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Strategies and business plan for regional and global biodiversity information infrastructures

M52

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Executive Summary

The EU BON project aims to Build the European Biodiversity Observation Network, and is the European contribution to the Group on Earth Observation Biodiversity Observation Network (GEO BON). This present deliverable, entitled “Strategies and business plan for regional and global biodiversity information infrastructures” (D7.4) fits under EU BON Work Package (WP) 7 “Implementation of GEO BON: strategies and solutions at European and global levels”, and provides an overview of the outputs resulting from two WP7 Tasks. The objectives of this deliverable were to develop (1) a strategy for a global GEO BON infrastructure with optimised functionality in terms of efficiency and operability (as part of Task 7.4), and (2) a business plan for sustaining the European Biodiversity Observation Network after the funded phase (as part of Task 7.5).

Building on the outputs from other EU BON work packages and extensive consultation (including externally to the project consortium), these objectives have been met. The global and European-level map of the biodiversity informatics landscape (Task 7.4) has led to a better understanding of the landscape’s current structure and functioning. This will enable key players to establish or strengthen collaborations, avoid effort duplication, and facilitate access to the biodiversity data, information and knowledge required to support effective decision-making. The business plan for the European Biodiversity Observation Network (Task 7.5) summarises what the network has to offer, to identified end-users (from policy, science/research, and citizen-science), in terms of products, tools and services, including those that can potentially generate income. A possible organisational structure, potential sources of funding, along with entry points for the network in other projects and initiatives (established or upcoming), are also presented.

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List of acronyms

Acronym	Long name
AP BON	Asia Pacific Biodiversity Observation Network
API	Application programming interfaces
BIP	Biodiversity Indicators Partnership
BISE	Biodiversity Information System for Europe
BON	Biodiversity Observation Network
CABI ISC	Centre for Agriculture and Biosciences International Invasive Species Compendium
CBD	Convention on Biological Diversity
CBMP	Circumpolar Biodiversity Monitoring Program
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMS	Convention on Migratory Species
CoL	Catalogue of Life
COST	Cooperation in Science and Technology
CSIC	Agencia Estatal Consejo Superior de Investigaciones Científicas
DOPA	Digital Observatory for Protected Areas
DG MARE	European Commission Directorate-General for Maritime Affairs and Fisheries
EBSA	Ecologically or Biologically Significant Marine Areas
EBV	Essential Biodiversity Variables
EC	European Commission
ECSA	European Citizen Science Association
ECOSCOPE	Fondation pour la Recherche sur la Biodiversité - FRB
EEA	European Environmental Agency
EMODnet	European Marine Observation and Data Network
ERC	ERC: European Research Council
ERMS	European Register of Marine Species
ETC	European Topic Center
EU	European Union
EU BON	European Biodiversity Observation Network
EUNIS	European Nature Information System
FP7	Seventh Framework Programme
FIN	Fishbase Information and Research Group
GBIF	Global Biodiversity Information Facility
GEO	Group on Earth Observations
GEO BON	Group on Earth Observations Biodiversity Observation Network
GEOSS	Global Earth Observation System of Systems
GISD	The Global Invasive Species Database
GISIN	Global Invasive Species Information Network
GRIIS	Global Register of Introduced and Invasive Species
HCMR	Hellenic Centre for Marine Research
IEEP	Institute for European Environmental Policy
IMMA	Important Marine Mammal Areas
IPBES	Intergovernmental Platform on Biodiversity & Ecosystem Services
ISPRA	Italian Institute for Environmental Protection and Research
IT	Information Technology
ITIS	Integrated Taxonomic Information System
IUCN	International Union for Conservation of Nature
KBA	Key Biodiversity Area
LTER	Long Term Ecological Research Network
MEA	Multilateral Environmental Agreement

MRAC	Musée Royal de l'Afrique Centrale
MfN	Museum für Naturkunde
OBIS	Ocean Biogeographic Information System
ODV	Ocean Data Viewer
PESI	Pan-European Species Directories Infrastructure
RIO	Research Ideas and Outcomes journal
SAM	EC Scientific Advice Mechanism
SDGs	Sustainable Development Goals
SDM	Species Distribution Modelling
UCAM	University of Cambridge
UFZ	Helmholtz-Zentrum für Umweltforschung GMBH
UK	United Kingdom
UN	United Nations
UNEP	United Nations Environment Programme
UTARTU	University of Tartu
UTIS	Unified Taxonomic Information Service
WCMC	World Conservation Monitoring Centre
WoRMS	World Register of Marine Species

1. Introduction

The EU BON project aims to *Build the European Biodiversity Observation Network*, and is the European contribution to the Group on Earth Observation Biodiversity Observation Network (GEO BON). This deliverable, entitled “*Strategies and business plan for regional and global biodiversity information infrastructures*” (D7.4) fits under EU BON Work Package (WP) 7 “*Implementation of GEO BON: strategies and solutions at European and global levels*”, led by the Centre National de la Recherche Scientifique (CNRS). This deliverable provides an overview of the outputs resulting from two WP7 Tasks, both led by UN Environment World Conservation Monitoring Centre (WCMC)¹:

- Task 7.4 “*Strategies for a global GEO BON infrastructure*”, and
- Task 7.5 “*Business plan for the European Biodiversity Observation Network*”

2. Progress towards objectives

The objectives of this “dual” deliverable were to develop:

- a strategy for a global GEO BON infrastructure with optimised functionality in terms of efficiency and operability (Task 7.4), and
- a business plan for sustaining the European Biodiversity Observation Network after the funded phase, i.e. after May 2017 (Task 7.5).

Results are presented separately for Tasks 7.4 (Sections 3 and 6.1) and 7.5 (Sections 4 and 6.2) below.

3. Strategies for a global GEO BON infrastructure (Task 7.4)

The initial scope of this task was very ambitious and had to be refined so as to be more meaningful, impactful and achievable in the project’s lifespan. As a result, effort was re-focused on producing one richly illustrated, online and “open access” article summarising all the work done under this task. The rationale behind adopting such an approach, instead of a more traditional long textual report, was to minimise text and summarise findings visual form (i.e. diagrams). This strategy has proven effective in communicating results to audiences that are non-technical and/or very often reluctant to read long reports (e.g. the policy sphere). As a result, this project output is expected to have significantly higher impact, and indeed the feedback received to date strongly supports this.

3.1. Achievements

The manuscript by Bingham et al. summarising all the work done under Task 7.4 can be found in advanced form in Pensoft’s “ARPHA writing tool platform”². The article is entitled “*the biodiversity informatics landscape: elements, connections and opportunities*”, a copy of which can be found in Section 6.1. Appendix 1. The global and European-level map of the biodiversity informatics landscape (Fig. 1 in Appendix 1) has led to a better understanding of the landscape’s current structure and functioning, thereby enabling key players to establish or strengthen collaborations, avoid effort duplication, and facilitate access to the biodiversity data, information and knowledge required to support effective decision-making.

3.2. Future developments

In the coming weeks, the manuscript of Bingham et al. will be reviewed by additional co-authors. The published article will then be added to EU BON’s collection of papers³ in the open access journal RIO (*Research Ideas and Outcomes*). The manuscript has identified a number of possible and logical next steps to take this exercise further, such as identifying specific entry points in the landscape for EU BON’s products, and assessing the sustainability of the landscape’s elements by identifying elements

¹ Task 7.5 was originally led by the Museum für Naturkunde (MfN)

² http://arpha.pensoft.net/preview.php?document_id=6993

³ http://riojournal.com/browse_user_collection_documents.php?collection_id=2&journal_id=17

at risk of being lost, and the potential implications for other elements they are linked to in the landscape (in particular in the context of EU BON). Although the landscape map has been produced in such a way that it is relatively easy to update it, should elements or links between them, need updating, it is not fully interactive. It could be made more interactive following the approach of the Earth Observation Network (<http://www.eneon.net/graph>). Finally, the landscape map could be included in the next versions of the “Global Biodiversity Informatics Outlook” (Hobern et al., 2013).

4. Business plan for the European Biodiversity Observation Network (Task 7.5)

The business plan presents options for sustaining EU BON’s essential components after the termination of the funding period (after May 2017). This plan summarises what EU BON as a network has to offer, to identified end-users, in terms of products, tools and services, including those that can potentially generate income. The end-users considered were from three main areas: policy, science/research, and citizen science, and the focus was placed on sustaining the network of experts, and on making use of their expertise and products to advance biodiversity knowledge in Europe. A possible organisational structure, potential sources of funding, along with entry points for the network in other projects and initiatives (established or upcoming), are also presented.

4.1. Achievements

The development of the business plan (presented in Section 6.2. Appendix 2) was a collaborative effort by the different project’s work packages, under the leadership of UN Environment World Conservation Monitoring Centre (WCMC), the Museum für Naturkunde (MfN), and Helmholtz-Zentrum für Umweltforschung (UFZ). EU BON partners were actively engaged in the process, and provided considerable input at project meetings and dedicated workshops, thereby reflecting how well the network can work together, now and in the future. Early in the project, two students were involved, to investigate and scope options (Pan, 2015; Thalmann, 2016). Engagement also took place with other European Union funded projects such as EKLIPSE (<http://www.eklipse-mechanism.eu>), OPERAs and OpenNESS behind the Oppla platform (<http://www.oppla.eu>), to share knowledge and experience of this process.

The business plan was framed around a “list of products” (http://wcmc.io/EUBON_Products, copy in Section 6.2.8. Annex 1) which had been developed during the project, in response to a need for communicating the project’s outputs and associated outcomes, to a broad audience of potential users. Products were found to range widely in terms of development stage, with some at the beginning of their journey (i.e. not yet fully operational), whilst others (termed “flagship” products) were more or less fully operational and/or with a financially secured future. The latter were often pre-existing products whose further development was supported by EU BON (e.g. GBIF’s *Integrated Publishing Toolkit*, Pensoft’s *ARPHA*, the Kew Royal Botanic Gardens’ *GeoCAT*, etc), whilst the former were usually more “experimental products” (e.g. various *tools related to Species Distribution Modelling*, EU BON’s *European Biodiversity Portal*, etc) generated by research and innovation activities. One main challenge that has not been overcome during the project’s life is that most (if not all) EU BON products have, to be sustainable, some reliance on “public” funds in the form of research grants or a core-funded host institution, instead of generating income by themselves.

The business plan was quite a challenging piece of work for a research consortium with limited business expertise. Business development training for researchers and academics, in the context of research and innovation projects, would help them unlock their business/entrepreneurial potential. For instance, while “free” and “open access” products such as those of EU BON, are not by themselves barriers to business opportunities, there are other, more cultural, barriers, such as the reluctance to market one’s time (i.e. charging for services based on labour) in academic circles, even in a not-for-profit context.

4.2. Future developments

Moving forward, the business plan suggests two possible approaches for ensuring the long-term sustainability of EU BON. The first option is to seek further funding from the European Commission and national governments, along with seeking a mandate to become the European Biodiversity Observation Network, with a mission to coordinate monitoring activities and communicating biodiversity status and trends to key stakeholders and decision-makers. The second option is to seek self-sustainability by adopting an entrepreneurial approach to develop demand-driven services that meet the needs of specific users (e.g. scientists/researchers, citizen scientists, policy advisors and other decision-makers). A number of concrete next steps towards implementing these options are provided in Section 6.2.6. Regardless of the option chosen, the effective implementation of the business plan, or parts of it, will require one organisation to take the lead after the project ends, as implementing the business plan was beyond the scope of Task 7.5.

5. References

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6. Appendices

6.1. Appendix 1. The biodiversity informatics landscape: elements, connections and opportunities (Bingham et al., final draft)

6.1.1. Abstract

There are a multitude of biodiversity informatics projects, datasets, databases and initiatives at the global level, and many more at regional, national, and sometimes local levels. Based on a high-level review of global and European-level elements, we present a map of the biodiversity informatics landscape. This is a first attempt at identifying the key players and mapping them in a way that depicts the links, gaps and overlaps in the landscape. For this non-exhaustive review, a key selection criterion for including an element is its connection to other elements within the landscape. Time-bound projects, decision-support tools, and institutions were excluded, with the focus instead on established, publicly-available datasets and databases. An additional, sub-global focus at the European-level was incorporated in the map in order to highlight how regional biodiversity observation networks can contribute to connecting some of the nodes within the landscape. Beyond simply describing the existing landscape, this map will support a better understanding of the landscape's current structure and functioning, enabling key players to establish or strengthen collaborations, avoid effort duplication, and facilitate access to the biodiversity data, information and knowledge required to support effective decision-making.

6.1.2. Introduction

As data on the natural world become more complex and more abundant, the challenges of collating, managing, analysing, visualising and sharing them are becoming greater. Biodiversity informatics applies information technology techniques to tackle these challenges, and develops systems that allow data to be stored, accessed and combined in ways that optimally serve the conservation community. At national and international levels, there is a clear need for information to support decision-making, including monitoring of the impacts of biodiversity-related policies. To address these needs, in their Global Biodiversity Informatics Outlook, Hobern et al. 2013 recommended coordinated action between researchers, policy-makers and other stakeholders to build a culture in which biodiversity information is openly shared, freely available and connected. The global biodiversity informatics landscape has a clear role to play in the foundation of such a culture, in particular by forging connections that enable datasets to feed into broader processes.

The first computerised taxonomic lists emerged in the 1970s (Swartz et al. 1972). Since then, biodiversity informatics has evolved to encompass a broad range of dataset and database categories including biogenic habitats, species habitats and distributions, biodiversity metrics, areas of biodiversity importance and protected areas, biogeographic classifications, and environmental descriptors, among others (Weatherdon et al. 2015). Biodiversity informatics projects increasingly integrate datasets from disciplines beyond biodiversity, such as those derived from climate, natural capital, ecosystem services, and socio-economic research, to create informatics products that are far broader in scope than their predecessors.

Within such a diverse landscape, there is high potential for linkages, mutually beneficial relationships, and complementarity. However, there are also risks, including mission overlap, redundancy and duplication of effort. These problems are compounded by issues around data sharing. With considerable shortfalls in data accessibility, discoverability and digestibility (Wetzel et al. 2015), there is a need for greater transparency among providers and curators of biodiversity data. In some cases, data accessibility suffers from a reluctance on the part of data creators to share data at all (Huang et al. 2012). In other cases, data creators are only willing to share data with significant restrictions (Groom et al. 2016), and there have been calls for open access to primary data to address this (e.g. Costello et al. 2013). At both the global and European levels, there is a clear perception that data and information are scattered, fragmented, and difficult to access for policy-level and other decision-making purposes (Hobern et al. 2013;Nesshöver et al. 2016). In the face of these challenges, it is important that

organisations operating within the biodiversity informatics landscape are able to identify the unique selling point of their product, and consider how it can benefit, and benefit from, other elements in the landscape. In this way, effort duplication and overlapping objectives can be minimised, and complementarity can be maximised.

This paper maps and explores the links that currently exist between elements of the global and European-scale biodiversity informatics landscape, and investigates how the landscape could be made more efficient by highlighting gaps, duplication of effort and potential opportunities for new or improved connections.

6.1.3. Methodology

Potential elements to include in the landscape map were initially identified through web searches using the following criteria:

- Includes online access to biodiversity data and/or related information;
- Is global or European-wide in geographic scope; and
- Is connected to other elements in the landscape, by uptaking and/or providing data and information.

Time-bound projects and decision-support tools were excluded to the extent possible, with the focus instead on established datasets and databases. Additional elements were collated via grey literature materials, such as Hernández Ernst et al. 2010 and Weatherdon et al. 2015. This study did not look at local, national, or regional-level initiatives, with the exception of the European region. To provide context on how informatics elements contribute to policy processes, several non-informatics, and policy-level elements were included in the map.

Linkages between elements were initially identified using publicly-available information. For each element in the map, background information, i.e. metadata, was compiled following a standard format (Annex 2). The map and its linkages were subsequently refined based on expert feedback received through informal discussions, including at a number of international meetings:

- [10th GEO European Projects Workshop](#), 31 May – 2 June 2016, Berlin (Germany);
- [GEO BON Open Science Conference & All Hands Meeting](#), 4 – 8 July 2016, Leipzig (Germany);
- [GEO-XIII Plenary](#), 7 – 10 November 2016, St. Petersburg (Russian Federation); and
- 4th EU BON ("[Building the European Biodiversity Observation Network](#)" project) Stakeholder Roundtable, 17 November 2016, Berlin (Wetzel et al. 2017).

Based on the feedback received, it was possible to add and edit elements and links, and also to elaborate additional connections in the map to represent links not fully established, such as:

- Links in development, e.g. an element that is currently being created and that would naturally feed into an existing overarching element;
- Links in discussion, e.g. an existing element is not yet connected to another, but discussions are on-going between their institutional homes;
- Opportunities for links, e.g. two existing elements could be connected but do not appear to be, based on publicly-available information and feedback received.

The landscape map was created using [MATLAB](#). The circular map and linkages were generated from an adjacency matrix using the [circularGraph](#) MATLAB script. Post-hoc adjustments to the landscape map (such as colour-shading to highlight different element types) were made in Adobe Illustrator.

6.1.4. Results

The landscape

The landscape map generated through this study contains 71 elements (**Fig. 1**). Shortened names or acronyms of elements have been used in a number of cases. Their expanded names are given in Annex 1. Standardised metadata on each element is available in Annex 2. A significant proportion of the elements identified are hosted by publicly funded organisations such as museums (e.g. [Fauna Europaea](#), hosted by [Museum für Naturkunde](#), Berlin), with some hosted by national research centres (e.g. Global Register of Introduced and Invasive Species ([GRIIS](#)), hosted by the Italian Institute for Environmental Protection and Research ([ISPRA](#))). A large number of other elements have non-/inter-governmental organisations or other business types as institutional homes (e.g. the Global Biodiversity Information Facility ([GBIF](#)) is hosted by an intergovernmental organisation; [Protected Planet](#) is hosted by a non-profit organisation).

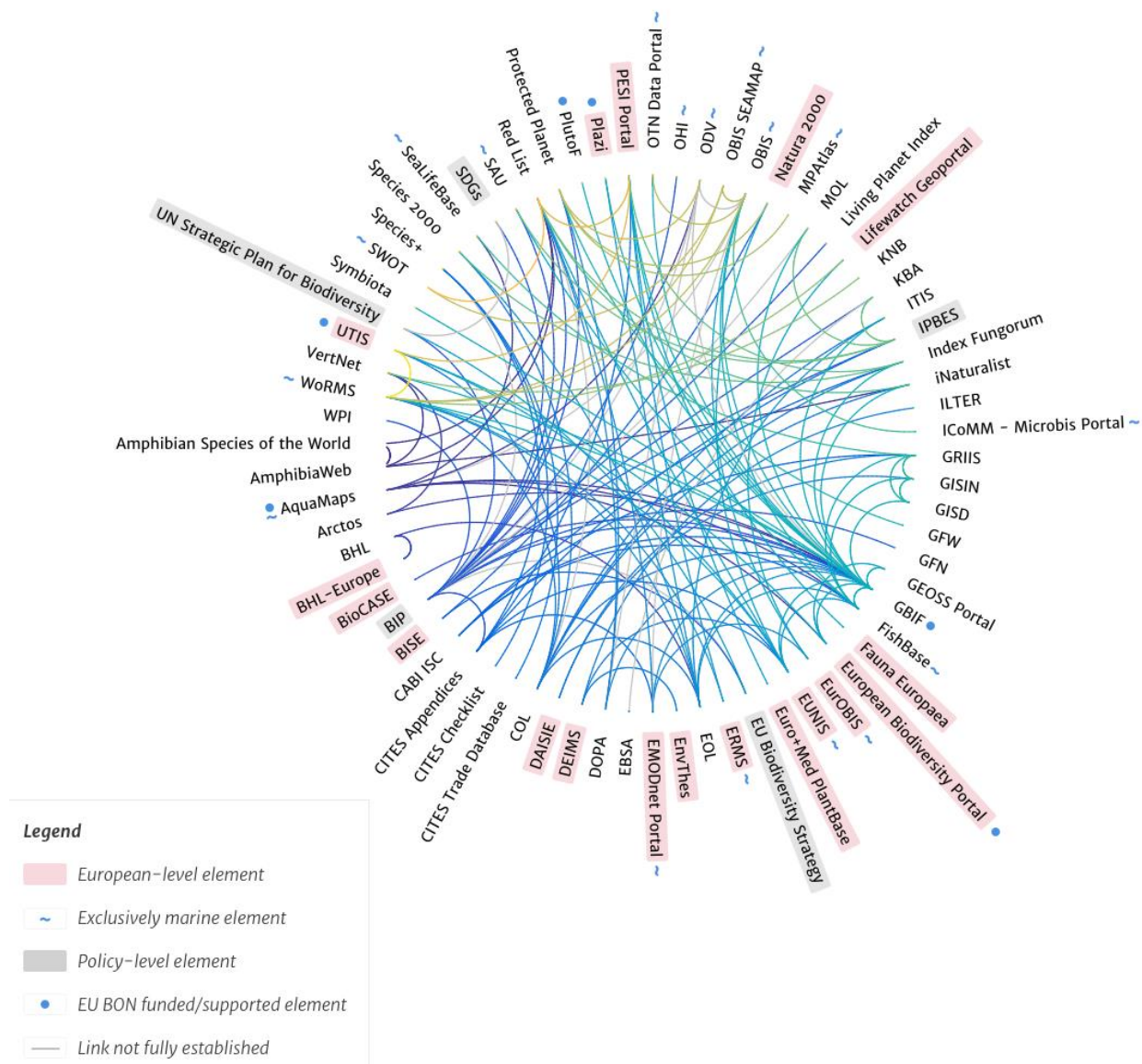


Figure 1. The biodiversity informatics landscape (Bingham et al., final draft).

In order to differentiate global and European-level elements, European elements (e.g. European Nature Information System ([EUNIS](#))) are highlighted in red. Within the European context, The European Biodiversity Observation Network ([EU BON](#) (Hoffmann et al. 2014)) is intended to be the European contribution to the global-scale Group on Earth Observation Biodiversity Observation Network ([GEO BON](#)). To demonstrate the existing role of EU BON in the landscape, elements that it is closely linked to, or sponsors, are identified in the map by a blue dot. These elements perform a variety of roles within the landscape, ranging from tools and platforms for data collection and management ([PlutoF](#); [Plazi](#)), to provision of taxonomic backbones (Unified Taxonomic Information Service ([UTIS](#))), open data hosting (GBIF) and visualisation of analysed and modelled data (GBIF).

A number of the elements identified relate exclusively to the marine environment, and have been highlighted in the map using a blue wave symbol. Links that are not yet fully established, i.e. in discussion, in development, or possible opportunities for linkages, are identified by grey lines, and are elaborated on in the Discussion section.

The elements of the landscape are highly varied in terms of their purpose and scope, and those performing single, specific roles often feed into more complex elements. For instance, site-level biodiversity data collected for a research project (e.g. time-series of species abundance) may be collated and incorporated in a regional or global database, and then used — potentially along with many other such datasets — for a policy-relevant purpose. For example, species abundance data may be used as part of an indicator (the [Living Planet Index](#), in this example) to track progress against a regional or global biodiversity target ([Aichi Biodiversity Target 12](#)). Other secondary purposes may include the use of biodiversity informatics databases by conservation organisations to identify areas of biodiversity importance (e.g. use of the [IUCN Red List of Threatened Species](#) in the identification of [Key Biodiversity Areas](#) (IUCN 2016), or by the corporate sector for high-level screening of sensitivities as part of the planning phase of development projects (Martin et al. 2015).

The degree to which an element is connected within the landscape also varies significantly, ranging from one link to 26. The most highly-connected element in the landscape is GBIF (**Fig. 2**).

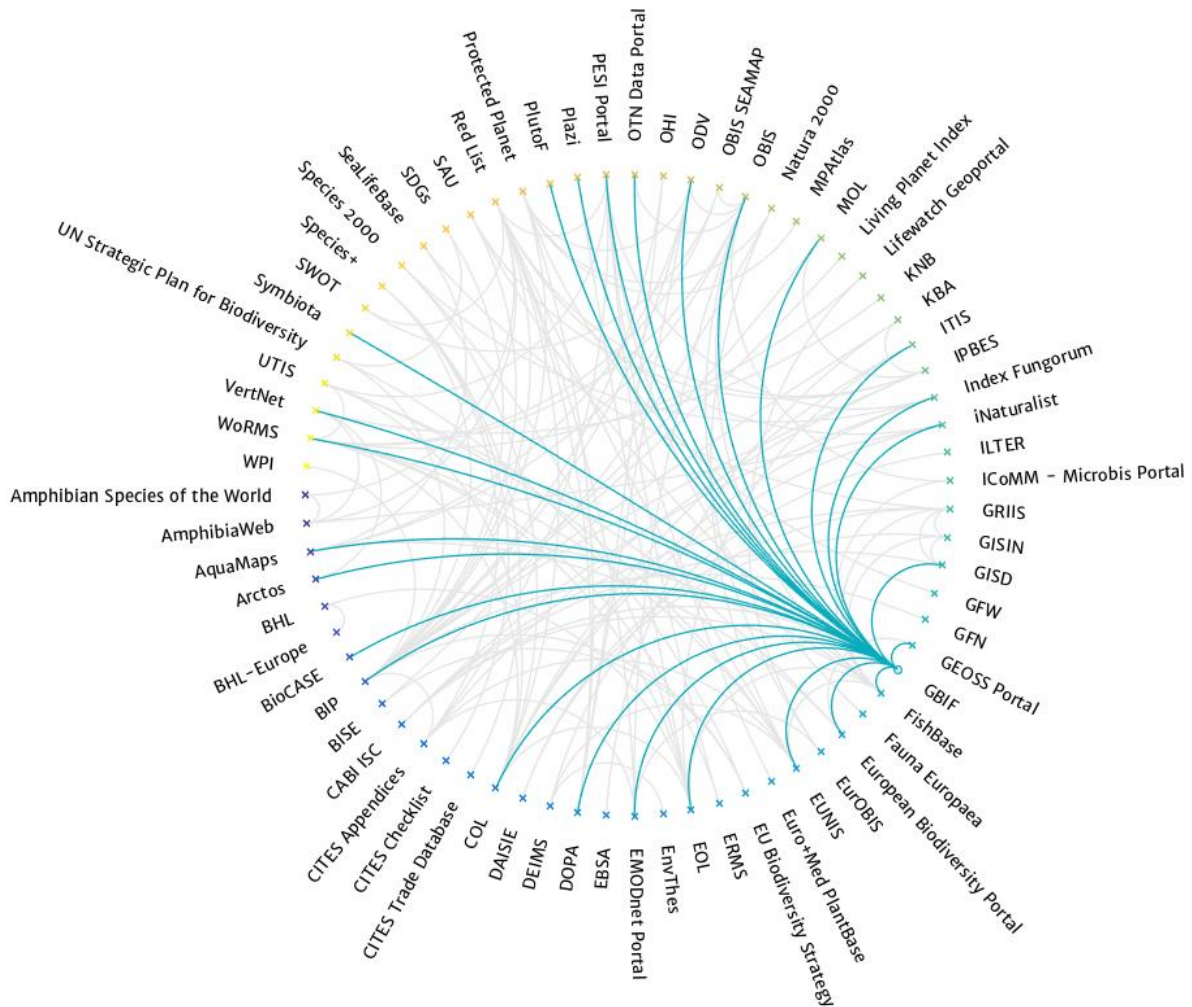


Figure 2. A highly-connected element in the landscape: the Global Biodiversity Information Facility (GBIF) (Bingham et al., final draft).

Types of elements

The elements of the landscape can be classed in three broad, sometimes overlapping, categories. Firstly, there are **elements with a single specific focus**, for instance the Catalogue of Life ([CoL](#)) is a taxonomic backbone used by the IUCN Red List of Threatened Species and GBIF to allow taxonomic searches, browsing and reporting operations across various resources in a consistent way, and to provide a means to compare/crosswalk names from one source to another.

Higher-level elements rely on one or more other elements. For instance, [AquaMaps](#) harvests species occurrence data from GBIF and the Ocean Biogeographic Information System ([OBIS](#)), in addition to life-history parameters from [FishBase](#), enabling it to create and provide access to automated distribution maps for thousands of marine species. Incidentally, OBIS uses a different taxonomic backbone (called the World Register of Marine Species, or [WoRMS](#)) to that used by GBIF (which uses a derivative of CoL).

Finally, there are a number of **complex elements** in the global landscape that rely on several other elements, while also providing more in-depth explorative and/or analytical functionalities to their users. An example is the European Marine Observation and Data Network ([EMODnet](#)) Portal, which can combine multiple datasets in interactive maps, drawing on [EurOBIS](#) (the European node of OBIS), the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) [appendices](#), and the IUCN Red List of threatened Species, among other sources. Likewise, the [European Biodiversity Portal](#) intends to act as a data broker for selected elements of the landscape

such as GBIF and the Long-Term Ecological Research ([LTER](#)) network, as well as various sources of remotely-sensed data, along with providing data analysis and visualisation tools.

Linkages with policy-level elements

Many of the elements in the map feed into processes at the policy-level. In order to reflect important relationships between policy and informatics initiatives, five policy-level elements have been added to the map: the [Biodiversity Indicators Partnership](#) (BIP); the United Nations' (UN) [Sustainable Development Goals](#) (SDGs); the UN [Strategic Plan for Biodiversity 2011-2020](#); the [EU Biodiversity Strategy](#); and the [Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services](#) (IPBES). Since these are not informatics initiatives, they are differentiated from the map's other elements by a grey background. The inclusion of the policy-level elements provides context on how informatics products contribute to global processes that define and direct political targets with regards to biodiversity and sustainable development.

Additionally, the policy-level elements are themselves connected. An example is the BIP (**Fig. 3**), which draws on multiple informatics elements to produce a suite of indicators, which then are used to assess progress towards the multiple aspects of the UN Strategic Plan for Biodiversity. Many of the BIP's indicators are also used by IPBES (e.g. the BIP indicator on coverage of protected areas, derived from Protected Planet), while other IPBES indicators stem directly from individual informatics elements (e.g. the IPBES indicator on protected area coverage of Key Biodiversity Areas (KBAs), which uses the KBA dataset). A further example of policy-level impact is the [path](#) taken by the data used to inform the BIP indicator, '[Growth in Species Occurrence Records Accessible Through GBIF](#)', which is used to track progress towards [Aichi Biodiversity Target 19](#). Some of the data used in this indicator come to GBIF from OBIS and its numerous nodes such as EurOBIS, including MedOBIS for the Mediterranean Sea, and OBIS Black Sea (the latter two are sub-regional and are therefore not shown in the map).

There are opportunities for the indicator curators that have emerged to track progress against the UN Strategic Plan for Biodiversity to assess progress towards the UN Sustainable Development Goals and the EU Biodiversity Strategy. The BIP, in particular, is already evolving to fill this niche. One key policy-level portal not shown on the map is [Environment Live](#), which has been built to support country-level reporting under Multilateral Environmental Agreements (MEAs) and UN-related assessments such as the Global Environment Outlook (Barthod et al. 2016). Environment Live is excluded from the map as its connections to the other elements are unknown, however it has a significant role to play in global biodiversity assessments.

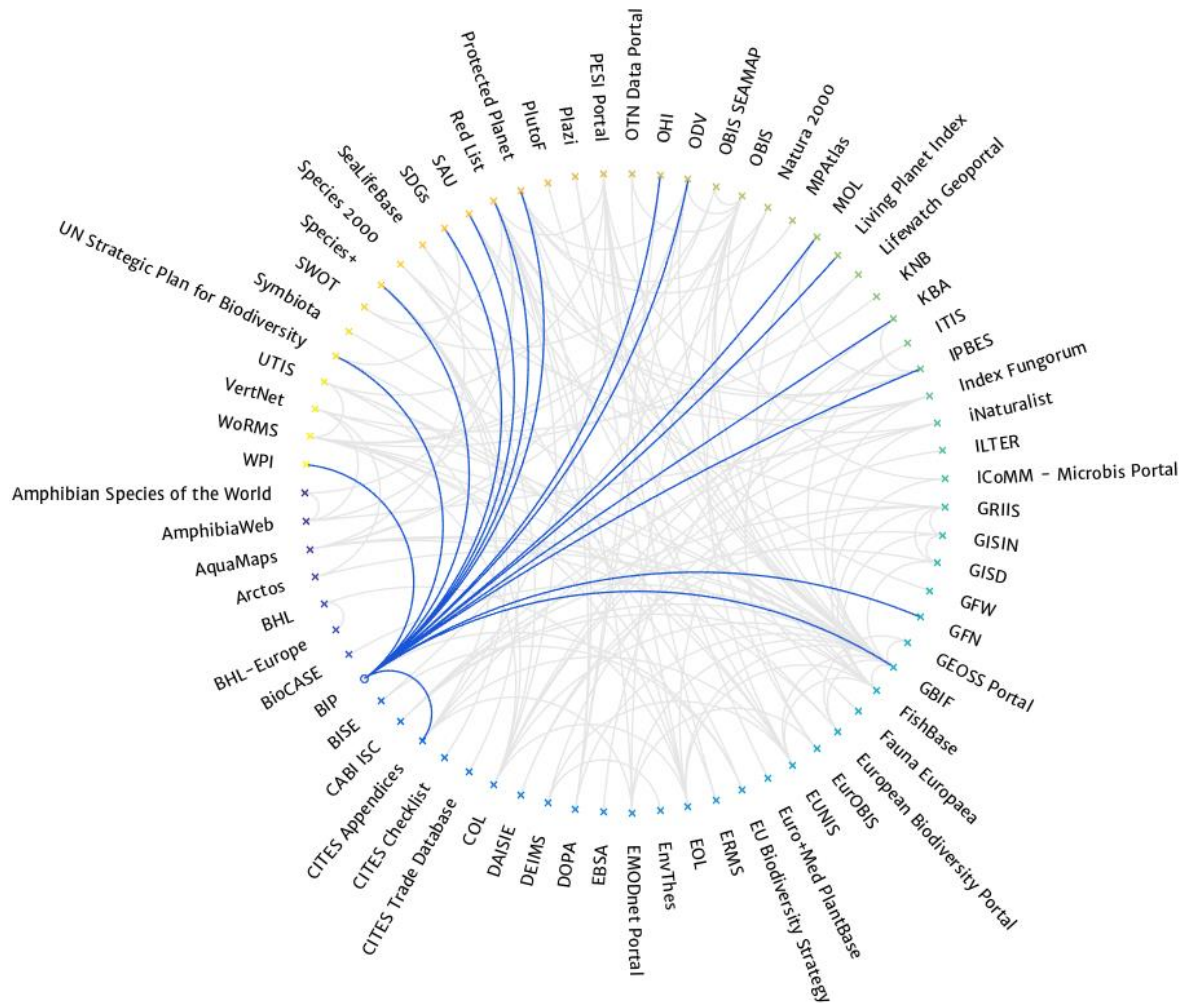


Figure 3. An example of links from the biodiversity informatics landscape to the policy-level: the Biodiversity Indicators Partnership (BIP) (Bingham et al., final draft).

6.1.5. Discussion

The biodiversity informatics landscape is diverse in terms of the scope, objectives and methodologies of its underlying elements. The map presented here shows that this diversity also extends to the degree of connectedness of elements within the landscape. However, the linkages that are marked as not fully established in the map demonstrate that there is potential for the landscape to be even better connected, including through improved links to the policy level. The map should not be considered exhaustive in terms of existing elements, or current or potential linkages, and readers should be aware that this is a snapshot of the landscape as it is in 2017. Furthermore, although extensive consultation took place during the building of the map, it was beyond the scope of this exercise to consult the responsible institutions behind all the elements.

With many organisations acting independently to maintain informatics products, there are instances of effort-duplication, and possibilities for new linkages can also be viewed as missed opportunities that currently limit the efficiency of the landscape. This is particularly important as funding is limited, and the cost of data creation and curation is significant (Juffe-Bignoli et al. 2016).

Effort duplication

Although the majority of elements offer something unique to the landscape, their broader missions sometimes overlap. An example is the potential for effort duplication between [iNaturalist](#) and PlutoF,

both of which are citizen science initiatives, and both of which contribute observation data to GBIF. Through the efforts made as part of the EU BON project, PlutoF is now dynamically linked to GBIF, resulting in near-real-time updates. Both iNaturalist and PlutoF are supplied by data from citizen scientists and verified by other members of their communities. Although iNaturalist and PlutoF have already adopted mechanisms for data standardisation, enabling interoperability, it is possible that further collaboration between the responsible institutions behind these initiatives would ensure efficient use of resources.

A further example is that of the elements providing taxonomic information, which are common within the map. This appears to be a section of the landscape where organisations have responded positively to instances of effort duplication. Over time, elements with a specific focus have been subsumed by lists that are broader in scope. An example is the amalgamation of FishNet2, MaNIS, HerpNet and ORNIS into [VertNet](#), a single vertebrate data hub (VertNet, 2017). Although these elements did not overlap in terms of their focal taxon, their incorporation into a single platform dealing with all vertebrates represents a move towards efficiency and improved accessibility for users. Similarly, at the European level, effort duplication is minimised by having taxonomic databases with different focuses feeding into a broader, overarching element (Fauna Europaea is mainly terrestrial, [Euro+Med PlantBase](#) specialises in plants, and the European Register of Marine Species ([ERMS](#)) is marine focused, and all are collated into a common taxonomic database, the Pan-European Species Directories Infrastructure, [PESI](#) (de Jong et al. 2015)).

Other sections of the map stand out as possible areas of overlap. For example, there are four different elements dealing with invasive species at the global level, and sharing similar objectives. The Global Invasive Species Database ([GISD](#)) aims to share specialist knowledge on invasive species with a broad audience. The Global Register of Introduced and Invasive Species (GRIIS) provides country-level inventories of introduced and invasive species. The Global Invasive Species Information Network ([GISIN](#)) provides a platform for sharing information on invasive species. The Centre for Agriculture and Biosciences International Invasive Species Compendium ([CABI ISC](#)) collates a range of science-based information on invasive species to support decision-making. GISD, GRIIS and GISIN do not act in isolation (IUCN's [Invasive Species Specialist Group](#) is involved in managing both GISD and GRIIS), and appear to have good data-sharing processes among themselves, but it is nevertheless unclear to what extent there is overlap in their workflows and outputs, and with those of CABI ISC. Discussions with the curators and users of these initiatives would be needed to establish whether effort duplication is an issue for these elements, and whether there are potential areas in which efficiency could be improved.

Similarly, the informatics landscape is populated by several different taxonomic backbones. Many of the other elements in the landscape depend on these backbones to standardise their taxonomic information. One example is the World Register of Marine Species (WoRMS). Two further backbones, [Species 2000](#) and the Integrated Taxonomic Information System ([ITIS](#)), together form the Catalogue of Life (CoL). The GBIF Backbone Taxonomy, referred to as the Nub taxonomy, has been assembled from 54 different sources, including WoRMS, ITIS and CoL (GBIF, 2017).

The existence of multiple different taxonomic backbones has the potential to result in inconsistencies in the way taxonomic information is stored and presented across the landscape, which in turn has potential implications for the interoperability of the different elements. In one example, [Species+](#) uses the standardised taxonomies adopted by CITES ([Conf. 12.11 \(Rev. CoP17\)](#)) and CMS (Convention on Migratory Species). This varies from the CoL backbone used by elements including the IUCN Red List of Threatened Species. For Species+, changes to nomenclature to reflect accepted use in biology must be adopted by the Conference of the Parties to the Conventions, which occurs every three years. This reflects a robust process for accepting changes, but also provides an example of how inconsistencies between taxonomic datasets may arise.

For taxonomic backbone data, linkages could be strengthened, for example by improving the harmonization efforts of taxonomic datasets and backbone data. Examples exist that have already reduced redundancies, such as VertNet (described above). However, tighter linkages between backbones (e.g. from PESI to CoL) could be fostered by future projects and initiatives. A further

approach to aligning different taxonomic initiatives and making their data available is UTIS, which gathers information from various taxonomic sources (PESI, CoL, WoRMS).

Opportunities for connections

Within the landscape, there are many opportunities to improve efficiency and complementarity by forging new, or adjusting existing, connections, some of which are already in discussion or development. This section describes several of these opportunities.

Firstly, a two-way data flow between the Ocean Data Viewer ([ODV](#)) and OBIS is currently absent, and could be of benefit to several elements. The ODV brings together a range of marine spatial datasets to inform decision-making, with a strong focus on marine and coastal habitats such as mangroves, warm- and cold-water corals, and seagrasses, among others. As the ODV and OBIS focus on different elements of the marine biodiversity landscape (i.e. OBIS is more species-focused), an exchange of information on marine habitats and species, respectively, would strengthen their values. A two-way dynamic link between ODV and GBIF, and a more stable one between GBIF and OBIS, could be similarly useful.

A further opportunity for the ODV's marine and coastal habitat data could be to feed into the Digital Observatory for Protected Areas ([DOPA](#)), in the same way that DOPA currently displays data from Protected Planet and the IUCN Red List of Threatened Species. Although DOPA contains information from ecoregion and land cover datasets, its usefulness could be enhanced by the addition of datasets made available through ODV, such as the global distribution of saltmarshes, and global distribution of cold-water corals. Datasets such as these are key to marine biodiversity conservation (see Supplementary Materials in Martin et al. 2015), and would therefore complement the objectives of DOPA.

A link from OBIS to EMODnet Portal could yield mutual benefits, and is currently in discussion. EMODnet is a consortium of organisations that form a long-term marine data initiative from the European Commission Directorate-General for Maritime Affairs and Fisheries (DG MARE) underpinning its [Marine Knowledge 2020](#) strategy. OBIS is well-placed to provide species data to the *Biology* thematic area of the EMODnet Portal, which provides access to a broad range of European datasets covering multiple thematic areas (e.g. seabed habitats, biology, physics and chemistry).

Although AquaMaps incorporates data from several other elements in the landscape (FishBase; GBIF; OBIS), it currently does not appear to feed its modelled maps, predicting species occurrences, into further elements, with the exception of the European Biodiversity Portal. While GBIF and OBIS currently supply data to AquaMaps, a two-way data flow could potentially be useful if it provided further tools to users of GBIF and OBIS. These tools could include, for example, visualisation of gaps and biases in species occurrence data.

In many cases, existing linkages could be optimised, for example by the uptake of technological innovations that improve data exchange and dynamic data linkages. Services could be offered by the different data providers so that data integration could be more easily achieved, e.g. by providing harvest lists for metadata of relevant monitoring programmes or citizen science projects; by the provision of application programming interfaces (API); or the use of web map services that allow a virtual link and easy way of integrating data.

Opportunities for indicators

In addition to the links suggested above, there are opportunities for several elements to better connect to the policy-level elements in the landscape, either directly or through other elements (shown in **Fig. 1**).

The dataset on Key Biodiversity Areas (KBAs) feeds into a BIP indicator on '[protected area coverage of Key Biodiversity Areas](#)'. This indicator helps with the measurement of progress towards [Aichi Biodiversity Target 11](#). The Convention on Biological Diversity (CBD) also calls on its Parties to consider KBAs, among other areas, when designating protected areas ([CBD/COP10 Decision X.31](#)). There are opportunities for the emerging databases on Important Marine Mammal Areas ([IMMAs](#)) (not shown, due to current absence of online data) and [Ecologically or Biologically Significant](#)

[Marine Areas](#) (EBSAs) to feed into the existing KBA dataset and associated BIP indicator, potentially enhancing the ability of the KBA dataset to guide conservation efforts. A link between IMMAs and KBAs is currently in development, and a link to EBSAs could be considered given the significant overlap in their criteria (Hoyt and Notarbartolo di Sciara 2013).

There is potential for the ODV to be incorporated into the BIP as a source of data for indicators under Goals B and C of the UN Strategic Plan for Biodiversity, and [SDG Goal 14](#) (Life below water). Similarly, Species+ could complement the current suite of BIP indicators on [Aichi Biodiversity Target 12](#), or SDGs 14 and 15. Map of Life could potentially also contribute to indicators on these targets. At the policy level, linkages are being discussed between the UN Strategic Plan and SDGs. These linkages will be important to ensure that international goals are properly aligned, and that biodiversity considerations are fully taken into account in the implementation of the SDGs.

Other opportunities

Beyond additional linkages, there are broader opportunities that have the potential to impact the entire biodiversity informatics landscape. One such opportunity is the rise of technologies like [Google Earth](#), which could in the future act as a hub for multiple datasets. Sharing and synthesising biodiversity data into a unified global map has been described as a key challenge for informaticians (Guralnick and Hill 2009). With the emergence of Google Earth and similar technology, an integrated world map could eventually be a reality.

Currently, work is ongoing to create a global biodiversity observation network through GEO BON, with multiple thematic, regional, and national biodiversity observation networks (BONs) in development (Scholes et al. 2008; Proença et al. 2016). As part of this process, EU BON and its European Biodiversity Portal have the potential to act as a hub or broker for biodiversity data within the European context. As a regional observation network, EU BON could provide leadership and build relationships within an often fragmented informatics landscape. As the network develops, several of [EU BON's own products](#) are becoming integrated in the landscape, or are supporting it (see **Fig. 1**), providing the foundation for EU BON to respond to gaps and create linkages where they are needed.

6.1.6. Conclusions and next steps

The map presented here has been produced at a time when biodiversity observation networks are in development, and when biodiversity informatics initiatives are proliferating. It provides a useful resource for organisations involved in developing new initiatives, or expanding the remits of those that exist. It can be used to identify work that is already being done, in addition to probable gaps that could be filled. It may additionally help the custodians of existing initiatives to identify potential linkages with other elements, including at the policy-level. Some of these linkages have been proposed here, but many more may be possible.

The inclusion of elements specific to Europe has particular relevance to the emerging EU BON network, highlighting those niches that are already occupied, and also gaps where EU BON might most meaningfully contribute. Further work could include identifying specific entry points in the landscape for [EU BON's products](#). An additional next step could be to assess the sustainability of the landscape's elements, identifying elements at risk of being lost, and the potential implications for other elements they are linked to in the landscape. Such an exercise would help highlight elements that are critical to the long-term sustainability of the European Biodiversity Observation Network.

Beyond datasets and databases, the human dimension of the biodiversity informatics landscape should not be underestimated, as it is crucial to the landscape's functioning and evolution. Communities of practice collectively hold significant knowledge and expertise (for example, on software, infrastructure, and best practice) on which the biodiversity informatics landscape depends. However, the human dimension also brings varying working cultures that sometimes create barriers to collaboration, and hence barriers to connections within the landscape. There is a crucial role for funding bodies, including the many national governments that have agreed to the Global Earth Observation System of Systems (GEOSS) [Data Sharing Principles](#), to play in encouraging funding-

recipients to dismantle barriers to data access, and in funding work that results in a better-functioning, and better-connected, biodiversity informatics landscape.

Contributing to policy-level processes is one way in which the landscape can most meaningfully have an impact. The wealth of information available in the landscape could undoubtedly be better communicated to policy-makers and other decision-makers. Although work is ongoing to address this (Despot-Belmonte et al. 2017), it remains a key challenge that requires consideration by all institutions involved in biodiversity informatics.

6.1.7. Acknowledgements

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6.1.9. Annex 1. Element expanded names

Short Name	Long Name
Amphibian Species of the World	Amphibian Species of the World
AmphibiaWeb	AmphibiaWeb
AquaMaps	AquaMaps
Arctos	Arctos
BHL	Biodiversity Heritage Library
BHL-Europe	Biodiversity Heritage Library Europe
BioCASE	Biological Collection Access Service
BIP	Biodiversity Indicators Partnership
BISE	Biodiversity Information System for Europe
CABI ISC	Centre for Agriculture and Biosciences International: Invasive Species Compendium
CITES Appendices	Convention on International Trade in Endangered Species of Wild Fauna and Flora Appendices
CITES Checklist	Convention on International Trade in Endangered Species of Wild Fauna and Flora Checklist
CITES Trade Database	Convention on International Trade in Endangered Species of Wild Fauna and Flora Trade Database
COL	Catalogue of Life
DAISIE	Delivering Alien Invasive Species Inventories for Europe
DEIMS	Dynamic Ecological Information Management System
DOPA	Digital Observatory for Protected Areas
EBSA	Ecologically or Biologically Significant Marine Areas
EMODnet Portal	European Marine Observation and Data Network Portal
EnvThes	Environmental Thesaurus
EOL	Encyclopedia Of Life
ERMS	European Register of Marine Species
EU Biodiversity Strategy	EU Biodiversity Strategy to 2020
Euro+Med PlantBase	Euro+Med PlantBase
EUNIS	European Nature Information System
EurOBIS	European node of Ocean Biogeographic Information System
European Biodiversity Portal	European Biodiversity Portal
Fauna Europaea	Fauna Europaea
FishBase	FishBase
GBIF	Group on Earth Observations Biodiversity Observation Network
GEOSS Portal	Global Earth Observation System of Systems Portal
GFN	Global Footprint Network
GFW	Global Forest Watch
GISD	Global Invasive Species Database
GISIN	Global Invasive Species Information Network
GRIIS	Global Register of Introduced and Invasive Species
ICoMM - Microbis Portal	ICoMM - Microbis Portal
ILTER	International Long Term Ecological Research
iNaturalist	iNaturalist
Index Fungorum	Index Fungorum
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
ITIS	Integrated Taxonomic Information System

KBA	Key Biodiversity Areas
KNB	Knowledge Network for Biocomplexity
Lifewatch Geoportal	Lifewatch Geoportal
Living Planet Index	Living Planet Index
MOL	Map of Life
MPAtlas	MPAtlas
Natura 2000	Natura 2000 Network Viewer
OBIS	Ocean Biogeographic Information System
OBIS SEAMAP	OBIS Spatial Ecological Analysis of Megavertebrate Populations
ODV	Ocean Data Viewer
OHI	Ocean Health Index
OTN Data Portal	Ocean Tracking Network Data Portal
PESI Portal	Pan-European Species Directories Infrastructure
Plazi	Plazi
PlutoF	PlutoF
Protected Planet	Protected Planet
Red List	IUCN Red List of Threatened Species
SAU	Sea Around Us
SDGs	Sustainable Development Goals
SeaLifeBase	SeaLifeBase
Species 2000	Species 2000
Species+	Species+
SWOT	State of the World's Sea Turtles
Symbiota	Symbiota
UN Strategic Plan for Biodiversity	United Nations Strategic Plan for Biodiversity 2011-2020
UTIS	Unified Taxonomic Information Service
VertNet	VertNet
WoRMS	World Register of Marine Species
WPI	Wildlife Picture Index

6.1.10. Annex 2. Element metadata

Short name: **Amphibian Species of the World**

Long name: Amphibian Species of the World

Website: <http://research.amnh.org/vz/herpetology/amphibia/>

Responsible Institution: American Museum of Natural History

Category: data curator, data distributor

Description: an amphibian taxonomy reference

Main users: researchers

Geographic scope and realm: global

Short name: **AmphibiaWeb**

Long name: AmphibiaWeb

Website: <http://www.amphibiaweb.org/>

Responsible Institution: University of California at Berkeley

Category: data curator, data distributor

Description: [AmphibiaWeb](http://www.amphibiaweb.org/) provides information on amphibian declines, natural history, conservation, and taxonomy

Main users: researchers, taxonomists

Geographic scope and realm: global

Short name: **AquaMaps**

Long name: AquaMaps

Website: <http://www.aquamaps.org>

Responsible Institution: FishBase; SeaLifeBase

Category: data curator, data distributor

Description: AquaMaps includes standardised distribution maps for over 22,000 species of fish, marine mammals and invertebrates. These maps are computer-generated predictions of natural occurrence of marine species, based on the environmental tolerance of a given species. The maps use colour-coding for showing the likelihood of a species to occur in a given area.

Main users: researchers, fisheries

Geographic scope and realm: global, marine

Short name: **Arctos**

Long name: Arctos

Website: <https://arctosdb.org/>

Responsible Institution: Texas Advanced Computing Center, University of Texas at Austin

Category: data curator,

Description: “a collaboration among multiple scientific collections that serves data on over 3 million natural history museum records”

Main users: collection managers, curators, collection users, researchers, educators

Geographic scope and realm: global

Short name: **BHL**

Long name: Biodiversity Heritage Library

Website: <http://www.biodiversitylibrary.org>

Responsible Institution: BHL Consortium

Category: data distributor

Description: the Biodiversity Heritage Library is a consortium of natural history and botanical libraries. The aim of this consortium is to digitise and thus make freely available the biodiversity literature held in their collections. The BHL works with the international taxonomic community and other stakeholders to ensure that biodiversity heritage is made accessible. The BHL has so far digitised millions of pages of taxonomic literature.

Main users: researchers

Geographic scope and realm: global; marine and terrestrial

Short name: **BHL-Europe**

Long name: Biodiversity Heritage Library – Europe

Website: <http://www.bhl-europe.eu/>

Responsible Institution: Museum für Naturkunde Leibniz Institute for Research on Evolution and Biodiversity, Humboldt University Berlin

Category: data distributor

Description: “the objective of the BHL-Europe project is to make available Europe’s biodiversity information to everyone by improving the interoperability of European biodiversity digital libraries.”

Main users: researchers

Geographic scope and realm: global

Short name: **BIP**

Long name: Biodiversity Indicators Partnership

Website: <http://www.bipindicators.net>

Responsible Institution: UNEP-WCMC

Category: policy-level element

Description: the BIP is a partnership of international organisations working on indicator development. It brings together indicators that allow biodiversity trends to be monitored in support of the Strategic Plan for Biodiversity 2011 – 2020, which includes the Aichi Biodiversity Targets. It provides at least one indicator for 17 of the 20 Targets. More broadly, it supports Multinational Environmental Agreements (MEAs), the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), the Sustainable Development Goals (SDGs), national and regional governments, and other sectors.

Main users: civil servants, decision-makers

Geographic scope and realm: global; marine and terrestrial

Short name: **BioCASE**

Long name: Biological Collection Access Service

Website: <http://www.biocase.org/>

Responsible Institution: Botanic Garden and Botanical Museum Berlin-Dahlem

Category: data curator, data distributor

Description: “a transnational network of primary biodiversity repositories. It links together specimen data from natural history collections, botanical/zoological gardens and research institutions worldwide with information from huge observation databases.”

Main users: researchers

Geographic scope and realm: global

Short name: **BISE**

Long name: Biodiversity Information System for Europe

Website: <http://biodiversity.europa.eu/>

Responsible Institution: European Environment Agency

Category: data curator, data distributor

Description: “a single entry point for data and information on biodiversity supporting the implementation of the EU strategy and the Aichi targets in Europe.”

Main users: researchers

Geographic scope and realm: Europe

Short name: **CABI ISC**

Long name: Centre for Agriculture and Biosciences International Invasive Species Compendium

Website: <http://sites.cabi.org/isc/>

Responsible Institution: Centre for Agriculture and Biosciences International

Category: data curator, data distributor

Description: “an encyclopaedic resource that brings together a wide range of different types of science-based information to support decision-making in invasive species management worldwide.”

Main users: researchers, site managers, taxonomists

Geographic scope and realm: global

Short name: **CITES Appendices**

Long name: Convention on International Trade in Endangered Species of Wild Fauna and Flora Appendices

Website: <https://www.cites.org/eng/app/index.php>

Responsible Institution: United Nations Environment

Category: data creator, data distributor

Description: Appendices I, II and III to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) list species that are protected from overexploitation. Each appendix corresponds to a different level of protection.

Main users: governments (civil servants, decision-makers), researchers

Geographic scope and realm: global; marine and terrestrial

Short name: **CITES Checklist**

Long name: Convention on International Trade in Endangered Species of Wild Fauna and Flora Checklist

Website: <http://checklist.cites.org/>

Responsible Institution: United Nations Environment

Category: data creator, data distributor

Description: the Checklist of CITES Species allows users to search all CITES-listed species, including scientific names and synonyms. It also provides information on historical changes to the level of protection afforded to species.

Main users: governments (civil servants, decision-makers), researchers

Geographic scope and realm: global; marine and terrestrial

Short name: **CITES Trade Database**

Long name: Convention on International Trade in Endangered Species of Wild Fauna and Flora Trade Database

Website: <http://trade.cites.org>

Responsible Institution: United Nations Environment

Category: data creator, data distributor

Description: the CITES Trade Database contains information on imports and exports of CITES-listed species. These are reported by national authorities, usually on an annual basis. Data in the database are freely available, and specific datasets can be accessed from the website using search queries.

Main users: governments (civil servants, decision-makers), researchers

Geographic scope and realm: global; marine and terrestrial

Short name: COL

Long name: Catalogue of Life

Website: <http://www.catalogueoflife.org>

Responsible Institution: Naturalis Biodiversity Center

Category: data curator, data distributor

Description: the Catalogue of Life is the most comprehensive database of species currently available. It contains information on the names, relationships and distributions of species.

Main users: researchers, policy and decision-makers in governments and international organisations, the general public

Geographic scope and realm: global; marine and terrestrial

Short name: DAISIE

Long name: Delivering Alien Invasive Species Inventories for Europe

Website: <http://www.europe-aliens.org/>

Responsible Institution: Centre for Ecology & Hydrology, Natural Environment Research Council

Category: data creator, data curator, data distributor

Description: “a ‘one-stop-shop’ for information on biological invasions in Europe, delivered via an international team of leading experts in the field of biological invasions, latest technological developments in database design and display, and an extensive network of European collaborators and stakeholders”

Main users: researchers, site managers, taxonomists

Geographic scope and realm: Europe

Short name: DEIMS

Long name: Dynamic Ecological Information Management System

Website: <https://data.lter-europe.net/deims/>

Responsible Institution: Centre for Ecology & Hydrology, Natural Environment Research Council

Category: data curator, data distributor

Description: “a place where you can register your research site, data products/activities and datasets.”

Main users: researchers

Geographic scope and realm: global

Short name: DOPA

Long name: Digital Observatory for Protected Areas

Website: <http://dopa.jrc.ec.europa.eu>

Responsible Institution: Joint Research Centre

Category: data distributor

Description: DOPA is a set of web services and interfaces which allows users to monitor multiple aspects of protected areas. It combines spatial data from the WDPAs with species richness, ecoregion, land-use and population data.

Main users: park managers, park agencies, other decision-makers and researchers

Geographic scope and realm: global; marine and terrestrial

Short name: EBSA

Long name: Ecologically or Biologically Significant Marine Areas

Website: <https://www.cbd.int/ebsa/>

Responsible Institution: Convention on Biological Diversity

Category: data creator, data distributor

Description: data portal for Ecologically or Biologically Significant Marine Areas (EBSAs)

Main users: researchers, marine spatial planners, fisheries

Geographic scope and realm: global

Short name: EMODNet Portal

Long name: European Marine Observation and Data Network Portal

Website: <http://www.emodnet.eu/>

Responsible Institution: EMODnet Secretariat

Category: data creator, data distributor

Description: “a network of organisations supported by the EU’s integrated maritime policy. These organisations work together to observe the sea, process the data according to international standards and make that information freely available as interoperable data layers and data products”

Main users: decision makers, researchers

Geographic scope and realm: Europe, marine

Short name: **EnvThes**

Long name: Environmental Thesaurus

Website: <http://vocabs.ceh.ac.uk/evn/tbl/envthes.evn>

Responsible Institution: Long Term Ecological Research (LTER) Network

Category: data curator

Description: “thesaurus for long term ecological research, monitoring, experiments”

Main users: researchers

Geographic scope and realm: global

Short name: **EOL**

Long name: Encyclopedia Of Life

Website: <http://eol.org>

Responsible Institution: EOL Secretariat

Category: data curator, data distributor

Description: the Encyclopedia Of Life aims to bring knowledge of different life-forms of animals, plants, protists and bacteria from books, journals, databases, websites and specimen collections to one place. The EOL is free and open to access for all.

Main users: general public, educators, students, researchers

Geographic scope and realm: global; marine and terrestrial

Short name: **ERMS**

Long name: European Register of Marine Species

Website: <http://www.marbef.org/data/erms.php>

Responsible Institution: **Society for the Management of European Biodiversity Data**

Category: data curator, data distributor

Description: “an authoritative taxonomic list of species occurring in the European marine environment”

Main users: researchers, taxonomists,

Geographic scope and realm: Europe, marine

Short name: **EU Biodiversity Strategy**

Long name: EU Biodiversity Strategy to 2020

Website: <http://ec.europa.eu/environment/nature/biodiversity/strategy/>

Responsible Institution: European Commission

Category: Policy-level element

Description: “The EU Biodiversity Strategy aims to halt the loss of biodiversity and ecosystem services in the EU and help stop global biodiversity loss by 2020. It reflects the commitments taken by the EU in 2010, within the international Convention on Biological Diversity.”

Main users: Policy-makers

Geographic scope and realm: Europe, terrestrial and marine

Short name: **Euro+Med PlantBase**

Long name: Euro+Med PlantBase

Website: www.emplantbase.org/

Responsible Institution: Dipartimento di Scienze ambientali e Biodiversità ed Orto botanico, Università degli Studi di Palermo

Category: data curator, data distributor

Description: “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.”

Main users: researchers, taxonomists

Geographic scope and realm: Europe, Mediterranean,

Short name: **EUNIS**

Long name: European Nature Information System

Website: <https://eunis.eea.europa.eu/>

Responsible Institution: European Environment Agency

Category: data curator, data distributor

Description: “brings together European data from several databases and organisations into three interlinked modules on sites, species and habitat types”

Main users: researchers

Geographic scope and realm: Europe

Short name: **EurOBIS**

Long name: European Ocean Biogeographic Information System

Website: <http://www.eurobis.eu/>

Responsible Institution: Flanders Marine Institute (VLIZ)

Category: data curator, data distributor

Description: EUOBIS aims “to centralize the largely scattered biogeographic data on marine species collected by European institutions and to make these data freely available and easily accessible.”

Main users: researchers, taxonomists

Geographic scope and realm: Europe, marine

Short name: **European Biodiversity Portal**

Long name: European Biodiversity Portal

Website: <http://biodiversity.eubon.eu/>

Responsible Institution: EU BON

Category: data curator, data distributor

Description: The European Biodiversity Portal was developed by the European Biodiversity Observation Network (EU BON, eubon.eu). It is an online platform, which facilitates the delivery of relevant biodiversity information and analysis to a range of end users (including researchers, policy-level users and other biodiversity stakeholders), thus supporting the biodiversity science and policy interface.

Main users: researchers, decision-makers, policy level users, the public

Geographic scope and realm: Europe, marine and terrestrial

Short name: **Fauna Europaea**

Long name: Fauna Europaea

Website: <http://www.fauna-eu.org/>

Responsible Institution: Museum für Naturkunde, Berlin

Category: data curator, data distributor

Description: “Europe's main zoological taxonomic index. Scientific names and distributions of all living, currently known, multicellular, European land and freshwater animal species are available in one authoritative database.”

Main users: researchers, taxonomists

Geographic scope and realm: Europe

Short name: **FishBase**

Long name: FishBase

Website: <http://www.fishbase.org>

Responsible Institution: FishBase Consortium

Category: data distributor

Description: FishBase provides online access to a variety of information and fish species data. This includes taxonomy, distribution, morphology, behaviour, habitats, ecology, biometrics, population dynamics, as well as data on reproduction, metabolism and genetics.

Main users: researchers, fisheries, zoologists

Geographic scope and realm: global, fish species

Short name: **GBIF**

Long name: Global Biodiversity Information Facility

Website: <http://www.gbif.org>

Responsible Institution: GBIF Secretariat

Category: data curator, data distributor

Description: global biodiversity database that provides access to point data on species occurrences. GBIF brings together over 15,500 datasets from over 1,000 publishing institutions. Fifty-four countries currently contribute to GBIF, alongside forty-three other participants and affiliates. The data stored by the facility are largely on species' distributions and changes over time.

Main users: researchers

Geographic scope and realm: global; marine and terrestrial

Short name: GEOSS Portal

Long name: Group of Earth Observations Portal

Website: <http://www.geoportal.org/>

Responsible Institution: Group on Earth Observations

Category: data curator, data distributor

Description: “a Global Earth Observation System of Systems (GEOSS) that will link Earth observation resources world-wide across multiple Societal Benefit Areas - Biodiversity and Ecosystem Sustainability, Disaster Resilience, Energy and Mineral Resources Management, Food Security and Sustainable Agriculture, Infrastructure & Transportation Management, Public Health Surveillance, Sustainable Urban Development, Water Resources Management - and make those resources available for better informed decision-making.”

Main users: researchers

Geographic scope and realm: global

Short name: GFN

Long name: Global Footprint Network

Website: <http://www.footprintnetwork.org/en/index.php/GFN>

Responsible Institution: Global Footprint Network

Category: data curator, data distributor, data creator

Description: The Ecological Footprint is the Global Footprint Network’s main tool, which is a data-driven metric demonstrating how close the world is to living sustainably.

Main users: decision-makers, the public

Geographic scope and realm: global

Short name: GFW

Long name: Global Forest Watch

Website: <http://www.globalforestwatch.org>

Responsible Institution: World Resources Institute

Category: data creator, data distributor, data curator

Description: GFW is a mapping application that uses satellite imagery, crowdsourcing, and external datasets to provide near-real-time information on forest loss.

Main users: governments, the private sector, NGOs, journalists, universities, and the general public

Geographic scope and realm: global; terrestrial

Short name: GISD

Long name: Global Invasive Species Database

Website: <http://www.iucngisd.org/gisd/>

Responsible Institution: IUCN

Category: data curator, data distributor

Description: “a free, online searchable source of information about alien and invasive species that negatively impact biodiversity.”

Main users: researchers, taxonomists, site managers

Geographic scope and realm: global

Short name: GISIN

Long name: Global Invasive Species Information Network

Website: <http://www.gisin.org/>

Responsible Institution: Natural Resource Ecology Laboratory, Colorado State University

Category: data curator, data distributor

Description: “a platform for sharing invasive species information at a global level”

Main users: researchers, taxonomists, site managers

Geographic scope and realm: global

Short name: GRIIS

Long name: Global Register of Introduced and Invasive Species

Website: <http://www.griis.org/>

Responsible Institution: Institute for Environmental Protection and Research

Category: data curator, data distributor

Description: “the Global Register of Introduced and Invasive Species (GRIIS) presents validated and verified inventories of introduced and invasive species at the country level”

Main users: researchers, taxonomists, site managers
Geographic scope and realm: global

Short name: ICoMM - Microbis Portal

Long name: International Census of Marine Microbes - Microbes Portal

Website: <https://vamps.mbl.edu/portals/icommm/icommm.php/microbis>

Responsible Institution: Josephine Bay Paul Center

Category: data creator, data distributor

Description: the ICoMM Microbis Portal is a database which serves legacy (including geospatial and environmental data), lipidomic and pyrosequencing data, as well as associated contextual data. The Microbis Portal links to lipid structures and a mass spectrometry library containing lipid data derived from microbes from both modern and ancient environments.

Main users: researchers

Geographic scope and realm: global

Short name: ILTER

Long name: International Long Term Ecological Research

Website: <https://www.ilternet.edu/>

Responsible Institution: **ILTER Secretariat**

Category: data curator

Description: “the International Long-Term Ecological Research (ILTER) consists of networks of scientists engaged in long-term, site-based ecological and socio-ecological research.”

Main users: researchers

Geographic scope and realm: global

Short name: iNaturalist

Long name: iNaturalist

Website: <http://www.inaturalist.org>

Responsible Institution: California Academy of Sciences

Category: data creator, data distributor

Description: iNaturalist allows users to identify species they observe and record their locations. Users can develop their own projects using the platform, and collaborate with other users to gather specific types of data. Data can be exported from the website, and research-grade observations are available to scientists through GBIF. iNaturalist presents citizen science observations online alongside datasets from other biodiversity informatics projects including Catalogue of Life, uBio and the IUCN Red List of Threatened Species.

Main users: public, researchers

Geographic scope and realm: global, terrestrial and marine

Short name: Index Fungorum

Long name: Index Fungorum

Website: <http://www.indexfungorum.org/>

Responsible Institution: Royal Botanic Gardens, Kew

Category: data curator

Description: “the Index Fungorum, the global fungal nomenclator coordinated and supported by the Index Fungorum Partnership, contains names of fungi (including yeasts, lichens, chromistan fungal analogues, protozoan fungal analogues and fossil forms) at all ranks.”

Main users: researchers, taxonomists

Geographic scope and realm: global

Short name: IPBES

Long name: Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

Website: <http://www.ipbes.net/>

Responsible Institution: IPBES Secretariat

Category: policy-level element

Description: “the intergovernmental body which assesses the state of biodiversity and of the ecosystem services it provides to society, in response to requests from decision makers.”

Main users: Policy-makers

Geographic scope and realm: Global; marine and terrestrial

Short name: ITIS

Long name: Integrated Taxonomic Information System

Website: <http://www.itis.gov>

Responsible Institution: Interagency Taxonomy Steering Committee, USA

Category: data distributor

Description: ITIS provides easily accessible database of taxonomic data and a directory of taxonomic expertise. The database is reviewed periodically to ensure high quality with accurate classifications, revisions and additions of newly described species. As ITIS develops, it aims to include the authority (author and date), taxonomic rank, associated synonyms and vernacular names where available, a unique taxonomic serial number, data source information and data quality indicators. Changes to taxonomic information in the database and expert reviews will be tracked.

Main users: researchers

Geographic scope and realm: global (initial emphasis on North America), terrestrial and marine

Short name: KBAs

Long name: Key Biodiversity Areas

Website: www.keybiodiversityareas.org/

Responsible Institution: BirdLife International and Conservation International

Category: data distributor, data curator

Description: Key Biodiversity Areas are places of global significance for biodiversity conservation, identified based on their importance for maintaining species populations.

Main users: Governments, intergovernmental organizations, NGOs, the private sector, and other stakeholders

Geographic scope and realm: global; marine and terrestrial

Short name: KNB

Long name: The Knowledge Network for Biocomplexity

Website: <https://knb.ecoinformatics.org/>

Responsible Institution: University of South Carolina Beaufort

Category: data curator, data distributor

Description: "an efficient way to share, discover, access and interpret complex ecological data. Due to rich contextual information provided with KNB data, scientists are able to integrate and analyse data with less effort."

Main users: researchers

Geographic scope and realm: global

Short name: LifeWatch Geoportal

Long name: LifeWatch Geoportal

Website: <http://maps.elie.ucl.ac.be/lifewatch/geoviewer.html>

Responsible Institution: Earth and Life Institute

Category: data curator, data distributor

Description: "LifeWatch offers a place where researchers can share expertise and information; it is also a structure providing access to numerous databases as well as tools for analysis and modeling."

Main users: Researchers; environmental managers

Geographic scope and realm: Europe; marine and terrestrial

Short name: Living Planet Index

Long name: Living Planet Index

Website: <http://www.livingplanetindex.org>

Responsible Institution: Zoological Society of London and WWF

Category: data creator, data distributor

Description: the Living Planet Index is a measure of global biodiversity. The index is focused on vertebrates, and is based on population trends.

Main users: policy-makers, researchers

Geographic scope and realm: global; marine and terrestrial

Short name: MOL

Long name: Map of Life

Website: <https://mol.org/>

Responsible Institution: Map of Life Steering Committee

Category: data curator, data distributor

Description: “built on a scalable web platform geared for large biodiversity and environmental data, Map of Life endeavors to provide ‘best-possible’ species range information and species lists for any geographic area.”

Main users: researchers

Geographic scope and realm: global

Short name: **MPAtlas**

Long name: MPAtlas

Website: <http://www.mpatlas.org/>

Responsible Institution: Marine Conservation Institute

Category: data curator, data distributor

Description: “a tool to provide real-time information on current and proposed MPAs and their effectiveness in protecting marine life”

Main users: researchers

Geographic scope and realm: global

Short name: **Natura 2000**

Long name: Natura 2000 Network Viewer

Website: <http://natura2000.eea.europa.eu/>

Responsible Institution: European Environment Agency

Category: data distributor

Description: data portal for Natura 2000 sites. “Natura 2000 is an ecological network of protected areas, set up to ensure the survival of Europe's most valuable species and habitats. Natura 2000 is based on the 1992 Habitats Directive, but also incorporates sites designated under the 1979 Birds Directive.”

Main users: researchers

Geographic scope and realm: Europe

Short name: **OBIS**

Long name: Ocean Biogeographic Information System

Website: <http://www.iobis.org>

Responsible Institution: IOC-UNESCO International Oceanographic Data and Information (IODE) programme

Category: data curator, data distributor

Description: OBIS provides access to information on the distribution of marine species. It is a part of UNESCO's Intergovernmental Oceanographic Commission. The aim of OBIS is to create a comprehensive picture of marine life from existing smaller datasets.

Main users: researchers, fishery scientists and managers, policy makers, educators, amateur naturalists, environmental NGOs, consultants, nature conservation organisations, and students.

Geographic scope and realm: global; marine

Short name: **OBIS SEAMAP**

Long name: Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations

Website: <http://seamap.env.duke.edu>

Responsible Institution: Nicholas School of the Environment, Duke University

Category: data distributor, data curator

Description: OBIS-SEAMAP is an interactive online database for marine protected species. The database includes both spatial and temporal data. The data is collected from ship and aerial surveys, satellite telemetry and acoustic monitoring, as well as PhotoID around the world.

Main users: researchers

Geographic scope and realm: global, marine

Short name: **ODV**

Long name: Ocean Data Viewer

Website: <http://data.unep-wcmc.org/>

Responsible Institution: UNEP-WCMC

Category: data curator, data distributor

Description: “the Ocean Data Viewer offers users the opportunity to view and download a range of spatial datasets that are useful for informing decisions regarding the conservation of marine and coastal biodiversity.”

Main users: researchers

Geographic scope and realm: global, marine

Short name: OHI

Long name: Ocean Health Index

Website: <http://www.oceanhealthindex.org> ; <http://ohi-science.org>

Responsible Institution: Ocean Health Index

Category: data creator, data distributor

Description: the OHI is the first comprehensive global measurement of ocean health that includes people and human impact as part of the ocean ecosystem. The Index takes advantage of data and information across disciplines, thus providing a broad picture of the health of oceans. More specifically, the Index evaluates how well the ocean provides 10 key benefits to people – and how well it is protected to do so in the future.

Main users: decision- and policy-makers, researchers

Geographic scope and realm: global, marine

Short name: OTN Data Portal

Long name: Ocean Tracking Network Data Portal

Website: <http://members.oceantrack.org/>

Responsible Institution: Dalhousie University

Category: data curator, data distributor

Description: “the OTN Data Centre is responsible for the collection, aggregation, cross-referencing, and dissemination (both public and private) of acoustic detection data.”

Main users: researchers

Geographic scope and realm: global

Short name: PESI Portal

Long name: Pan-European Species directories Infrastructure Portal

Website: <http://www.eu-nomen.eu/portal/>

Responsible Institution: Flanders Marine Institute (VLIZ)

Category: data curator, data distributor

Description: “EU-nomen enables the correct use of species names and their classification, to more accurately manage information on animals and plants. This is the first all-taxa inventory for European species.”

Main users: taxonomists, researchers

Geographic scope and realm: global

Short name: Plazi

Long name: Plazi

Website: <http://plazi.org/>

Responsible Institution: Plazi

Category: data curator, data distributor

Description: “a digital taxonomic literature repository to enable archiving of taxonomic treatments.”

Main users: taxonomists, researchers

Geographic scope and realm: global

Short name: PlutoF

Long name: PlutoF

Website: <https://plutof.ut.ee/>

Responsible Institution: Universias Tartuensis; NATARC; Research Group for Biological Informatics

Category: data curator, data distributor

Description: “PlutoF platform has been designed for storing and managing biodiversity data over the web.

PlutoF provides database and computing services for the taxonomical, ecological, phylogenetical, etc. research.

The purpose of the platform is to provide synergy through common modules for the classifications, taxon names, analytical tools, etc.”

Main users: researchers

Geographic scope and realm: global

Short name: Protected Planet

Long name: Protected Planet

Website: <http://www.protectedplanet.net>

Responsible Institution: IUCN and UNEP-WCMC

Category: data curator, data distributor

Description: Protected Planet is the online interface for the World Database on Protected Areas (WDPA). It is a product of UNEP and IUCN, managed at UNEP-WCMC. The WDPA is mandated by the Convention on

Biological Diversity, and draws together national datasets on protected areas. The majority of the data are sourced from national governments, and these are supplemented by data from NGOs and other protected area managers.

Main users: researchers, NGOs, businesses, policy and decision-makers in governments and international organisations

Geographic scope and realm: global; marine and terrestrial

Short name: **Red List**

Long name: International Union for Conservation of Nature Red List of Threatened Species

Website: <http://www.iucnredlist.org>

Responsible Institution: IUCN

Category: data creator, data distributor, data curator

Description: the IUCN Red List of Threatened Species provides taxonomic, conservation status, and distribution information on species that have been assessed according to the IUCN Red List Categories and Criteria.

Main users: researchers, policy-makers, the public

Geographic scope and realm: global; marine and terrestrial

Short name: **SAU**

Long name: Sea Around Us

Website: <http://www.seaaroundus.org>

Responsible Institution: The University of British Columbia

Category: data curator, data distributor, data creator

Description: Sea Around Us is a research initiative based at the University of British Columbia. The initiative assesses the impact of fisheries on marine ecosystems around the world. It also offers mitigating solutions to the stakeholders involved in fisheries. The data is presented at spatial scales relevant to policy-making, and where possible, this data is visualised. All data is available freely and downloadable.

Main users: researchers, fisheries

Geographic scope and realm: global, fisheries

Short name: **SDGs**

Long name: Sustainable Development Goals

Website: <http://www.un.org/sustainabledevelopment/sustainable-development-goals/>

Responsible Institution: United Nations

Category: policy-level element

Description: “the SDGs build on the success of [the Millennium Development Goals \(MDGs\)](#) and aim to go further to end all forms of poverty. The new Goals are unique in that they call for action by all countries, poor, rich and middle-income to promote prosperity while protecting the planet.”

Main users: researchers, NGOs, businesses, policy and decision-makers in governments and international organisations

Geographic scope and realm: global

Short name: **SeaLifeBase**

Long name: SeaLifeBase

Website: <http://www.sealifebase.org>

Responsible Institution: a joint project of the *Sea Around Us* (University of British Columbia, Vancouver, Canada) and The FishBase Information and Research Group, Inc (FIN, Los Baños, Philippines), and is endorsed and monitored by the FishBase Consortium

Category: data curator, data distributor

Description: “the long-term goal of this project is to create and maintain a FishBase-like information system for all non-fish marine organisms, ca. 400,000 spp. Of these, marine organisms (about 240,000 spp) are the target of the current project phase.”

Main users: researchers, fisheries

Geographic scope and realm:

Short name: **Species 2000**

Long name: Species 2000

Website: <http://sp2000.org>

Responsible Institution: Species 2000 Secretariat, hosted at Naturalis Biodiversity Center

Category: data creator

Description: Species 2000 is an autonomous federation of taxonomic database custodians.

Main users: taxonomists

Geographic scope and realm: global; marine and terrestrial

Short name: **Species+**

Long name: Species+

Website: <http://www.speciesplus.net>

Responsible Institution: UNEP-WCMC

Category: data curator, data distributor Type: non-governmental organisation product

Description: Species+ assists parties to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and parties to the Convention on the Conservation of Migratory Species of Wild Animals (CMS), in implementing the conventions, along with other Multilateral Environmental Agreements (MEAs). Species+ provides users with information on species' distributions, alternate names, and legal protection under CITES and/or CMS.

Main users: civil servants

Geographic scope and realm: global; marine and terrestrial

Short name: **SWOT**

Long name: The State of the World's Sea Turtles

Website: <http://seamap.env.duke.edu/swot>

Responsible Institution: OBIS-SEAMAP team at the Marine Geospatial Ecology Lab, Duke University.

Category: data curator, data distributor

Description: "this online database and mapping application is built with sea turtle nesting and telemetry data contributed to SWOT since 2004 and also incorporates earlier efforts that produced the [WIDECAST nesting database](#). Since 2012, the data collection and database management are conducted by the OBIS-SEAMAP team at the Marine Geospatial Ecology Lab, Duke University."

Main users: researchers

Geographic scope and realm: global

Short name: **Symbiota**

Long name: Symbiota

Website: <http://symbiota.org/>

Responsible Institution: University of Arizona, University of Wisconsin- Madison, California Academy of Science, Northern Arizona University, Harvard University and Universidad de Sonora-DICTUS

Category: data curator, data distributor

Description: "the Symbiota Software Project is working toward building a library of webtools to aid biologists in establishing specimen-based virtual floras and faunas."

Main users: researchers, taxonomists

Geographic scope and realm: global

Short name: **UN Strategic Plan for Biodiversity**

Long name: United Nations Strategic Plan for Biodiversity 2011 - 2020

Website: <https://www.cbd.int/sp/>

Responsible Institution: Convention on Biological Diversity

Category: policy-level element

Description: "this plan provides an overarching framework on biodiversity, not only for the biodiversity-related conventions, but for the entire United Nations system and all other partners engaged in biodiversity management and policy development."

Main users: researchers, NGOs, businesses, policy and decision-makers in governments and international organisations

Geographic scope and realm: global

Short name: **UTIS**

Long name: Unified Taxonomic Information Service

Website: <http://cybertaxonomy.eu/eu-bon/utis/1.0/>

Responsible Institution: Botanic Garden and Botanical Museum Berlin-Dahlem

Category: data curator, data distributor

Description: "the Unified Taxonomic Information Service (UTIS) is the taxonomic backbone for the EU BON project"

Main users: taxonomists, researchers

Geographic scope and realm: Europe

Short name: **VertNet**

Long name: VertNet

Website: <http://vertnet.org/>

Responsible Institution: National Science Foundation, USA

Category: data curator, data distributor

Description: “a tool designed to help people [discover](#), capture, and [publish](#) biodiversity data.”

Main users: researchers

Geographic scope and realm: global

Short name: **WoRMS**

Long name: World Register of Marine Species

Website: <http://www.marinespecies.org>

Responsible Institution: Flanders Marine Institute (VLIZ)

Category: data curator

Description: WoRMS provides an authoritative and comprehensive list of names of marine organisms, including information on synonymy.

Main users: researchers

Geographic scope and realm: global

Short name: **WPI**

Long name: Wildlife Picture Index

Website: <http://wpi.teamnetwork.org/wpi/dashboard>

Responsible Institution: hp, Conservation International, team network

Category: data creator, data distributor

Description: the Wildlife Picture Index was developed by the Wildlife Conservation Society and the Zoological Society of London as an indicator derived from primary camera trap data. The WPI monitors ground-dwelling tropical medium and large mammals and birds – species that are important economically, aesthetically and ecologically. The Index can be aggregated upwards from the local site to global level, and also disaggregated to capture trends at regional levels, functional groups of interest and national levels, pending adequate national data.

Main users: policy-makers, researchers

Geographic scope and realm: global, terrestrial

6.2. Appendix 2. Business plan for the European Biodiversity Observation Network

6.2.1. Who we are

The European Biodiversity Observation Network (EU BON) presents an innovative approach towards the integration of biodiversity information systems, from on-ground to remote sensing data, for addressing policy and information needs in a timely manner. EU BON aims to advance biodiversity knowledge in Europe, and to be the European contribution to the Group on Earth Observation Biodiversity Observation Network (GEO BON)⁴.

The EU BON (“Building the European Biodiversity Observation Network”⁵) project was funded under the European Union’s Framework Programme 7, from December 2012 to May 2017. EU BON is composed of 31 partners from 18 countries, who are members of networks of biodiversity data-holders, monitoring organisations, and leading scientific institutions⁶. For the past four and a half years, partners have worked together to integrate scientific, technological, IT infrastructure and policy networks. The project has built on existing infrastructures such as GBIF⁷ and LifeWatch⁸, citizen science initiatives (e.g. *PlutoF*), and national biodiversity data centres across Europe, to integrate relevant biodiversity data covering terrestrial, freshwater and marine habitats. One key end result from this work is an open-source platform for accessing biodiversity data and tools — the *European Biodiversity Portal*⁹ and associated “product list” (copy in Section 6.2.8. Annex 1)¹⁰.

The *European Biodiversity Portal* provides access to biodiversity data, both from on-ground observation and remote sensing, and a set of tools/products and training modules for mobilising, curating, managing, accessing, analysing, publishing, sharing, and visualising biodiversity data. The *Portal* and its associated products/tools aim to allow a range of users to freely access biodiversity data-related services for determining the status and trends of biodiversity in Europe.

EU BON’s products and services have ambitions on a time scale that exceeds the funding period of the research project they were generated from. As a result, the European Biodiversity Network as a whole, with its different components, needs to be further sustained to continue to function as a central infrastructure for generating biodiversity data and information at the European scale. This business plan provides two main options for ensuring EU BON’s sustainability after the end of the funding period. It also provides suggestions on how the essential components of the network could be sustained to address end-users’ needs (i.e. policy-level, science/research, and citizen science) in the long term.

The business plan is structured as follows:

- *What we can offer* provides an outline of EU BON’s products/tools and services, including those that can potentially generate income (Section 6.2.2.),
- *Who we could offer it to* provides information on the end-users of the products/tools and services, and potential sources of funding associated with these (Section 6.2.3.),
- *Proposed organisational structure* for the network (centralised and decentralised options) (Section 6.2.4.),
- *Financial summary* presenting estimated costs, and potential revenue that could be generated from products/tools and services (Section 6.2.5.),
- *Summary of options* towards achieving sustainability, *and next steps* (Section 6.2.6.).

⁴ <http://geobon.org>

⁵ <http://www.eubon.eu/>

⁶ http://www.eubon.eu/show/partners_2735/

⁷ <http://www.gbif.org/>

⁸ <http://www.lifewatch.eu/>

⁹ <http://biodiversity.eubon.eu/>

¹⁰ A list of EU BON’s products, tools and training modules can be accessed at http://wcmc.io/EUBON_Products, a subset of which has descriptive factsheets (http://wcmc.io/EUBON_Factsheets).

6.2.2. What we can offer

What we are trying to sustain is a network of biodiversity experts, so that their expertise and the products they have developed can be used to advance biodiversity knowledge in Europe. Hence, the “unique value proposition” that EU BON offers is a EU BON branded network of experts and products (Thalmann A, 2006), for advancing biodiversity knowledge in Europe. To ensure the long term sustainability of the network, key components that add value to the EU BON brand need to be sustained, such as the consortium itself, its network of collaborators, the *Portal* and associated tools/products (including the underlying infrastructure), and services such as biodiversity monitoring and scientific forecasting. The *European Biodiversity Portal* can serve as the core interface to link network partners with the different end-users.

EU BON currently has no mandate to generate its own biodiversity data, and relies on already published and ideally freely available data belonging to, or being curated by, others. For this reason, access to databases, tools and knowledge products needs to remain freely available to the public. However, other added value products and services have the potential to generate income for the network. The section below provides an overview of what EU BON can offer and what needs to remain freely available. The information is organised under four themes that target different end-users:

- a) science and research,
- b) policy,
- c) citizen science,
- d) GEO BON and IPBES¹¹.

Examples of “flagship” products and potential services are provided for each theme.

a) Science and research

EU BON brings together biodiversity data from across Europe, which can be used to monitor the status and trends of European biodiversity. The key contribution of the EU BON project towards science and research has been the launch of the *European Biodiversity Portal*, which offers free open access to biodiversity databases, analytical tools and visualisations. The *Portal* provides access to integrated monitoring data, based on international data standards, such as occurrence or abundance indices in Europe from early records to more recent data from existing monitoring programs. Another feature available is the virtual laboratory, eLab, which was designed for researchers to collaborate on a project, share documents and use the same web interface.

The integration and provision of free available data represent a core service that has been provided by EU BON network partners and that needs to be sustained in the long term. Although data and tools/products are to be made freely available, some value-added products for modelling, forecasting, mapping and data publishing have the potential to generate income for the network. This could be achieved, for example, by providing training courses on the use of specific EU BON tools such as *GeoCAT*, *AquaMaps*, *PlutoF*, the *Spatial Dataset Browser*, the *Species Population Trend Browser*, *Species Distribution Modelling (SDM) tools*, and *ARPHA*, which have good marketing potential. EU BON has already developed a successful *training programme* that is led by the Royal Museum of Central Africa (MRAC), and this could continue to be provided to European and non-European scientists, researchers and conservation groups. Demand-driven training programmes could be further developed through requests received from end-users via the *Portal*'s helpdesk.

b) Policy

EU BON has the potential to make scattered biodiversity data useful to inform policy and decision-making processes. The network's expertise and tools can be used to develop knowledge products (e.g. policy briefs, assessments, etc.) and answer information requests on the status and trends of

¹¹ Intergovernmental science-policy Platform on Biodiversity and Ecosystem Services

biodiversity in Europe. The services provided by EU BON can complement the work already done by the European Environmental Agency (EEA) and the European Topic Centres (ETC), such as “ETC Nature Conservation” and “ETC Biodiversity”. Opportunities to explore methods of operationalising data to support the EEA’s reporting requirements have already been discussed with this organisation. However, synergies between the EEA, ETCs, and EU BON need to be further developed, based on these initial interactions.

EU BON’s expertise and the tools developed can also be used for assessments and analysis, visualisation of biodiversity and ecosystem information, predictive modelling, identification of key drivers of change, and development of biodiversity indicators. Furthermore, EU BON could support European national governments, and sectoral stakeholders with their internal and international reporting obligations, e.g. under the European Nature Directives (Birds and Habitats Directives), the Convention on Biological Diversity, and other biodiversity-related conventions such as Ramsar and the Convention on Migratory Species (see Fig. 1 in Wetzal et al., 2015). EU BON tools that could be used to address specific policy needs are, for example, *AquaMaps*, *DINA-Web*, the *SDM tools*, *EuroLST*, *Freshwater SDM*, *GeoCAT*, and the *Species Population Trend Browser*. EU BON’s expertise and the different tools developed can also serve to support the identification of Essential Biodiversity Variables (EBV) to improve forecasting and the development of early warning systems (Schmeller et al., *in press*).

There are current opportunities for EU BON to provide policy-relevant services via the EKLIPSE mechanism and Oppla’s “marketplace”, as both EKLIPSE¹² and OPPLA¹³ aim to link the policy and scientific communities by passing on information requests. Furthermore, EU BON could liaise with the Biodiversity Information System for Europe (BISE)¹⁴ to support their indicator development efforts. There is potential to generate revenue through service contracts to meet specific information needs that support policy and decision-making processes. The key users are likely to be policy-advisors, national environmental agencies and sectoral stakeholders.

c) Citizen science

EU BON has developed strong relationships with the European Citizen Science Association (ECSA)¹⁵ and the citizen science community in Europe, and there is a fertile ground to foster synergistic collaborations. For example, EU BON can help the citizen science community in overcoming challenges related to their collection, curation, standardisation, and sharing of data. Additionally, EU BON’s expertise can be useful in raising the quality and profile of citizen science projects and give citizen science projects public recognition by making their data citable and published in data papers. Furthermore, citizen science activities in the field have the potential to fill spatial and taxonomic data gaps, and assist EU BON’s efforts in making biodiversity observations useful for monitoring and forecasting European biodiversity.

The EU BON Citizen Science Gateway¹⁶ on the *Portal* provides information and tools for citizen scientists. The Gateway includes a wealth of information on project designs, tools, standards, guidelines, and data provider directories (Runnel et al. 2016). Other EU BON tools that are relevant to citizen science stakeholders are *PlutoF*, *I Saw a Butterfly app*, and the *Biodiversity Monitoring mobile app*. Although these tools are freely available on the *Portal*, income could be generated through the provision of training or through adapting tools to meet specific citizen science needs. The target audience of these services are the ECSA and citizen scientists groups.

d) GEO BON and IPBES

A key objective of the EU BON project was to be the European contribution to the Group on Earth Observations Biodiversity Observation Network (GEO BON). In this context, EU BON has provided significant outputs that were fed to GEO BON, for instance the improved *Integrated Publishing*

¹² <http://www.eclipse-mechanism.eu>

¹³ <http://www.oppla.eu>

¹⁴ <http://biodiversity.europa.eu/topics/sebi-indicators>

¹⁵ <https://www.ecsa.co.za/default.aspx>

¹⁶ <http://biodiversity.eubon.eu/web/citizen-science/cs-tools>

Toolkit with extended Darwin Core Data Standard, and associated *Species Population Trend Browser*. Another key contribution of EU BON to GEO BON has been the conceptual thinking done around Essential Biodiversity Variables (EBVs) by EU BON's "EBV Task Force" (e.g. Brummitt et al., 2016; Geijzendorffer et al., 2015; Schmeller et al., in press) towards the effective implementation of EBV use cases at national and regional levels.

EU BON's work and expertise can be very useful in optimising long-term biodiversity monitoring in Europe, providing information to support the implementation of the EU Biodiversity Strategy 2020, as well as supporting the work under the "Europe and Central Asia" IPBES assessment. Lastly, a number of "flagship" tools/products developed by EU BON could also be made available to the GEO BON network through BON in a Box¹⁷. However, it is very unlikely that GEO BON or IPBES can provide funding for EU BON's contributions so it is important to keep in mind that any contributions from the network may need to be provided free of cost (i.e. in-kind).

6.2.3. Who we could offer it to

EU BON has been successful in addressing some of the challenges of making biodiversity data accessible, digestible and interoperable (Wetzel et al., 2015). It has also helped to produce robust models and tools to understand and predict biodiversity change. As a result, the *European Biodiversity Portal* is now the central access point for biodiversity data and analysis in Europe. However, there is still further work required to fill data gaps, and make data-driven information useful to address policy needs. In order to sustain the technical and social infrastructures of EU BON in the long term, access to ongoing sources of funding is required to cover costs and develop the network further. In this context, there are two approaches that could be taken by the network:

- a) the first would be to seek "core" funding from the European Commission (EC) and national governments, and
- b) the second to take an entrepreneurial path and provide demand-driven income-generating services to specific users.

a) Funding from the EC and national governments

EU BON could follow a similar approach to that taken by the Asia Pacific BON (AP BON)¹⁸ and the Circumpolar Biodiversity Monitoring Program (CBMP)¹⁹ a.k.a the "Arctic BON". AP BON and the Arctic BON are good examples of existing regional BONs that contribute towards GEO BON, while also providing relevant information and outputs at the national and regional levels. AP BON and the Arctic BON each have a mandate and core funding from member countries to monitor biodiversity and provide credible biodiversity information that informs policy and decision-making (e.g. monitoring plans, indicators, assessments, reports).

EU BON could seek a policy mandate to become the "European BON" by building a case to demonstrate that continued EC funding and national contributions represent the best available option to address scientific, policy and decision-making needs in Europe in terms of biodiversity status and trends. It would be important to highlight how the network's expertise and the tools/products developed can be used to provide information on the current condition of European biodiversity, answer policy-relevant questions, and assist European countries with their environmental reporting needs. Lastly, EU BON would need to proactively link to national BONs, the EEA and other European initiatives and projects (e.g. EKLIPSE, SAM²⁰, BID-REX²¹, BISE) to understand their needs and co-design demand-driven outputs.

¹⁷ <http://geobon.org/bon-in-a-box/what-is-bon-in-a-box/>

¹⁸ <http://www.esabii.biodic.go.jp/ap-bon/index.html>

¹⁹ <http://www.caff.is/monitoring>

²⁰ <https://ec.europa.eu/research/sam/index.cfm?pg=about>

²¹ <http://www.interregeurope.eu/bid-rex/>

b) Self-sustainability - an entrepreneurial approach

EU BON partners have expressed interest in the “Enspiral” approach, which was presented at the EU BON 4th Stakeholder Roundtable (Wetzel et al., 2017). This model was developed by the Enspiral Network²² and could be adapted to suit EU BON’s specificities in terms of [structure, governance, decision-making, and finances](#).

Enspiral is a network of small independent organisations (social enterprises) and individuals who provide demand-driven products and services. The networks makes the most of online tools to work together, share resources (skills and funding) and promote collaborative decision-making. The network remains connected through the Enspiral Foundation, which is the not-for-profit legal entity collectively owned by members of the network.

EU BON could follow a similar approach by providing demand-driven products and services that meet specific user needs (e.g. training, knowledge products, and user-friendly interfaces). The network’s expertise and the tools/products need to be tailored to meet the needs of end-users (e.g. EEA, SAM, BISE, scientists/researchers, policy advisors, citizen science groups, conservation groups, agri-environment schemes, etc.). The benefit of taking this approach and setting up a not-for-profit organisation (e.g. Foundation or Charity) is that the network could raise funds from different sources (e.g. grants, service contracts, philanthropic contributions) and all revenue to be re-invested in the network. Producing relevant outputs for end-users would result in successful fundraising and hence more funds to available to the network.

In this context, the *European Biodiversity Portal* could have a dedicated page highlighting training packages and the services offered. Other possible entry points to advertise EU BON’s expertise and services include:

- Oppla’s marketplace (<http://www.oppla.eu/marketplace>)
- Eclipse mechanism (http://www.eclipse-mechanism.eu/how_to_get_involved) and open calls (http://www.eclipse-mechanism.eu/eclipse_calls)
- COLUMBUS knowledge transfer (www.columbusproject.eu)
- GEO BON’s BON in a Box (<http://geobon.org/bon-in-a-box/what-is-bon-in-a-box/>)
- BISE supporting indicator development (<http://biodiversity.europa.eu/topics/sebi-indicators>)
- BID-REX making biodiversity data useful for decision-making (<http://www.interregeurope.eu/bid-rex/>)
- SAM the EC’s Scientific Advice Mechanism (<https://ec.europa.eu/research/sam/index.cfm?pg=about>)

6.2.4. Proposed organisational structure for the network

The organisational structures suggested below aim to sustain the EU BON brand rather than an individual product.

A semi-centralised structure (**Fig. 1**) was initially proposed for the EU BON network (Pan, 2015), in which the current EU BON structure is maintained, with the possibility of taking advantage of arising funding opportunities. The core structure (the orange shapes) is composed of a technical management team, an administration team, and the *European Biodiversity Portal* (“EU BON database” on the diagram). The core structure links to optional teams (green boxes) to provide added value products and services to different end-users.

²² <https://enspiral.com/>

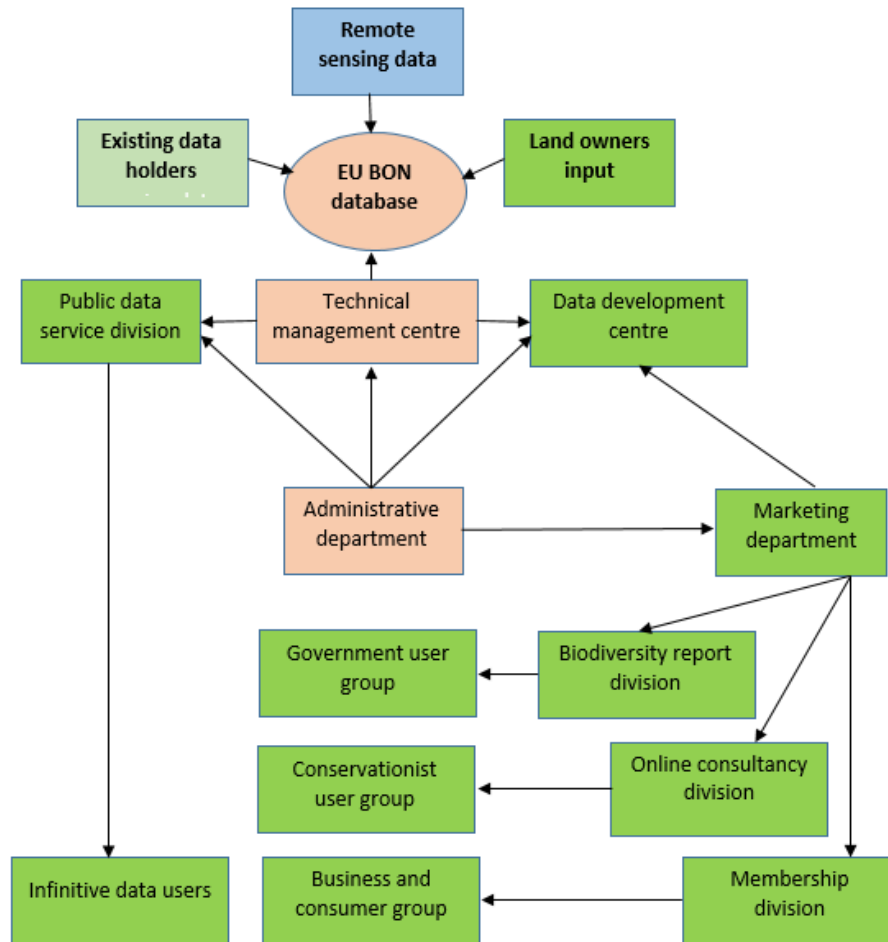


Figure 1. One possible organisational structure for EU BON: semi-centralised option (Pan, 2015). The core structure (orange shapes) link to optional departments/divisions (green boxes) to provide added value products and services to different end-users from the science/research (conservation group), policy (government) and the corporate sector (business).

The advantage of a centralised structure is that it allows datasets, tools and products developed by the network to be sustained, and aims to take advantage of funding opportunities. The main disadvantage of a fixed structure is the ongoing cost of supporting a permanent technical team and administrative department. This option requires the appointment of a partner organisation to permanently host the *European Biodiversity Portal* (e.g. CSIC, with LifeWatch funding), along with the availability of funds to cover operational costs of the core structure.

A decentralised organisational structure (“teal organisation”) was proposed in a second stage (Thalmann, 2016). This type of organisational structure is suitable for networks as it provides the flexibility to develop teams around products and services that are demand-driven (i.e. users/customers).

An example of a successful network that runs as a teal organisation is the Enspiral network²³. This network keeps a lean decentralised structure, members share a common purpose and mission, resources are shared and income re-invested in the network through collaborative funding. EU BON could follow a similar format (**Fig. 2**) to avoid fragmentation and to allow different teams to emerge organically for future projects/services that are demand-driven. The network could remain connected through a core team (i.e. in the form of a Foundation, Secretariat or Steering Committee) to look after

²³ <https://enspiral.com/>

legal, administrative, financial, and fundraising matters. The main advantages of a decentralised structure are its flexibility and low fixed costs.



A network of ventures and partners connected through a core Foundation

Figure 2. One possible organisational structure for EU BON: decentralised structure. EU BON teams would develop organically depending on the skills and expertise required for products and services that add value and meet the needs of specific end-users.

6.2.5. Financial summary

This section provides a summary of the estimated costs to sustain the different tools/products (including the *Portal*) for the next three years (from June 2017 to May 2020), as well as the potential sources of revenue that could be generated from different products and services.

Information regarding the costs to maintain the different EU BON tools/products was provided by EU BON tool/product ‘owners’ (see contacts in Section 6.2.8. Annex 1). The information was compiled via a spreadsheet template complemented by a “tool scoring exercise” during a dedicated “business plan workshop” at the final EU BON meeting in Meise (Brussels, March 2017). The spreadsheet template allowed partners to select a theme to specify the ‘primary use’ of their tool (i.e. science/research, citizen science, policy), and to estimate the costs in Euros (€) for the period of June 2017 to May 2018 (1 year). A 2% inflation rate was then added to estimate costs for the next 2 years (i.e. June 2018 to May 2020). Partners provided an estimation of the minimum amounts required to sustain their tool/products, including the costs of infrastructure, personnel time, publications/outreach, and travel/meetings/workshops. Partners were also asked to indicate if the costs of maintaining the tools could potentially be provided by their organisation as an “in-kind” contribution, or if the costs need to be covered from other sources (to be identified) in order to be sustained.

The total amount required to sustain EU BON tools/products was estimated to be € 3,604,714 for the period from June 2017 to May 2020. This amount only takes into account the minimum cost required to maintain the tools (costs of further development are excluded). **Table 1** presents total amounts per

theme, and demonstrates that most of the tools/products that have been developed under EU BON are for science/research purposes.

Table 1. Total costs of tools by theme.

Theme	Number of tools/products	Costs (€) for 2017—2020
Citizen Science	3	399,076
Policy	3	176,891
Science/Research	24	3,028,746
TOTAL	30	3,604,714

A large proportion of the costs could potentially be covered by host organisations or tool owners for the next three years (by in-kind funding, and/or incoming funding available to the host institution). However, there are a number of tools for which the sources of funding have not yet been identified by host institutions or tool owners, as illustrated in **Fig. 3**.

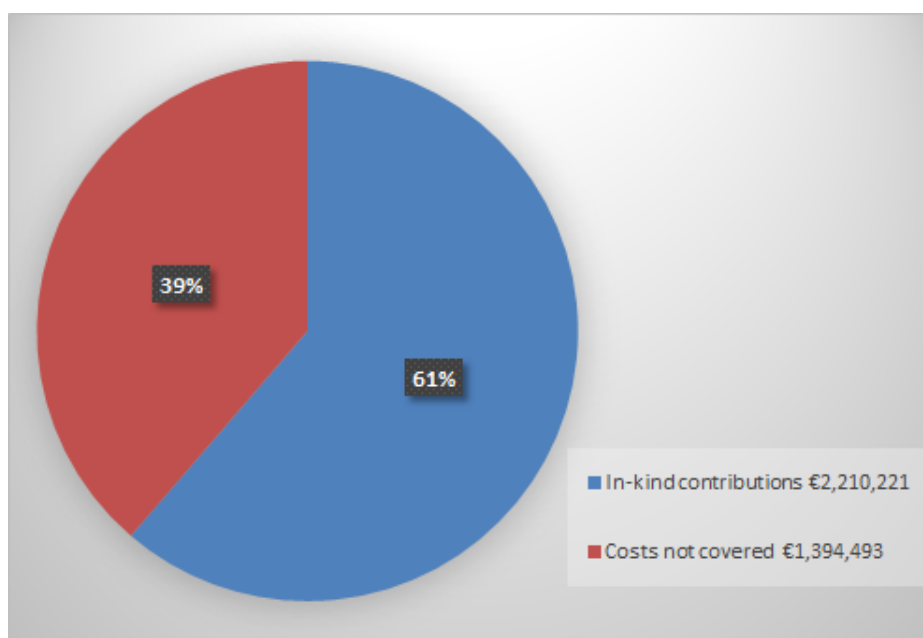


Figure 3. For the period 2017 to 2020, proportion of in-kind contributions by the EU BON network versus proportion of costs that are not yet covered by identified sources of funding.

At the final EU BON meeting, partners provided further input regarding the sustainability of their tools/products, as part of a dedicated “business plan workshop”. **Tables 2 and 3** hence provide more detail about the costs of individual tools, personnel required (in days), sources of funding, and host institutions/individuals that will maintain the tools/products for the next three years.

Table 2. For each tool/product, total costs that are to be covered by in-kind contributions.

Tool/Product	Theme	Source of funding	Host	Personnel time (days)	Costs (€) 2017—2020
Pluto F	Citizen Science	UTARTU	UTARTU	190	355,006
Registry	Science/Research	GBIF Core Operations	GBIF	200	489,664
Species population tool	Science/Research	GBIF Core Operations	GBIF	20	48,966
Sample based data standards and publishing tools	Science/Research	GBIF Core Operations	GBIF	20	48,966
EU BON Taxonomic Backbone	Science/Research	BGBM	FUB-BGBM Berlin	10	15,302
Hierarchical Random Forest habitat classification	Science/Research		Yoni Gavish	7	8,569
Population downscaling tools	Science/Research		Yoni Gavish	7	8,569
Diversity upscaling tools	Science/Research		Yoni Gavish	7	1,530
Alpha-adjusted species distribution models	Science/Research		Yoni Gavish	1	1,224
Species distribution model profiling	Science/Research		Yoni Gavish	1	1,224
Hybrid species distribution models	Science/Research		Yoni Gavish	1	1,224
ARPHA	Science/Research	Pensoft	Pensoft	330	97,627
TreatmentBank	Science/Research	Plazi	Plazi	190	281,557
GoldenGate Imagine	Science/Research	Plazi	Plazi	150	367,248
Biodiversity literature repository	Science/Research	Plazi	Plazi	20	24,483
R virtual laboratory (R vLab)	Science/Research	LifeWatch	LifeWatch	520	229,530
Marine Ecological Modelling virtual laboratory	Science/Research	LifeWatch	LifeWatch	520	229,530
TOTAL					2,210,221

Table 3. For each tool/product, total costs without an identified source of funding.

Tool/Product	Theme	Source of funding	Host	Personnel time (days)	Costs (€) 2017—2020
Directory of citizen science data providers	Citizen Science		Israel Peer	24	14,690
I Saw a Butterfly	Citizen Science		Israel Peer	48	29,380

List of research infrastructures, portals and data providers	Policy		MfN	90	74,674
GeoCAT	Policy		Kew Royal Botanic Gardens	10	12,242
Possible climate change impact tools	Policy		FIN	77	89,976
Freshwater species distribution model	Science/Research		Mathias Kuemmerlen	494	238,711
BMSapp	Science/Research		Israel Peer	60	36,725
AquaMaps for EU BON/CYOM	Science/Research		FIN	293	322,000
EuroLST	Science/Research		Duccio Rocchini/FEM	5	13,772
Fourier transform	Science/Research		Duccio Rocchini/FEM	20	48,966
SDM toolbox	Science/Research		Duccio/FEM	10	24,483
European Biodiversity Portal	Science/Research		CSIC	286	230,271
Training packs for EU BON tools	Science/Research		MRAC	125	258,604
TOTAL					1,394,493

Worth noting is the amount of personnel (labour) time required to maintain the tools/products. Personnel time actually is the main cost for all tools/products that will need to be covered with funds from the host institution, volunteer time, or covered indirectly with funds from other projects.

During the scoring exercise at the “business plan workshop”, partners were asked to provide more details about the “unique selling points” of their tools/products, key users, and marketing potential to generate revenue in the long term. The results from the exercise highlight that most tools are heading towards sustainability (see Section 6.2.9. Annex 2). Furthermore, specific end-users were identified for each tool/product, and a number of services that could be provided were outlined.

The results from the scoring exercise, along with Deliverable 6.1 (*Report on stakeholder engagement for integrated biodiversity information*; Martin et al., 2016), can be useful for EU BON to develop “proof of concepts” or to apply for funding such as COST Actions²⁴, COST being a funding organisation for research and innovation networks. Proof of concepts are useful to test the feasibility of ideas with targeted end-users (customers) and the European Research Council (ERC) offers a proof of concept funding scheme for researchers who have been honoured with an ERC grant beforehand²⁵. In contrast, COST Actions support networking activities and are funded by the European Cooperation in Science and Technology (COST)²⁶. As shown above, there are a number of products and services that are at the beginning of their development journey whilst having potential to generate income for the network. These products and services would need to be co-designed with end-users, and market analyses would need to be carried out beforehand. These activities could take place in the context of workshops financed by COST Actions, or under the umbrella of “proof of concept” projects.

²⁴ www.cost.eu/COST_Actions

²⁵ <https://erc.europa.eu/funding/proof-concept>

²⁶ http://www.cost.eu/about_cost/how_cost_works

6.2.6. Summary of options and next steps

The business plan focused on the unique value of EU BON, which is its network of biodiversity experts. The EU BON brand can open opportunities to progress biodiversity knowledge in Europe by making use of the network's expertise and the associated tools/products and services. As such, there are two different paths that EU BON could take towards long-term sustainability. The first option is to seek further funding from the EC and national governments, as well as a mandate to become the European BON that coordinates monitoring activities and communicates biodiversity-related status and trends to key stakeholders and decision-makers. The second option is an entrepreneurial path to develop demand-driven services and adapt products to meet the needs of specific users (scientists, citizen scientists, policy advisors, decision-makers). A decentralised organisational structure seems to be the most feasible option to enable the network to remain connected, and to provide the flexibility for different teams/ventures/working groups to develop organically. However, both of these paths require an EU BON partner organisation to be willing to take the lead in implementing the business plan and coordinating efforts after the funded phase ends in May 2017.

Next steps

The following are logical next steps to take towards sustaining the EU BON brand and the different components of EU BON:

Funding:

- Identify EU BON partner organisation(s) to lead funding applications and implement the business plan.
- Partners and/or lead organisation to apply for funding linked to the four core themes (science/research, policy, citizen science, GEO BON & IPBES) to meet end-user needs and make use of the products already developed.
- Submit proposals to calls under COST Actions and “proof of concepts”, to further develop ideas for services for a target audience (e.g. policy, citizen science, science/research).

Marketing campaign:

- Showcase EU BON flagship products for specific users and make them available on the homepage of the *European Biodiversity Portal*, Oppla's marketplace, and BON in a Box.
- Provide a list of services and training that can be provided to specific end-users as well as the contact points for these services. Services and training could be advertised and coordinated via the EU BON helpdesk.
- Print business cards with a sales pitch for EU BON tools and services.
- Demonstrate the usefulness of EU BON for policy by developing policy briefs or infographics that illustrate how biodiversity data can feed into assessments, existing collaborations and users' requirements.
- Visualise a few services that could be provided to specific users and the pathways to get there.

Networking:

- Engage in proactive external networking with European initiatives, projects and organisations, such as EKLIPSE, BISE, EEA, JRC, Oppla, SAM, Future Earth Knowledge-Action Network. For instance, partners can register as experts to contribute to the EKLIPSE mechanism, and submit products/tools to the Oppla marketplace.

- Promote internal networking via the mailing list for EU BON partners, which will remain active for another five years after the funded phase.
- Extend the network by developing links/partnerships with national BONs (e.g. ECOSCOPE in France).

Decision context assessments:

- Tool/product owners to undertake a 'decision context assessment' for their tools, which will allow the network to see which of the tools might be made relevant and useful to address policy needs, and which ones to focus on. The decision context assessments will provide answers regarding 1) Who is the user? 2) Why should they want to use the tool? 3) What do they want it to look like? 4) How does it fit into existing decision workflows? and 5) How do EU BON let users know about it?




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6.2.8. Annex 1. EU BON product list

This is a list of tools and products produced or improved as part of the “Building the European Biodiversity Observation Network” (EU BON) project (<http://eubon.eu>).

Products are organised in the following categories:

-  Data analysis (e.g. R package for SDM)
-  Decision-support (i.e. tackling a specific question, database providing digested information/metadata)
-  Data management/collation (e.g. for handling, curating, accessing, publishing, managing, sharing, training)

Product name	High-level description	Format & showcase(s)	Audience / User(s)	Contact(s)	Tag
EuroLST	Fine-scale (250 m) Land Surface Temperature maps allow to create spatially more accurate species distribution models.	Format: European-wide continental maps in GIS-ready formats: http://www.geodati.fmach.it/eurolst , http://www.mdpi.com/2072-4292/6/5/3822	Research scientists Expert groups Citizen scientists	Duccio Rocchini (ducciorocchini@gmail.com)	SDM Ecosystem and environmental modelling Data analysis
Fourier Transform	Uses remotely-sensed landscape fragmentation data for monitoring ecosystem condition (e.g., extent of deforestation, forest degradation).	Format: Methodology	Research scientists Governmental Organisations Expert groups	Duccio Rocchini (ducciorocchini@gmail.com)	Monitoring Data analysis
Freshwater Species Distribution Model Ensemble	Supports decision-making on where river barriers should be removed to reduce impacts to threatened species (e.g., lamprey).	Format: Methodology Showcase: Case study for one catchment in Germany.	Environmental managers Research scientists Policy Makers Government organisations	Mathias Kuemmerlen (mathias.kuemmerlen@eawag.ch)	SDM Environmental Management Data analysis
Hierarchical RandomForest Habitat Classification	Machine-learning classification that accounts for the hierarchical structure of habitats, providing a cost-effective way to improve the classification accuracy.	Format: R package (<i>HieRanFor</i>)	Research scientists Expert groups Government Organisations Policy-makers	Yoni Gavish (Gavish.Yoni@gmail.com)	Environmental management R Data analysis
Alpha-adjusted Species Distribution Model	Model that accounts for the number of species a site can support (alpha diversity) and the suitability of the sites to the focal species, relative to its suitability to other species.	Format: R script	Research scientists Expert groups Environmental managers	Yoni Gavish (Gavish.Yoni@gmail.com)	SDM R Data analysis

Product name	High-level description	Format & showcase(s)	Audience / User(s)	Contact(s)	Tag
Species Distribution Model Profiling	Spatially-explicit evaluation tool for species distribution modelling that helps identify new monitoring sites that are most likely to increase the accuracy of predicted distributions for a species of interest.	Format: R script	Research scientists Environmental managers	Yoni Gavish (Gavish.Yoni@gmail.com)	SDM Monitoring R Data analysis
Hybrid Species Distribution Models	A set of four hybrid species distribution models—each with different assumptions, emphasis, and data requirements—that account for environmental heterogeneity and spatial aspects (e.g., dispersal limitation, spatial autocorrelation) to increase the accuracy of predicting species distributions and operate at various spatial resolutions.	Format: R script (<i>downscale</i>)	Research scientists Expert-groups Government Organisations NGOs	Yoni Gavish (Gavish.Yoni@gmail.com)	SDM R Data analysis
Population downscaling tools	Set of 10 models that predict the number of occupied sites at fine resolution from coarse-scale atlas data.	Format: R package	Research scientists Expert-groups Governmental organisations NGOs	Charlie Marsh (charliem2003@gmail.com)	SDM R Data analysis
Diversity upscaling tools	Advanced methods to predict the number of species in a large area of interest from a limited number of fine-scale samples taken from within the area.	Format: R package	Research scientists Expert-groups Governmental organisations NGOs	Yoni Gavish (Gavish.Yoni@gmail.com)	SDM R Data analysis
VirSysMon (Virtual Systematic Monitoring)	VirSysMon is a cost-efficient tool for optimizing systematic monitoring schemes based on a Virtual Ecologist approach. It allows testing, optimizing, and demonstrating the cost-efficiency of voluntary versus paid-expert monitoring toward higher quality, greater trust and support. The idea is to mimic the sampling behaviour of alternative observers, and thereby assess the potential influence of observers on monitoring outcomes (e.g. data quality, abundance estimates, or chances of identifying the status and trends of species and communities). Spatially explicit, individual-based simulation models are used to create ‘virtual reality’ as a baseline to which model results are compared.	Format: R package Showcase: A set of virtual species simulated over 50 years (using RangeShifter) and re-sampled by volunteers versus paid experts.	Research scientists	Guy Pe’er (guy.peer@ufz.de) Ferdinand Schirrmeister	Monitoring R Data analysis
R virtual laboratory (R vLab)	Supports and integrated and optimized (with respect to computational speed and data manipulation) online R environment. vLab allows for a predefined, commonly used set of R functions to run on the LifeWatch Infrastructure in order to support large-scale computational and modelling activities.	Formats: Online platform allowing users to run R scripts (R_vLab of LifeWatchGreece at https://rvlab.portal.lifewatchgreece.eu/). Also available as a mobile app.	Research scientists	Christos Arvanitidis ; Anastasis Oulas	R Data analysis

Product name	High-level description	Format & showcase(s)	Audience / User(s)	Contact(s)	Tag
rAquaMaps	A set of tools that make it easier to produce AquaMaps outputs (model-based, large-scale predictions of natural occurrences of marine species).	Format: R package available at: https://github.com/raqumaps/raqumaps	Research scientists	Markus Skyttner	SDM R Data analysis
AquaMaps' Create-Your-Own-Map tool	A web-interface tool linked to an AquaMaps species distribution map that allow species experts to edit an erroneous map, and re-generate and publish an improved version of it. Pop-up user guide included.	Online tool: http://www.aquamaps.org/eubon/home.php , and http://www.aquamaps.org	Research Scientists	Kathleen Reyes ; Cristina Garilao	SDM Data analysis
Diversity calculator	A tool for calculating alpha and beta diversity from a large stack of gridded maps (large in extent and high in resolution, resulting in a high number of grid cells).	Currently available as stand-alone software, but transformation into an R package to be used in the Rvlab is under way.	Research Scientists	Johannes Penner	R Species occurrence Environmental management Data analysis
SDM Communication Toolbox	This toolbox includes three resources that explain the value of species distribution models (SDMs) to different audiences: <ul style="list-style-type: none"> • “Roadmap to SDMs”; • “Value of SDMs to decision/policy-makers; • “From SDMs to policy (applications of SDMs to EU relevant policy).” 	Formats: PDF document and infographics.	Research scientists Policy-makers Research scientists	“ Roadmap to SDMs ”: Duccio Rocchini ; Carol Garzon “ Value of SDMs ”/“ From SDMs to policy ”: Sarah Darrah ; Corinne Martin	SDM Data analysis Capacity Building
GeoCAT	Browser-based tool that performs rapid geospatial analysis to ease the process of Red Listing taxa (threat assessments).	Online tool: Geospatial tool (http://geocat.kew.org)	Expert groups Policy-makers Governmental organisations	Simão Belchior	Environmental management Decision-support
AquaMaps for EU BON Interface	Explore and download data for modelled species distributions of European marine and freshwater species.	Online tool: http://www.aquamaps.org/am_eubon/ (marine) and http://www.aquamaps.org/am_europe/ (freshwater)	Research scientists Environmental managers NGOs	Kathleen Reyes ; Cristina Garilao	Species Distribution Modelling Decision-support
Possible climate change impact on the spatial distributions of threatened species	This tool illustrates how the (modelled) spatial distributions of IUCN red listed species may change, based on IPCC A2 emissions scenario.	Online tool: http://www.aquamaps.org/am_eubon/other/specieslist.php?type=threatened	Government organisations NGOs Expert groups Citizen scientists	Kathleen Reyes ; Cristina Garilao	Climate change Species Distribution Modelling Decision-support

Product name	High-level description	Format & showcase(s)	Audience / User(s)	Contact(s)	Tag
Possible climate change impact on bony fish diversity in Large Marine Ecosystems	This tool illustrate the possible climate change impact on bony fish community composition, for a number of EU-relevant LMEs.	Online tool: http://www.aquamaps.org/am_eubon/SpecRichLME.php Infographic: http://wcmc.io/North-Sea .	Governmental organisations NGOs Expert groups Citizen scientists	Kathleen Reyes ; Cristina Garilao	Climate Change Species Diversity Decision-support
Marine Ecological Modelling virtual laboratory: ecosystem modelling	Provides information on the ecological status of water bodies, based on various indices related to the implementation of the Water Framework Directive (WFD) and the Marine Strategy Framework Directive (MSFD). Provides decision-support for when to open channels of communication between lagoons and open sea based on predicted oxygen depletion rates.	Format: Graphic User Interface (GUI) with visualization maps Showcases: four in total (Greece and Cyprus), including the study site of the Amvrakikos Gulf lagoons.	Environmental managers Governmental organisations NGOs Expert groups Citizen scientists Research scientists	Christos Arvanitidis (on behalf of Alkis Kalabokis, Manolis Potiris, and George Petihakis)	Ecosystem Modelling Decision-support
Marine Ecological Modelling virtual laboratory: alien and invasive species	Provides information on the geographic location of alien and invasive species of Indo-Pacific origin found in the Mediterranean sea, along with likely spread under climate change and maritime traffic scenarios. It is based on the BioVel Workflows.	Format: Maps of probability of occurrence.	Environmental managers Governmental organisations NGOs Expert groups Citizen scientists Research scientists	Christos Arvanitidis (on behalf of HCMR, FIN, and the University of Gothenburg). Not a direct EU BON product.	Alien and Invasive Species Species occurrence Decision-support
DaEuMon, BioMAT, and PMN: Toolbox on biodiversity monitoring in Europe	DaEuMon provides metadata of habitat and species monitoring schemes in Europe covering the terrestrial, freshwater and marine realms (the later added only recently). Currently more than 600 schemes are included. Among other information, data on habitat/taxa coverage, spatial and temporal coverage, effort, design and costs are provided. BioMAT is a search and graphical display tool that provides an overview of monitoring schemes in Europe and their characteristics. Search options are available to extract schemes that fulfil particular criteria, e.g. launching reason and coverage of Natura 2000 issues. The Participatory Monitoring Networks (PMN) database is comprised of monitoring organisations and their characteristics (e.g., organisation structure, recruitment and maintenance of members, data sharing).	DaEuMon: Online portal accessible via http://eumon.ckff.si/about_daeumon.php . BioMAT: http://eubon.ckff.si/biomat . PMN-database: http://eumon.ckff.si/wp1/wp1.php	Environmental managers Citizen scientists Research scientists Governmental organisations Policy Makers	Klaus Henle , Dirk Schmeller	Monitoring Decision-support

Product name	High-level description	Format & showcase(s)	Audience / User(s)	Contact(s)	Tag
Cartograms to represent spatial uncertainty in species distribution	Provides guidance regarding appropriate models to use for different levels of inputs, offering a workflow (assumptions, limitations, required data, scale, etc.).	Format: Methodology. Showcase: infographic (/ policy briefing?) https://doi.org/10.3897/rio.3.e12029	Research scientists Policy-makers	Duccio Rocchini (ducciorocchini@gmail.com)	Species Distribution Modelling Decision-support
List of research infrastructures, portals and data providers	Lists and provides high-level information (brief description, datasets provided, type, user groups, institution/location, partners, hyperlink) on research infrastructures, initiatives, portals and data providers from the global, regional and national levels. Linking and mapping networks and initiatives with metadata.	Format: metadata list, and possible showcase.	Research scientists Environment managers Expert groups Government organisations NGOs	Florian Wetzel (Florian.Wetzel@mfn-berlin.de)	Data Mobilisation Decision-support
Directory of citizen science data providers	Inventory of citizen science initiatives which provide data (http://biodiversity.eubon.eu/web/citizen-science/directory-of-cs-data-providers). The 'Directory of CS Data Providers', accumulated by NBIC partner, is maintained on PlutoF database and deployed on Liferay page using a portlet software package developed by GlueCAD.	Format: metadata list	Citizen scientists, environment managers	Israel Peer (israel@gluecad.com)	Data Mobilisation Decision-support
EU BON Biodiversity Portal	Links to relevant databases and information systems, and structured advice for assessing relevant distributed information/datasets for different user groups, including contributions from citizen science data gathering gateways. Technically integrates various data sources under one search facility and spatially/temporally oriented user interface. The portal will also act as showcase for the various EU BON products.	Online platform (in development, http://test-eubon.ebd.csic.es).	All	Hannu Saarenmaa ; Antonio Garcia Camacho	Species occurrence Citizen-science
Data mobilisation and curation with PlutoF	Allows users to create, manage, share, analyse and publish biology-related databases and projects, in a cloud environment.	Online platform: https://plutof.ut.ee	Research scientists Expert groups	Urmaz Koljal	Citizen science Data Mobilisation Data management
Mobilisation of specimen data	Easy-to-use import tool for the mobilisation of specimen data (e.g. middle sized and private collection data). Data can be imported using custom template files (https://plutof.ut.ee/#/import), and are fully manageable through the PlutoF cloud after upload. Uploaded specimen data can be automatically released to GBIF, published with DOI, or sent to the Pensoft journal manuscript editing tool	Online platform: https://plutof.ut.ee	Research scientists Expert groups Citizen scientists	Urmaz Koljal	Citizen science Data Mobilisation Data management

Product name	High-level description	Format & showcase(s)	Audience / User(s)	Contact(s)	Tag
Taxonomy module	Provides an online workbench for managing multiple biological classifications in the same system. Fully implemented on the PlutoF platform. Taxon occurrences may be identified and linked to taxon names in several classifications. Additional functionalities include taxon name search, RESTful API, and importing taxon names from GBIF	Online service provided by PlutoF platform. Stand-alone version with base support (database and web services) also available as a separate package at https://github.com/TU-NHM/plutof-taxonomy-module .	Research scientists Expert groups	Urmaz Koljalj	Taxonomy
GoldenGate Imagine	Allows semiautomatic, interactive extraction (text mining) of taxonomic treatments, scientific names, named entities, bibliographic references, and observation data from taxonomic publications (example of an article on dragonflies)	Open source desktop software: http://plazi.org/resources/treatmentbank . Online version in preparation. Showcase: extracted research data can be visualised as a dashboard .	Research scientists Citizen scientists	Donat Agosti	Taxonomy Citizen science Data Mobilisation
DNA based species hypotheses	Provides access to datasets for the identification of eukaryotic species from any biological samples based on rDNA ITS sequences. These can be utilised in Sanger-based, as well as in High Throughput Sequencing (HTS), projects. Datasets are available through the HTS pipelines like QIIME, mothur, CREST, UCHIME, etc. or can be downloaded for the in-house analyses.	Online platform: https://unite.ut.ee/repository.php	Research scientists Expert groups	Urmaz Koljalj	Taxonomy
PlutoF/Pensoft automated workflow	Provides a direct connection between PlutoF's databases and Pensoft's ARPHA writing tool. It allows users to import their data from PlutoF's databases directly into online Pensoft journal article in a dynamic and seamless way.	Online solution available through https://plutof.ut.ee and http://arpha.pensoft.net/	Research scientists Citizen scientists Expert groups	Urmaz Koljalj	Data publication Citizen science
Citizen Science project management tool	Allows users to manage and optimize citizen science workflow by working with contributors who collect, analyse and publish data. PlutoF's workbench provides an integrated solution for creating data forms, reaching out for contributors and moderating observation data. The tool also allows to work with specimen data, e.g. digitising specimen information from labels.	Format: Citizen science module. Showcase: Example of a project public output https://plutof.ut.ee/#/citizen-science-projects/loodusheli	Citizen scientists Governmental organisations Expert groups	Veljo Runnel (Veljo.Runnel@ut.ee)	Citizen science Data management
Training packs	Provides detailed, practical information on how to use and implement data tools designed by EU BON and its associated partners.	Accessible online as PowerPoint presentations and complementary training content, such as videos via the EU BON Helpdesk: http://eubon.cybertaxonomy.africamuseum.be/past-trainings .	Research scientists Citizen scientists Expert groups	Patricia Mergen (patricia.mergen@africamuseum.be)	Capacity Building Citizen science

Product name	High-level description	Format & showcase(s)	Audience / User(s)	Contact(s)	Tag
Mirroreum	A platform for authoring and publishing “Reproducible Open Research”, so that researchers are able to share and collaborate at all steps in the research chain, i.e., from raw data to scientific knowledge dissemination, using R packages produced within EUBON. Reproducibility allows for researchers and users of the outputs to focus on the actual content of a data analysis, rather than on superficial details reported in a written summary. In addition, reproducibility makes an analysis more useful to others because the data and code that actually conducted the analysis are available.	Docker-Compose app available at: https://github.com/raqumaps/mirroreum .	Research scientists Expert groups Governmental organisations NGOs	Markus Skyttner	Data dissemination
Extended Darwin Core for sample data	Extension of an existing and widely used data standard (doi:10.1371/journal.pone.0102623) so as to handle sample-based datasets and hence trends, e.g. time series collected using standardised protocols, abundance data from monitoring activities. Project wiki , software , stats , release page , and blogs .	Format: Extended data standard. Showcase: Online discovery tool for datasets of interest for developing Essential Biodiversity Variables (EBVs) - species distribution and population abundance (http://eubon-ebv.gbif.org , http://geobon.org/essential-biodiversity-variables/what-are-ebvs/). Species trend visualisation: http://beta.eubon.ebd.csic.es/species-trend-visualization	Research scientists Governmental organisations NGOs Expert groups	Tim Robertson (troberson@gbif.org)	Data management
ARPHA-BioDiv A toolbox for scholarly publishing and dissemination of biodiversity data	A set of standards, guidelines, recommendations, tools, workflows, services, and journals, based on Pensoft’s ARPHA Journal Publishing Platform, designed to ease scholarly publishing of biodiversity and biodiversity-related data that are of primary interest to the EU BON and GEO BON networks. Compatible with GBIF IPT, DataONE, iDigBio, PlutoF, BOLD and any other platform supporting EML and Darwin Core standards.	Online tool (constantly updated).	Research scientists Institutions Data managers Data curators	Lyubomir Penev (penev@pensoft.net)	Data publication
ARPHA Dwc Archive export plugin	Articles published via the ARPHA platform and associated Biodiversity Data Journal (BDJ) have a Darwin Core Archive export functionality, which allows for direct import of an article’s underlying specimen records in GBIF.	Showcase: http://bdj.pensoft.net/articles.php?id=7975&display_type=list&element_type=5	Research scientists Expert groups	Lyubomir Penev (penev@pensoft.net)	Data publication

Product name	High-level description	Format & showcase(s)	Audience / User(s)	Contact(s)	Tag
Create a data paper from metadata “at the click of a button”	Articles published via the ARPHA platform benefit from an easy creation of data paper manuscripts from EML metadata stored in GBIF IPT, LTER and DataONE.	Format and showcase: http://arpha.pensoft.net/tips/?tip=24 http://arpha.pensoft.net/tips/?tip=25 http://arpha.pensoft.net/tips/?tip=26 http://blog.pensoft.net/2015/10/13/a-data-paper-at-the-click-of-a-button-streamlining-metadata-conversion-into-scholarly-manuscripts-for-gbif-and-dataone-data/	Research scientists Expert groups	Lyubomir Penev (penev@pensoft.net)	Data publication
Plugin for direct online import of specimen records into manuscripts from GBIF, BOLD, iDigBio and PlutoF.	Authors can import occurrence records in articles created in ARPHA via Excel spreadsheets or directly from GBIF, BOLD, iDigBio and PlutoF.	Format and showcase: http://arpha.pensoft.net/tips/?tip=28 http://arpha.pensoft.net/tips/?tip=30 http://arpha.pensoft.net/tips/?tip=31 http://arpha.pensoft.net/tips/?tip=32 http://arpha.pensoft.net/tips/?tip=33 http://blog.pensoft.net/2015/10/20/streamlining-the-import-of-specimen-or-occurrence-records-into-taxonomic-manuscripts/	Research scientists Expert groups	Lyubomir Penev (penev@pensoft.net)	Data publication
Novel IUCN-compliant article templates: Species Conservation Profiles (SCP) and Alien Species Profile (ASP)	Authors using the ARPHA Writing Tool can work collaboratively on their Species Conservation Profiles (SCP) and Alien Species Profiles (ASP), peer-review and publish them as citable scholarly articles.	http://bdj.pensoft.net , http://bdj.pensoft.net/articles.php?id=10356	Research scientists Expert groups	Lyubomir Penev (penev@pensoft.net)	Data publication
TreatmentBank	Treatment Bank is a resource that stores and provides access to the taxonomic treatments, observation records, and data therein provided from taxonomic publications using, among other tools, Golden Gate.	Format: Online (http://TreatmentBank.org)	Research scientists Expert groups	Donat Agosti (agosti@plazi.org)	Taxonomy

Product name	High-level description	Format & showcase(s)	Audience / User(s)	Contact(s)	Tag
EU BON Taxonomic Backbone	<p>The EU BON Taxonomic Backbone allows federated searches on multiple European checklists, returning a unified set of individual responses of various checklists.</p> <p>Unified Taxonomic Information Service (UTIS) connects to the web services of the Pan-European Species Directories Infrastructure (EU-Nomen), EUNIS, which fully covers Natura 2000. Therefore, UTIS can be used in full compliance with Appendix 3 of the INSPIRE directive. Furthermore, it connects to the Catalogue of Life (CoL) and the World Register of Marine Species (WoRMS).</p>	http://cybertaxonomy.eu/eu-bon/utis/1.2/ http://cybertaxonomy.eu/eu-bon/utis/1.0/	Research scientists Expert Groups Government Organisations	Andreas Kohlbecker (a.kohlbecker@bgbm.org)	Taxonomy
Mobile App tools for citizen science butterfly sightings, which implement PlutoF's API for observation reporting.	<p>"I-Saw-a-Butterfly" is a reporting app for sporadic observations that takes advantage of Mobile high-end technology to provide quality data on butterfly sightings, based on the concept of getting maximum data with minimum typing. Developed by GlueCAD the app aims at citizen science observers (Europe and Israel). It currently covers all European day butterfly species with a specific focus (and pictures) on Estonian and Israeli butterflies.</p>	<p>Format: Mobile application packages. "I-Saw-a-Butterfly" is freely available for the public on Google Play.</p>	Citizen scientists Research scientists	Israel Peer (Israel@gluecad.com)	Citizen Science Monitoring
Biodiversity Monitoring Schemes Mobile App (BMSapp)	<p>Mobile data collection app for systematic monitoring observations for any transect-based list of taxa, e.g. butterfly or amphibians. Identify using scientific/common list or by pictures, enable accurate mapping of transect sections (KML outputs). Support offline and online modes.</p>	<p>Format: Mobile application packages</p>	Citizen scientists Research scientists Scientists Data creators	Israel Peer (Israel@gluecad.com)	Citizen Science Systematic Monitoring
DINA	<p>The DINA-Web project develops an open-source web-based digital information management system for natural history collections. It supports collection management – the assembling, managing and sharing data associated with natural history collections and their curation. Targeted natural history collections include zoological, botanical, geological and paleontological collections, living collections, biodiversity inventories, observation records and molecular data.</p>	<p>Format: Online (http://dina-project.net/)</p>	Data curators Research scientists Expert Groups	Markus Skyttner (Markus.Skyttner@nrm.se)	Data management

6.2.9. Annex 2. EU BON tools/products sustainability scores table

This table is an output from the business plan workshop at the EU BON final meeting (Meise, Belgium). EU BON product/tool owners were asked to work in groups and make qualitative assessments on the sustainability of EU BON tools by taking into account identified end-users, tools' unique selling point, identified institution to host each tool, identified sources of funding, potential services to be provided to end-users, and tools' marketing potential.

Not sustainable yet
 Almost there
 Sustainable

Score	Name of the tool/knowledge product	Key end-user	What is the unique selling point	Host	Source of funding	Purpose or service to be provided by this tool/product	Marketing potential (revenue that could be generated from this tool)
	Aquamaps for EUBON/CYOM	NGOs, IUCN, marine conservation groups	Data available to end users	FIN		Mapping species Useful to answer policy-questions	
	Possible climate change impact on bony fish in LMEs / Threatened species	Countries reporting on Regional Seas Conventions (e.g. OSPAR, HECCOM, Barcelona, Black Sea)	Easy to access and use	FIN		Estimates distribution changes in marine species	Contribute towards GEO BON's "BON in a Box"
	I saw a butterfly	Citizen science and conservation groups	Designed for butterfly observations	GlueCAD		GBIF data provider	
	Hierarchical Random Forest Habitat Classification	Scientists	Makes less mistakes than other methods	Yoni Gavish		Mapping rare habitats	EU-level funding
	Diversity upscaling	Scientists	Allows to incorporate B-diversity effects	Yoni Gavish & Bill Kunin		Targeted interventions (e.g. Agri Env Schemes)	EU-level funding
	Training pack for EU BON tools	Scientists/researchers, citizen science groups	Hands on training from developers of tools	RMCA		Capacity-building	Registration fees
	DINA	Collection curators,	Open-source web-	NRM		Might be useful to answer	EU-level funding

		research scientists, expert groups	based			specific funded policy-driven questions	
	SDM tools	Experts interpreting species distributions	Better maps	Markus Kuemmerlen		Might be useful to answer specific policy-driven questions	EU-level funding
	EuroLST	Scientists	Finer temperature resolution data	Duccio Rocchini		Provision of temperature maps	SEA/EIA
	Freshwater SDM	Scientists	Adopted to specific requirements of connectivity in stream networks	Mathias Kuemmerlen		Modelling impact of specific management interventions WFD implementation Local and regional planners,	SEA/EIA
	European Biodiversity Portal	Scientists	Designed to support Biodiversity science	CSIC	CSIC, MfN	House data, products and services for biodiversity monitoring	
	Biodiversity Monitoring Mobile App	Citizen Science, Research	Systemic monitoring	GlueCad		Systematic monitoring schemas	
	Downscaling tools	Research scientists	The only downscaling tool that make all proposed models available with one software	University of Leeds		Monitoring biodiversity	
	TreatmentBank and GoldenGate	Scientists, citizen science	Open access and makes data citable	PLAZI	PLAZI	Free data from scientific publications	Conversion services
	Directory of citizen science data providers	Citizen Science project managers	Source of data	NBIC	NBIC	Might be useful to answer specific policy-driven questions	
	Citizen science project management	Citizen science groups	Easy use via mobile apps and webpages	UTARTU	UTARTU	Citizen science project management	EU-level funding

	tool					GBIF data provider	
	Species Observation System	Citizen Science	Efficient and user friendly	NBIC	NBIC	Sightings and data collections from citizen science	
	PlutoF	Biodiversity data creator and manager	Ready to use and mobilise data via GBIF and PENSOFT	UTARTU	UTARTU	Creating and managing biodiversity databases	Training courses targeted at consultancies doing EIA
	UTIS	Developers of BDI applications	Instant access to multiple taxonomic checklists	BGBM	BGBM	Integration into taxonomic information systems (e.g. EU BON, GFBIO)	
	Downscaling tools	Research scientists	The only downscaling tool that make all proposed models available with one software	University of Leeds	University of Leeds	Monitoring	