network an advanced support to achieve EU BON's specific objectives and deliverables, to pursue its goals, which are:

- Enabling greater interoperability of relevant data layers and systems
- Advancing biodiversity data integration
- Increasing data mobilization (from science and society)
- Harmonizing and mainstreaming biodiversity recording and monitoring schemes
- Improving analytical tools and services
- Supporting (biodiversity) science policy interfaces
- Linking integrated information to relevant stakeholders
- Strengthening European capacities and infrastructures for environmental information management

Over the project period many other projects and institutions joined the network and have contributed in different ways and extent to the project. Thirty-three MoUs were signed by the end of 2016 (**Annex 2, Tab. A1**), thereof one associate partner, the University of Granada, became a full project partner in early 2015 and contributed with its LTER site Sierra Nevada Observatory, one additional test site to the project.

New associated partners have been introduced to the community through news articles on the website, mailing lists and newsletters and are listed on the EU BON webpage (http://www.eubon.eu/showpage.php?storyid=10373). Associated partners were also linked directly to respective EU BON partners, tasks and work packages, but their active involvement happened on different levels, such as sharing data and infrastructures, presenting new ideas and use cases, testing tools and attending EU BON workshops and meetings. Six associated partners (**Annex 2, Tab. A2**) interlinked particularly strongly with WP5 and its test sites. Some became additional test-sites, such as Mercantour/AlpiMarittime (France/Italy), Amvrakikos Wetlands National Park (Greece) and HaMaarag (Israel).

5.3 Integration and communication of results

The EU BON project accentuates the need of a shift towards an integrative biodiversity information framework (**Fig. 2**), starting from collection to the final interpretation and packaging of data, with the aim to make data discoverable, accessible and digestible. The availability of comprehensive and up-to-date biodiversity data is a key requirement to implement policies, strategies and actions to address current status and future trends of biodiversity. An essential part of building and sustaining a network of EU BON sites, is to integrate data within a single portal. Such portals will be useful to data holders who want their data to be used (e.g. citizen scientists, nature associations, scientists) and serve as a

central access point for stakeholders from different disciplines. An essential aspect of the data storage is to strive for harmonization. This will increase the accessibility of the resources.

In the long term, the portal should not only hold biodiversity data of EU BON sites but should rather be an access point which also contains additional data sources. There are currently several portals offering various services and information from metadata to data, including data visualization and analysis (for a non-comprehensive overview see **Table 1**). Ideally, all existing available data (e.g. GBIF) should be accessible through a single portal, to achieve wide scale coverage of biodiversity data. Essential Biodiversity Variables (EBVs) could be used as an overarching framework to process existing biodiversity data sets. Individual regional or thematic biodiversity observation networks could actively help to make existing data usable and accessible by standardizing protocols, publishing data sets and provide feedback from science-policy interfaces.

Table 1. Non comprehensive list of biodiversity related portals

Name	Taxon Group	Network	URL
GBIF	all		http://www.gbif.org/
Map of Life (MOL)	all		https://www.mol.org/
PlutoF			https://plutof.ut.ee/#
Ecoscope		France	http://ecoscope.fondationbiodiversite.fr/ecoscope-portal
Fishbase	Fish		http://fishbase.org/
DEIMS	all	LTER	https://data.lter-europe.net/deims/
Biofresh	Freshwater biodiversity		http://project.freshwaterbiodiversity.eu/

Finally, communication of results is a crucial part of EU BON and aims to reach a wide audience by focusing on two audience groups: the scientific audience (by publishing in various scientific journals and the presentations at meetings, workshops and conferences) and non-scientific groups (through publications in popular newspapers, journals and magazines, web publications, social media, TV and radio interviews and broadcasts, presentations at information days). The detailed dissemination and communication strategy and implementation plan is provided in EU BON (2013b).

In the course of the EU BON project, data interoperability was explored extensively at various levels. The European biodiversity portal offers a selection of data sharing tools that facilitate the exchange of data and information among scientists and to other relevant stakeholders at the management, planning and conservation sectors (see also EU BON 2016b). Further, summarized information should be simplified and communicated in an easy-to-understand manner. Experiences within EU BON, such as the info sheets, proved that this approach can have an effective impact on policy makers and the general public. Similar tools are also available from the same portal.

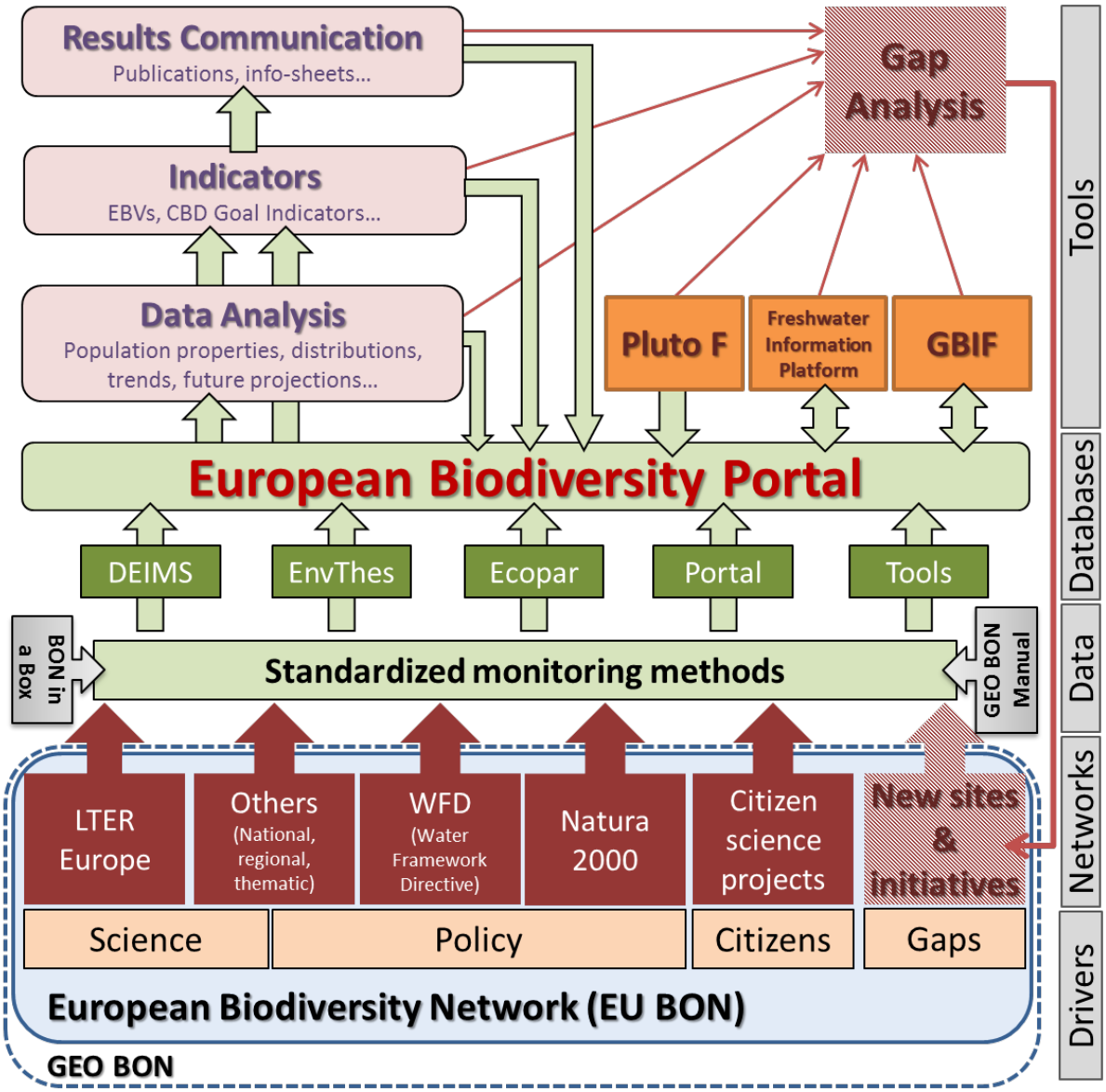

Figure 2: Conceptual map for a European Biodiversity Observation Network strategy, integrating some of the many existing elements and showing possible interactions (for details see main text).

5.4 Strategy

Setting up a European biodiversity observation network requires specific steps. These steps are depicted in **Fig. 2**: During the past decades, networks have been established motivated by different driving groups within Europe (i.e. scientists or policy makers), which are reflected by a large heterogeneity in biodiversity monitoring standards. A common standard for monitoring needs to be implemented in order to assure interoperability of various databases and their final storage in a Europe-wide biodiversity portal. This portal can be used as a source for data analysis, or to draw data for immediate interpretation using specific indicators (e.g., EBVs). Such indicators are the main output of the biodiversity observation network, which are communicated to the relevant stakeholders and reveal potential gaps. These gaps serve as a feedback to complement the biodiversity monitoring efforts through new initiatives. The core of the biodiversity observation network is the portal as it serves as both data storage and source for many essential processes. In this crucial role, the portal needs to be interlinked actively with other biodiversity portals (e.g. GBIF) to exchange and complement stored data and its derivates.

In addition to the conceptual overview provided in **Fig. 2**, the following steps should facilitate the effective development of the current EU BON network into a Europe wide, standardized structure.

5.4.1 Identify potential partners of the network

- Build up collaborative network of relevant, existing sites, networks of sites and monitoring schemes regularly monitoring biodiversity status and changes, ideally in combination with environmental variables.
- Promote data sharing at all levels of organization.
- Offer the framework established in the course of EU BON to existing networks which lack such a structure (e.g., WFD; Hering *et al.* 2010).
- Formalize intentions by signing a collaboration agreement (see **Annex 1**).
- Schedule regular meetings to improve cooperation, provide for regular feedback and the combined further development of the biodiversity observation network.
- All collaborators should be included in all of the next steps.

5.4.2 Optimize and homogenize biodiversity observation data

- Standardize data collection and harmonize its storage (see EU BON 2015b).
- Aim for seamless data integration & sharing (see EU BON 2016b).
- Develop a central portal that is ready to receive large amounts of data.
- Use and test existing tools, while developing new tools (see EU BON 2013c, 2014a, 2015c, 2016a)

5.4.3 Identify gaps in biodiversity observation

While many observation efforts are already widespread and established, there are still deficiencies related to the taxonomic groups being monitored and the spatial distribution of the monitoring sites. Some first analyses of which issues need more attention have been made (Geijzendorffer *et al.* 2015). Nevertheless, there are important knowledge gaps concerning some taxonomic groups, even within Europe. In addition, some regions are currently very densely monitored, while others lack any kind of monitoring at all. Finally, mostly seriously threatened species get most of the attention, with many other species requiring attention in order not to become threatened.

5.4.4 Establish new biodiversity observation initiatives to fill gaps

New monitoring sites will be necessary to fill in gaps; however these need to be planned efficiently. The benefit of new sites is that they can immediately start off working with consensus methods and provide data that is easy to exchange. A growing number of supporting documentation has been recently published (e.g., Walters & Scholes 2017). Also within EU BON numerous resources have been produced (EU BON 2013a, d, 2014b, 2015a). Further, online resources are also freely available through BON in a box.

5.4.5 Produce and disseminate results from biodiversity observation

- Define indicators to implement (e.g., EBVs, CBD goal indicators).
- Promote and follow up the development of new indicators.
- Train scientists and stakeholders to calculate and interpret the indicators.
- Communicate results to relevant stakeholders.
- Discuss results and indicators.
- Facilitate indicator communication.

- Continuously evaluate effectiveness of communication process.

5.4.6 Define development cycle in the biodiversity observation network

- Develop an exemplary guide to help in the process.
- Schedule regular workshops for task forces that develop particular topics faster.
- Fix annual meetings to revise existing goals and plan new ones.
- Plan a large conference every 3 years to gather the community and present results.

5.5 Conclusions and Outlook

In order to become operational, a European Biodiversity Observation Network requires long term sustainability. Only in this way can all existing monitoring networks and sites converge to serve a common purpose. The existing elements described here, demonstrate that there is enormous potential for a central European network. Many of the existing working groups have already done significant progress in many core issues that will facilitate the process. The challenge rather consists in picking the most developed elements and putting them forward as a consensus solution.

Further, the merging of the efforts will require testing what biodiversity data is collected at different sites and how that matches with requirements developed within EU BON. This will indicate how much work is required to enable the interoperability of monitoring efforts. There is likely to be a demand for adjustment in the different methodologies, but this must be first identified, then solutions outlined and finally solved in a consensus approach. Important support can be drawn from existing initiatives such as environmental thesaurus (EnvThes) and Ecopar (glossary of parameters, http://www.ufz.de/lter-d/index.php?en=32141&contentonly=1).

A European Biodiversity Observation Network has to aim for a clear and easy linkage with GEO BON efforts. Any advancement in the technological and informatics infrastructure should also consider GEO BON principles by moving existing biodiversity monitoring towards global standards-based, service-oriented approach, enabling full interoperability through the GEOSS Common Infrastructure.

Future efforts need to emphasize on an ongoing process, rather than on a concrete product. Biodiversity is not static and neither can a monitoring network be. A continuous improvement includes increasing the range and quality of the methods and tools for assessment, analysis, and visualization of biodiversity and ecosystem information. Further, a particular focus should be placed on predictive modelling, identification of drivers of change, and biodiversity indicators, to support the clear definition of priorities. These should also aim to be harmonized with ongoing relevant, global-scale programs such as the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES).

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7. Annexes

1.) Memorandum of Understanding

MEMORANDUM OF UNDERSTANDING
between the
EU BON (Building the European Biodiversity Observation Network) Consortium
and
Associated Partners

Preamble

The European Commission has decided within its 7th Framework Programme (FP7), to support the collaborative project "Building the European Biodiversity Observation Network" (EU BON) (Grant Agreement No. 308454) for a duration of 4.5 years, starting 1st December 2012. The main objective of EU BON is to build a substantial European contribution to the "Group on Earth Observations – Biodiversity Observation Network" (GEO BON). To achieve this goal, EU BON will pursue innovative approaches towards the integration and analyses of biodiversity information ranging from on-ground to remote sensing data, to address policy and stakeholder needs and to deliver information in a timely and customized manner. EU BON will provide integration between social networks of science and policy and technological networks of interoperating IT infrastructures, resulting in a new open-access platform for sharing biodiversity data and analyses tools. EU BON will build on existing components, programmes and infrastructures, in particular, on GBIF, LifeWatch, as well as national biodiversity data and observation centres, and will contribute to GEOSS.

The EU BON project (www.eubon.eu) is carried out by a consortium of originally 30 partners from 18 countries, coordinated by the Museum für Naturkunde – Leibniz Institute for Research on Evolution and Biodiversity (MfN), Berlin, Germany. In addition to its formal **"Consortium Partners"**, the EU BON project intends to connect to other leading institutions, organizations and projects in the biodiversity research and environmental information realm in Europe and also globally.

The purpose of the present Memorandum of Understanding (MoU) is to describe the relationship between, and the respective roles and responsibilities of the **EU BON Consortium** and those institutions and organizations being accredited an "**Associate Status"** for the EU BON project and within the **network.** Association with EU BON is completely voluntary and based on common interests towards achieving the objectives of the network. This MoU also provides general information about the aims and objectives of the EU BON project, and outlines the benefits associated with participation in EU BON.

This Memorandum of Understanding is not a legally binding agreement nor does it obligate any of the parties to any financial commitments or expenditures.

I. DEFINITIONS
For the purpose of this MoU, the following terms are used as here defined:

EU BON Consortium
The EU BON Consortium is the group of those institutions and organizations, which are contractual partners to the EU BON project with the European Commission (Grant Agreement No. 308454). These partners are bound to deliver part of the EU BON project as laid down in the Description of Work (DoW) annexed to that contract.

EU BON project
In addition to the members of the EU BON Consortium, the EU BON project involves all associates, stakeholders, and interested parties who are linked to EU BON and take part in its facilitation and implementation.

EU BON Associate
An Associate to EU BON can be any R&D institution, national or international organization, NGO, SME or a project, which formally declares its interest to participate in the EU BON project, and to support the network. The acceptance of an EU BON Associate will be based on submission of a formal letter of interest addressed to the EU BON coordinator, and the approval by the EU BON General Assembly. Associate members are not eligible to vote in the General Assembly.

II. The EU BON project: GOALS and PRINCIPLES
For achieving its specific objectives and deliverables, the EU BON project pursues the following **goals**:

- Enabling greater interoperability of relevant data layers and systems
- Advancing biodiversity data integration
- Increasing data mobilization (from science and society)
- Harmonizing and mainstreaming biodiversity recording and monitoring schemes
- Improving analytical tools and services
- Supporting (biodiversity) science policy interfaces
- Linking integrated information to relevant stakeholders
- Strengthening European capacities and infrastructures for environmental information management

The EU BON project is based on major **GEOSS** and **GEO BON principles.** The EU BON project will build a substantial part of the Group on Earth Observations Biodiversity Observation Network (GEO BON), and in doing so EU BON will be based on the "GEO BON Detailed Implementation Plan", and, in particular, apply the "Principles of the GEO BON Information Architecture" (www.earthobservations.org/geobon_docs.shtml) as prepared by the GEO BON Working Group for Data Integration. EU BON also intends to seek close cooperation with other consortia, projects, and organizations undertaking efforts towards sharing and integrating biodiversity and environmental information, and, more generally, acting in response to the challenge of sustainable use and management of the biodiversity of land and seas. By following the "GEOSS Data Sharing Principles" (www.earthobservations.org/geoss_dsp.shtml) and in promoting open access, EU BON will also develop an overall strategy and framework for biodiversity data publishing, sharing, and dissemination.

Regarding technology transfer and intellectually property, the EU BON project will adhere to the principles of free and open exchange of data, knowledge, and open-access publishing, in accordance with the "Council of Europe's policies", first declared in the 2832nd COMPETITIVENESS - Internal Market, Industry and Research Council meeting Brussels, 2007, as well as in the "FP7 Open Access Pilot". These policies also follow the "OECD's Principles and Guidelines for Access to Research Data from Public Funding".

III. ROLES and RESPONSIBILITIES of EU BON
EU BON recognizes Associates as prioritized partners for pursuing the goals of the project, and to be involved in the network, and to benefit from the project achievements. EU BON will seek to regularly provide information to its Associates about the progress achieved, as well as grant them access to the project deliverables and products as far as possible.

IV. ASSOCIATES: ROLES, RESPONSIBILITIES, and BENEFITS
Associates agree to engage and work with the members of the EU BON Consortium towards the project goals and to participate in and contribute to the network. Associates acknowledge the guiding principles of EU BON (see above, II), and respect the general and IPR policies of the EU BON Consortium, in particular the data sharing agreements. EU BON Associates may only represent their institutions or organizations as a participant in the network, but not as a branch or designated entity of the EU BON Consortium.

Benefits for Associates within the EU BON network:

- Recognition by the EU BON Consortium as a privileged partner
- Awareness by the larger GEO BON partnership
- Representation on the EU BON website and data portal
- Taking part in the EU BON project, by:

- having direct access to the work areas and results of the project
- having the opportunity to contribute to, present new ideas and use cases to the EU BON project
- receiving updates on the latest developments in the EU BON project
- being invited to attend the EU BON workshops and meetings
- being able to publish original data through EU BON workflows
- being able to participate in data sharing, under the principles of the EU BON Data Sharing Agreement
- having the opportunity to contribute to the EU BON newsletter and participate in communication fora

• Opportunity to become part of a sustained EU BON

V. FINANCIAL ASPECTS

Participating in the EU BON project as an Associate partner is free and without any financial obligation. Likewise, Associates cannot request funds from the EU BON Consortium or its individual partners.

VI. EU BON ORGANIZATION and MANAGEMENT

- The EU BON Consortium is governed by the General Assembly composed of all contractual partners.
- The EU BON Consortium and the project implementation are guided by a dedicated EU BON Advisory Board (AB).
- As laid down in the EU BON DoW, the project implementation will be organized via nine Work Packages (WPs).
- The coordination for the EU BON Consortium is based at the Museum für Naturkunde in Berlin, Germany, where the project management team oversees the day-to-day operations of the EU BON project.
- The EU BON Project Coordinator is the official representative of the EU BON Consortium and the EU BON project, and acts in close co-operation with the EU BON Steering Committee (SC).
- Individual EU BON Work Packages, working parties and activities may establish and maintain their own communication and network groups.
- Detailed information on the EU BON project organization can be found at the EU BON website (www.eubon.eu).

VII. TERMINATION

The participation in EU BON is terminated by the end of the EU BON project or when one of the parties gives notice of termination in writing.

This Memorandum of Understanding is understood and agreed:

Associate Consortium	**On behalf of the EU BON**
(name of organization/project)	Project Coordinator
(name of person responsible)	Dr. Christoph Häuser
Signature:	**Signature:**
_____ Date _____	_____ Date _____

2.) Associated partners

Table A1: Associated partners of the EU BON project (all)

EKLIPSE - Establishing a European Knowledge and Learning Mechanism to Improve the Policy-Science-Society Interface on Biodiversity and Ecosystem Services	UK
ConnectinGEO - Coordinating an Observation Network of Networks EnCompassing saTellite and IN-situ to fill the Gaps in European Observations	Spain
ECSA – the European Citizen Science Association	Germany
BACI: Towards a Biosphere Atmosphere Change Index	Germany
MUSE (Museo delle Scienze)	Italy
IGG-CNR - Institute of Geosciences and Earth Resources of the National Research Council of Italy	Italy
ECOPOTENTIAL - Improving Future Ecosystem Benefits through Earth Observations	Italy
GLOBIS-B - GLOBal Infrastructures for Supporting Biodiversity research	The Netherlands
GFBio - German Federation for Biological Data	Germany
Socientize (University of Zaragoza-BIFI) - Ibercivis Foundation	Spain
Museum National d'Histoire Naturelle	France
Norwegian Institute for Nature Research (NINA)	Norway
LTER-Europe (the European Long-Term Ecosystem Research Network) - Secretariat	Poland
Museo de Historia Natural UNMSM	Peru
Natural Environment Centre / SYKE (Finnish Environment Institute)	Finland
Atlas Florae Europaeae (AFE)	Finland
Fondation pour la Recherche sur la Biodiversité (FRB) / ECOSCOPE	France
DataOne (Observation Network for Earth)	USA
Indonesian Institute of Sciences (LIPI), Research Center for Biology / Indonesian Biodiversity Information System	Indonesia
University of Granada & Andalusian Environmental Protection Agency (LTER site)	Spain
PESI & Fauna Europaea	The Netherlands
Amvrakikos Wetlands National Park	Greece
HaMAARAG- The Israel National Program for Ecosystem Assessment	Israel
BioFresh-The network for global freshwater biodiversity	Germany
Naturalis Biodiversity Center	The Netherlands
University of Zurich, URPP 'Global Change and Biodiversity'	Switzerland
National Taiwan University (NTU), Department of Bioenvironmental Systems Engineering	Republic of China (Taiwan)
Centre de Recherche pour la Gestion de la Biodiversité (CRGB)	Benin
Research Centre in Biodiversity and Genetic Resources (CIBIO)	Portugal
CETAF, AISBL - Consortium of European Taxonomic Facilities	Belgium
Mercantour National Park (PNM)	France
Alpi Marittime Natural Park (PNAM)	Italy
Biodiversity Virtual e-Laboratory Project (BioVeL)	EU

Table A2: Associated partners interlinked with WP5

LTER-Europe (the European Long-Term Ecosystem Research Network) - Secretariat	**Poland**	
University of Granada & Andalusian Environmental Protection Agency (LTER site)	**Spain**	
Amvrakikos Wetlands National Park	**Greece**	
HaMAARAG- The Israel National Program for Ecosystem Assessment	**Israel**	
Mercantour National Park (PNM)	**France**	
Alpi Marittime Natural Park (PNAM)	**Italy**	