2017
2020

Implementation Plan

VERSION 1.3 – AUGUST 2017

GROUP ON EARTH OBSERVATIONS BIODIVERSITY OBSERVATION NETWORK

Published by the GEO BON Secretariat
ISBN: 978-3-9817938-4-0
doi: 10.978.39817938/40

Note: This new version (1.4) contains an updated list of the Implementation Committee (as of July 2017) and the detailed organization and activities of the French Biodiversity Observation Network.

Citation
GEO BON (2017) *GEO BON Implementation Plan 2017-2020. Version 1.3.*
Group on Earth Observations Biodiversity Observation Network Secretariat. Leipzig, 101 pages.

This version of the Implementation Plan was approved by the Implementation Committee of GEO BON at its in-person meeting of June 26th to 28th 2017.

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1. Introduction

The core objective of the Group on Earth Observations Biodiversity Observation Network (GEO BON) is the observation of biodiversity change. To achieve this objective, GEO BON focuses on the initiation and coordination of interdisciplinary efforts to set up interoperable national and regional biodiversity observation systems. Through its global network, GEO BON supports the sharing and dissemination of information and technology available locally or in large existing initiatives. GEO BON also supports the development and application of the most recent scientific knowledge to advance biodiversity observation collection, integration and interpretation. GEO BON is not directly involved in advocacy for on the ground conservation efforts, nor focused directly on biodiversity assessment. Instead, GEO BON is a network of stakeholders, a community of practice, focused on improving the infrastructure for monitoring biodiversity change and ensuring that both scientists and decision makers have access to better data.

GEO BON is the biodiversity arm and one of the "flagships" of the Group on Earth Observation (GEO), a partnership of more than 100 national governments and more than 100 Participating Organizations that envisions a future where decisions and actions for the benefit of humankind are informed by coordinated, comprehensive and sustained Earth observations. Biodiversity is one of GEO's eight Societal-Benefit-Areas, alongside *inter alia* public health, food security, and disaster resilience (Fig.1). In this context, GEO BON is also building up the pathway to link biodiversity data and metadata to GEOSS, *the Global Earth Observation System of Systems*. GEOSS will provide decision-support tools to a wide variety of users.

Figure 1. The eight Societal-Benefit-Areas addressed by GEO and its partner organizations

Since its inception in 2008, GEO BON has developed a global social network and community of practice for biodiversity observations. This network includes many world leaders in biodiversity observation as well as major partner organisations in that field. GEO BON moved into its second phase in 2014 by refocusing on its core goals, realistically assessing what is possible, and making strategic decisions on where its limited resources should go to achieve those goals. As a result, its focus has narrowed, though it still utilizes and builds upon the networks and communities of practice that have already been established. Now entering its third phase, this three-year work-plan represents a targeted and integrated effort to further refine and apply a framework for biodiversity observations through targeted and continued development of the EBVs and application of the EBV concept at multiple scales in partnership with national, regional and global partners. This approach will advance the theory and practice of efficient, user driven biodiversity observation design, leading to improved biodiversity observation data in support of decision-making.

This Implementation Plan presents the GEO BON strategy, structure, and activities for the 2017-2020-time period. Its outline reflects the new structure of GEO BON, as adopted by the Implementation Committee in the Summer of 2016. In particular, the current Implementation Plan reflect the core activities of GEO BON: 1) Developing a standard and flexible framework for biodiversity observations, with the development of the Essential Biodiversity Variables within the different working groups; 2) Supporting the development of Biodiversity Observation Networks; and 3) Producing outputs that are adequately communicated to the various GEO BON user groups, from the scientific community to policy bodies such as the IPBES and CBD.
The Implementation Plan of GEO BON will be a living document, which will be updated as new activities, and/or new working groups are being developed. The current version and its structure was approved by the Implementation Committee of GEO BON at its in-person meeting of June 26th to June 28th.

2. A strategy towards 2020 and beyond

2.1. Vision and mission

Established in 2008, GEO BON, has grown from a concept to a "GEO Flagship Initiative" in recognition of its rapid progress, maturity and global partnerships. With a mission to "improve the acquisition, coordination and delivery of biodiversity observations and related services to users including decision-makers and the scientific community" and a vision for "a global biodiversity observation network that contributes to effective management policies for the world's biodiversity and ecosystem services", GEO BON is organizing its efforts using a top-down and bottom-up approach (Fig.2). The top-down approach involves the implementation and adoption of the Essential Biodiversity Variables (EBVs) and related monitoring guidelines, interoperable data management systems and analytical tools. The bottom-up approach involves targeted capacity building efforts for the development or enhancement of biodiversity observation networks (e.g. national, regional and thematic BONs). This approach reflects the need to provide a consistent framework for global, regional and national observation systems (e.g. EBV's, monitoring guidelines, interoperable data systems) with the pragmatism of a bottom-up construction process (e.g. through user-driven national and regional capacity building).

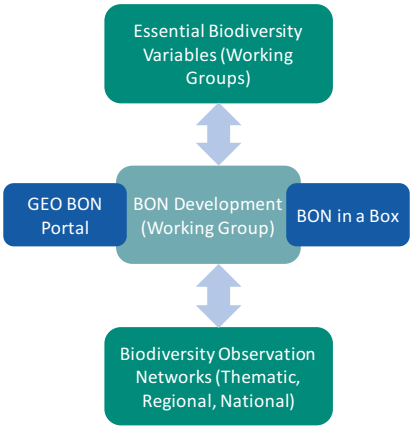


Figure 2. The bottom-up and top-down approach of GEO BON to develop a global biodiversity observation network.

2.2. Users

A successful and sustainable biodiversity observation network must clearly and effectively meet "user" needs. Perhaps the most important block of users are the national governments who are responsible for reporting on the status and trends in ecosystems and the biodiversity they support to meet their national mandates (e.g. national biodiversity plans, recovering species at risk, sustaining ecosystem services) and international obligations (e.g. Convention on Biological Diversity, RAMSAR Convention, Convention on Migratory Species, etc.). These users are particularly important since, more than any other group, they have the ability to enact and change policy and to implement it; both of which are dependent upon better observations, products, and tools than are currently available. Collectively, they also have the greatest access to resources to support implementation.

Another key user group of a global biodiversity observation system and the resulting data is the scientific community that needs sound and reliable data to produce and populate models, study the drivers of biodiversity change and distribution, identify new and emerging threats to biodiversity along with effective responses, and that must create scenarios and assessments of policies to facilitate decision-making (e.g. Intergovernmental Platform on Biodiversity and Ecosystem Services - IPBES). Many non-governmental (e.g. IUCN) and international organizations (e.g. Arctic Council) are actively involved in conducting biodiversity assessments to facilitate more effective conservation and sustainable use of biodiversity and ecosystem services and thus, are also reliant on high quality biodiversity data.

Currently, our collective ability to detect and understand the status and trends of biodiversity, to develop sound assessments, and produce scenarios to guide more effective policy is greatly hampered by a lack of access to high quality observations. GEO BON is concerned with the development of more integrated, efficient and interoperable biodiversity observation networks that can produce more reliable, accessible and timely observations to serve these needs. Being part of the GEO network allows GEO BON the opportunity to connect with the observations and data organized in the other GEO SBA's. These cross-linkages provide an opportunity to produce value-added, integrated tools and products that facilitate more informed and effective policy - going beyond reporting on status and trends to also identifying the causal mechanisms driving biodiversity change and producing predictive models for examining future scenarios.

Considering these various clients, their needs, our current limited capacity, and opportunities from the GEO network, we must prioritize our strategic engagement and capacity building efforts. With this in mind, it is believed that the Convention on Biological Diversity's (CBD) 2020 Aichi Targets and the UN Sustainable Development Goals (SDG) and Agenda 2030 provide an impetus for improved biodiversity observations from the national to regional and, ultimately, to the global level. As such, GEO BON has identified the Parties to the CBD as key clients and GEO BON has continually engaged the Parties to the CBD on key topics, including capacity building for biodiversity observations and the development of new models to inform the Aichi Targets. This interaction has led to a greater awareness of GEO BON and thus, increased collaborations with member nations and a greater understanding of national needs and challenges with regard to biodiversity observations and what is needed to support national reporting. GEO BON is also increasingly focusing attention on the Sustainable Development Goals and will, through this three-year work plan, be making efforts to map the EBVs to the SDGs, apply its partners' models to support SDG tracking and raise awareness of the value of GEO BON to support improved data for tracking the SDGs. GEO BON will also continue to engage the Intergovernmental Platform on Biodiversity and Ecosystem Services, the broader scientific community (e.g. the new international programme on global sustainability, Future Earth), non-governmental conservation organizations, and other relevant biodiversity conventions (e.g. RAMSAR Convention, Convention on Migratory Species).

2.3. Essential Biodiversity Variables and Biodiversity Observation Networks

The Essential Biodiversity Variables, or EBVs, are a minimum set of measurements, complementary to one another, that are required to study, report, and manage biodiversity change. The EBVs (Fig.3) can hence be understood as the level of integration between the raw biodiversity observations (derived either from in-situ observations or remote sensing), and the high-level indicators that are needed by stakeholders for reporting (e.g. protected area managers, national governments). The Essential Biodiversity Variables are organized in EBV classes which will ultimately each be represented by a working group within the new GEO BON structure: Genetic Composition, Species Populations, Species Traits, Community Composition, Ecosystem Structure, and Ecosystem Function. Ideally, regardless of the class, these EBVs should match the following criteria and be:

- Able to capture critical scales and dimensions of biodiversity
- Biological
- A state variable (in general)
- Sensitive to change
- Ecosystem agnostic (to the degree possible)
- Technically feasible, economically viable and sustainable in time.

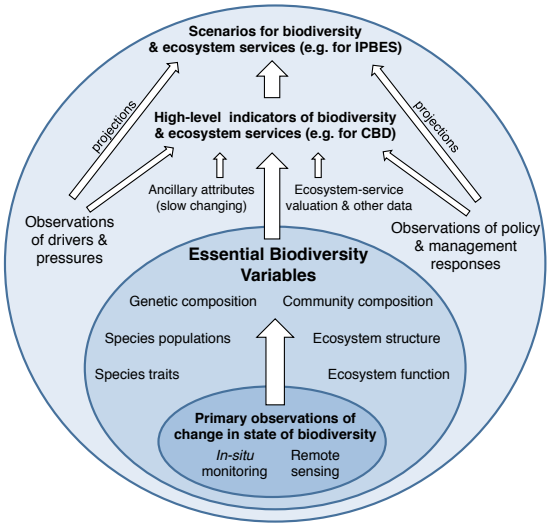


Figure 3. The Essential Biodiversity Variables. EBVs provide the first level of abstraction between low-level primary observations and high-level indicators of biodiversity.

The GEO BON network is structured as working groups (WGs) as well as national, regional and thematic Biodiversity Observation Networks (BONs). GEO BON actively facilitates the development of BONs by building capacity and engaging stakeholders (particularly national governments, institutes, scientists and practitioners). One focus in this new implementation phase is placed on the development of national BONs, which can act as national units and networks bringing biodiversity change data and information together.

The development of national BONs is also directly facilitated through the application of the BON in a Box platform. China, Brazil, South Africa, Colombia, Japan and Korea are national BONs already in operation or in development. The Asia Pacific BON (AP-BON), the Circumpolar Biodiversity Monitoring Program (Arctic BON), the Global System of Ecosystem Observatories (GSEO), the Freshwater Biodiversity Observation Network and the Marine Biodiversity Observation Network (MBON) are existing or developing regional or thematic BONs under the GEO BON umbrella.

2.4. Governance

In early 2016, the Management Committee of GEO BON proposed that a reorganization of the structure was desirable to match and align with the key development activities and governance structure of the GEO BON network over the past few years. The participants of the 2016 Open Science Conference and All Hands meeting (July 2016) were invited to submit ideas and proposals for workshops that would translate into a new structure for the network. This was later discussed by the Implementation Committee, the Advisory Board, and the organisers of the workshops. The new GEO BON structure (Fig. 4) is the result of those discussions[1].

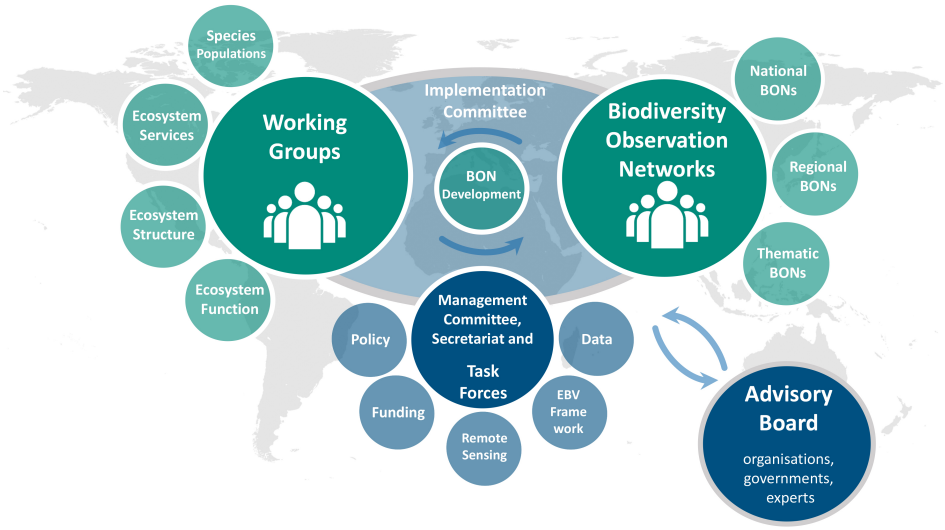


Figure 4. The structure of GEO BON for 2016 – 2020, adopted in September 2016

2.4.1. Working Groups

Working Groups (WG) are structured around particular classes of Essential Biodiversity Variables or other integrating activities. Activities of working groups cut across multiple BONs, as they are developing applied and relevant methods, tools and activities that ultimately support the development of powerful, efficient and interoperable biodiversity observation networks. Working groups have one or multiple coordinators and organize their work around activities, most being dedicated to the development of EBVs, which may have their own leads. The outputs of those activities should, when appropriate, feed into the GEO BON Data Portal or into the BON in a Box platform. Activities and outputs of working groups may also include the identification of Research and Development gaps and needs, the establishment of Technical Readiness Levels to help track progress towards the development of EBVs, research papers, books, white papers, web apps, data collection and analysis (e.g. modelling) tools.

The working group on **Biodiversity Observation Networks Development (BON Development)** will be responsible, in part, for creating a direct link between the EBV working groups and the Biodiversity Observation Networks (e.g. integrated product development and delivery, webinars, etc.) to ensure an integrated approach to the top-down/bottom-up approach for the GEO BON implementation.

[1] Note that three new working group on the currently missing EBV classes will be created in 2017 and 2018.

Composition of the working groups: Any expert may participate in a working group, pending approval by the WG leads based on declaration of interest and submission of Curriculum Vitae. WG leads can be suggested by the MC, but ultimately are elected by the members of the WG and confirmed by the Implementation Committee.

2.4.2.Task forces

The new structure also considered that some specific tasks may not require a fully-fledged working group but do require strong coordination and interaction from the Secretariat. They will be co-led by members of the GEO BON network and by a least one member of the Secretariat. A few have already been identified and will be launched in 2017: **EBV development** (see section 3.1); **EBV Data** (see section 5.1); **Remote Sensing** (see section 5.2); **Policy support** (see section 5.3). A fifth Task Force on **Funding** should be set up in late 2017 or early 2018.

Composition: due to their nature, the task forces will be limited to fewer members than the working groups and BONs. Members will be invited by the leads of the task forces but can also be suggested by the Implementation Committee.

2.4.3.Biodiversity Observation Networks (BONs)

Biodiversity Observation Networks (BONs) that are formally connected to GEO BON can be national (e.g. Colombia), regional (e.g. the Circumpolar Biodiversity Monitoring Program) or thematic (e.g. Marine BON) in scope (Fig.5). The role of the Biodiversity Observations Networks is to develop, apply and test the concepts, methods and tools to implement and enhance operational networks; collecting observations and providing data to the community and users. In this capacity, they will both be recipients of the outputs of the EBV Working Groups (e.g. EBV monitoring frameworks and tools) but also contributors via the development and contribution of useful tools for EBV generation and application at national, regional and thematic scales.

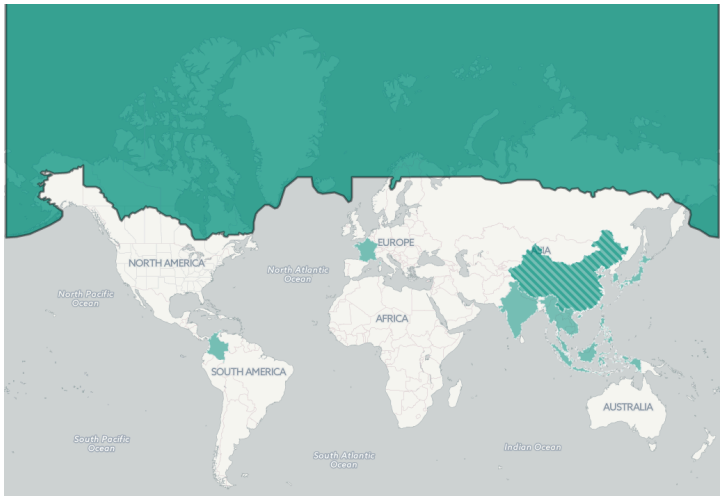


Figure 5. Map of the national (Colombia, France, China) and regional (Arctic, Asia-Pacific) Biodiversity Observation Networks

BONs can have one or multiple coordinators and their work is organized around design and implementation of a biodiversity observation network. The BONs are seen as key components to GEO BON as they will both produce, test and apply GEO BON tools and applications and produce EBV relevant data that can be upscaled and downscaled to underpin more informed sustainable

development and conservation decisions. The outputs of the BONs should, when appropriate, feed into the GEO BON Data Portal or into the BON in a Box platform. Activities and outputs of BONs may also include the identification of Research and Development gaps and needs, the establishment of Technical Readiness Levels to help track progress towards the development of EBVs (particularly within thematic/biome scales), research papers, books, white papers, web apps, data collection and analysis (e.g. modelling) tools.

Composition of the Biodiversity Observation Networks: Any expert may participate in a BON, pending approval by the BON lead(s) based on declaration of interest and submission of Curriculum Vitae. BON leads can be suggested by the MC, but ultimately are elected by the members of the BON and confirmed by the Implementation Committee.

2.4.4. Implementation Committee and Advisory Board

The governance of GEO BON also comprises of an Implementation Committee (IC) and an Advisory Board (AB).

The **Implementation Committee** (IC - Table 1) is the organ that implements the deliverables and implementation plan of GEO BON. It is also in charge of approving the annual budget, and nominating and electing the Chair(s) of GEO BON. The IC has an executive function, although much of the daily operation tasks are delegated to the Management Committee and to the Secretariat. The Implementation Committee meets by conference call quarterly and in person once a year. The Chair(s) of the Management Committee is (are) also the Chair(s) and Vice-Chair of the Implementation Committee.

Composition: Those actively engaged in implementing GEO BON including all members of the Management Committee, the Working Group Leads, the Task Forces leads, and National, Regional, and Thematic BONs coordinators. New members should be confirmed by the peers in the Implementation Committee. In addition, the coordinators of large scale projects in which GEO BON is actively involved (e.g. work package lead, partner organisation) are invited to the Implementation Committee as observers. Observers can participate in the meeting and make suggestion on the implementation of GEO BON. They are however not allowed to vote.

The (co-)Chair(s) and, when appropriate Vice-Chair, are elected by the Implementation Committee for 3 years terms, renewable once. In June 2017, Henrique M. Pereira and Michael Gill were elected as co-chairs of GEO BON for an additional 3-years term.

The **Advisory Board** (AB – Table 2) of GEO BON is composed by representatives of key partner organisations. The AB meets once a year to provide strategic direction and feedback on GEO BON and provides help in the search of funding.
Composition: Representatives of NGOs, governments, commercial companies, and experts, in a geographically balanced composition; influential individuals and with good ties to funding; 3 year terms, renewable once. It should be composed by around 15 individuals.

Table 1. Composition of the Implementation Committee of GEO BON as of July 2017

Name	Institution	Country	Capacity
Patricia Balvanera	National University of Mexico	Mexico	WG Ecosystem services
Tom Christensen	Aarhus University	Denmark	Arctic BON
Mark Costello	University of Auckland	New Zealand	Marine BON
Aurélie Delavaud	Foundation for Research on Biodiversity (FRB)	France	French BON
Simon Ferrier	CSIRO	Australia	EBV Development TF
Néstor Fernández	iDiv	Germany	GEO BON Secretariat / Data TF
Gary Geller	US National Aeronautics and Space Administration (NASA)	USA	GEO / NASA
Ilse Geijzendorffer	Tour du Valat	France	Ecosystem services WG
Mike Gill	Polar Knowledge Canada	Canada	Co-Chair/ BON development WG
Carlos Guerra	iDiv	Germany	GEO BON Secretariat
Matthew C. Hansen	University of Maryland	USA	Ecosystem structure WG
Walter Jetz	Yale University	USA	Species populations WG
Melodie McGeoch	Monash University	Australia	Species populations WG
Robert Guralnick	University of Florida	USA	Data TF
Frank Muller-Karger	University of South Florida	USA	Marine BON
Eun-Shik Kim	Kookmin University, Seoul	South Korea	AP BON
HyeJin Kim	iDiv	Germany	GEO BON Secretariat
Daniel Kissling	University of Amsterdam	The Netherlands	Coordinator GLOBIS-B Data TF
Maria Cecilia Londoño	Alexander von Humboldt Institute Colombia	Colombia	Colombia BON BON development WG
Corinne Martin	UNEP – WCMC	UK	Policy TF
Tuyeni Heita Mwampamba	National University of Mexico	Mexico	Ecosystem services WG
Laetitia Navarro	iDiv	Germany	GEO BON Secretariat Policy TF
Jeanne Nel	VU University Amsterdam /Nelson Mandela Metropolitan University	The Netherlands South Africa	Freshwater BON
Emily Nicholson	Deakin University	Australia	Ecosystem function WG
Henrique M. Pereira	iDiv	Germany	Co-Chair
Isabel Sousa Pinto	University of Porto	Portugal	Marine BON
Nathalie Pettorelli	Zoological Society of London (ZSL)	UK	Ecosystem function WG
Michael Schaepman	University of Zurich	Switzerland	Coordinator BioDiscovery & GlobDiversity
Ghada El Serafy	DELTARES	Netherlands	Coordinator ECOPOTENTIAL
Andrew Skidmore	University of Twente	The Netherlands	Ecosystem structure WG Remote Sensing TF
Jason Taylor	Bureau of Land Management	USA	Arctic BON
Eren Turak	Office of Environment & Heritage	Australia	Freshwater BON
Sheila Vergara	University of the Philippines Los Baños	Philippines	AP BON
Petteri Vihervaara	Finnish Environment Institute, Helsinki	Finland	BON development WG
Aaike De Wever	Royal Belgian Institute of Natural Sciences	Belgium	Freshwater BON
Haigen Xu	Nanjing Institute of Environmental Sciences	China	China BON
Tetsukazu Yahara	Kyushu University	Japan	AP BON

Table 2. Composition of the Advisory Board of GEO BON as of July 2017

Name	Institution	Country
Donald Hobern	Global Biodiversity Information Facility (GBIF)	Denmark
Robert Höft	Convention on Biological Diversity (CBD)	Canada
Anne Larigauderie	Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES)	Germany
Harold Mooney	Stanford University	USA
Marc Paganini	European Space Agency (ESA)	Italy
Anne-Hélène Prieur-Richard	Future Earth	Canada
Jon Paul Rodrigues	IUCN	Venezuela
Bob Scholes	Council for Scientific and Industrial Research (CSIR)	South Africa
Woody Turner	US National Aeronautics and Space Administration (NASA)	USA

2.4.5.GEO BON Secretariat

The Secretariat and Management Committee are the supporting body of this structure. The GEO BON **Secretariat** is hosted by the German Centre for Integrative Biodiversity Research (iDiv) – Halle, Jena, Leipzig since 2014 and at least until the fall of 2020. As of 2017, it is composed by:

1. The *Executive Secretary* who is tasked with, *inter alia*, engaging WG's and activity leads, overseeing product delivery; coordinating technical development (website, etc.), fundraising, representing GEO BON at key meetings.
2. The *GEO BON IT Officer* in charge of the coordination of the Web Page and IT infrastructure
3. The *Secretary* (part-time) who provides assistance with all administrative and management duties
4. The *GEO BON Scientists* working at the Secretariat to provide scientific outputs and support regarding subjects directly related to GEO BON.

Occasionally, *interns* and *Master students* might also join the secretariat and contribute to the development of the GEO BON activities, under the supervision of the Executive Secretary or the GEO BON Scientists.

The **Management Committee** of GEO BON is responsible for the daily GEO BON operations and meets at least bimonthly to discuss more technical and substantive issues regarding the implementation and coordination of the network. It is composed by:

5. All the members of the GEO BON Secretariat (see above)
6. The (co-)*Chair(s)* whose tasks are to provide overall leadership, coordination and oversight, and represent GEO BON at key meetings. The (co-)Chair(s) can also be attributed a particular set of tasks for coordination
7. The *GEO Science Officer*, who manages the link between GEO BON activities and the GEO secretariat

3. Developing Essential Biodiversity Variables

3.1. EBV conceptual framework and development

The main focus of GEO BON is the monitoring of ecological features related to biodiversity, ecosystems and ecosystem processes. In the course of its activities, identifying Essential Biodiversity Variables has become one of GEO BON's major tasks, structuring its working groups and its development strategy. Through time, this identification procedure assumed different forms (Figure 6) from a pure expert based approach, where Essential Biodiversity Variables based on expert knowledge about available information and the potential need for specific ecological features that also match current institutional and research capacity, to a user needs approach, where, from a previously identified list, Essential Biodiversity Variables are screened against their relation to current policy instruments (e.g. Aichi Targets) that are assumed to reflect user needs. Recently, a new approach is gaining some traction in order to invert the data availability paradox and at the same time stress the need for strategic monitoring at the ecosystem level. This system based approach developed within the ECOPOTENTIAL project (http://www.ecopotential-project.eu) focusses in the description of a given social-ecological system and on the data needs relevant to describe the system. This system approach goes beyond the identification of Essential Biodiversity Variables and tries to bring to the biodiversity monitoring communities the necessary links to other GEO initiatives (e.g. the identification and operationalization of Essential Climate Variables).

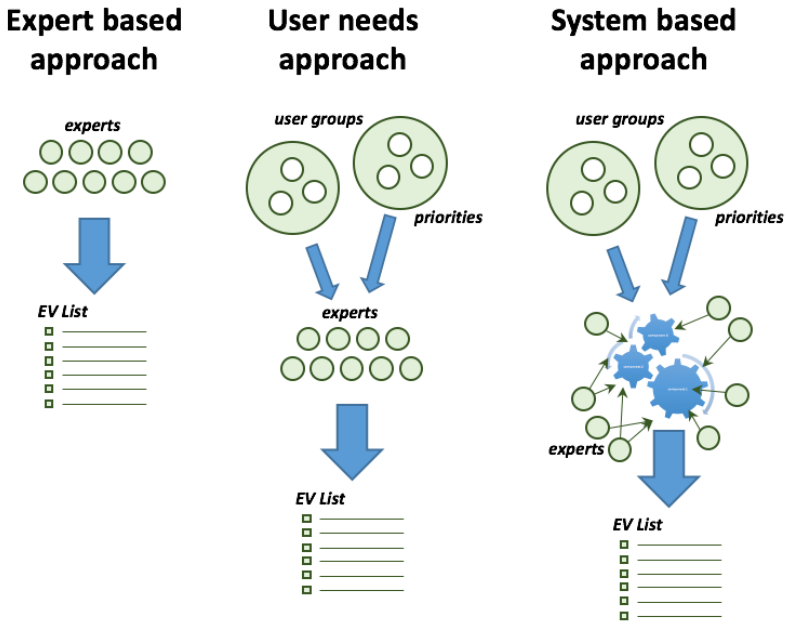


Figure 6. Schematic representation of different approaches to obtain Essential Biodiversity Variables

Within GEO BON, the **Task Force on Essential Biodiversity Variables Conceptual Framework and Development** will focus on bringing together these different but complementary approaches into a common framework that will allows the different biodiversity and ecosystem communities to coherently contribute to a common and prioritized Essential Biodiversity Variable list. This effort will allow GEO BON to identify current Essential Biodiversity Variables that are already ready to be delivered to end users but also to identify monitoring gaps that need to be fulfilled in the short term, and potential for collaboration within the network. Finally, it is imperative that Essential Biodiversity Variables development approaches be used and implemented across scales, from local to global.

Co-Leads: Carlos Guerra (iDiv/GEO BON), Henrique M. Pereira (iDiv/GEO BON), Simon Ferrier (CSIRO)
Membership*:* To be determined in the fall of 2017.

Key objectives:
1. Expand current conceptual approaches in order to obtain a relevant list of Essential Biodiversity Variables for specific ecosystems and/or regional strata. This activity will focus on bringing together the different communities that are developing Essential Biodiversity Variables lists across GEO BON with a particular focus on specific ecosystems (e.g. Savannas, Freshwater systems, etc.);
2. Together with the Species Populations Working Group, expand the system based approach to the monitoring of invasive species;
3. Finally, together with the Policy Task Force, identify key institutions that could become strategic partners to design and implement a global biodiversity monitoring backbone focussed on monitoring all relevant ecological features.

3.2. Species populations

The dynamics of species populations, i.e. the variation of species geographic distributions and abundances in space and time, represent one of the most fundamental aspects of biodiversity and its change. Decreases in the sizes of populations and contractions in the distribution of species result in the loss of potentially significant functions from communities and ecosystems, and in extreme cases may cause their global extinction. Conversely, expanding or shifting populations translate in the perturbation of existing or invasion of new communities, both with multifold consequences for ecosystems. Changes in the occurrence or abundance of species are thus key drivers of changes in ecosystem function and services. When related to information on patterns of environmental change, spatiotemporal data on species populations can inform about the putative causes of biodiversity and ecosystem change. In the context of resource management and conservation, species population data supports spatially explicit planning, risk and threat analysis, and the assessment of management outcomes.

Table 3. Definitions of the candidate EBVs within the Species Population EBV class, and links identified with specific Aichi targets, and Sustainable Development Goals

Species Populations EBVs	Definition, measurement & feasibility	Link with Aichi targets	Link with SDGs
Species Distributions	Presence surveys for groups of species easy to monitor, over an extensive network of sites with geographic representativeness.	4,5,6, 7,8,9, 10,11, 12,14,15	3,6, 14, 15
Population Abundance	Population counts for groups of species easy to monitor and/or important for ecosystem services, over an extensive network of sites with geographic representativeness.		

Two interrelated EBVs make up the Class of "Species Populations" EBVs (Table 3), the Species Distribution EBV (SD EBV) and the Population Abundance EBV (PA EBV). Species distribution data over time can inform on range shifts, on the connectivity of protected areas, on the vulnerability of a species to extinction, and the effectiveness of interventions to slow the rate of biological invasion. Species distribution data can also help prioritize conservation and monitoring efforts for species and habitats. More basic information on the geographic distribution of species with the potential to inform the Species Distribution EBVs are now available for hundreds of thousands of species worldwide. This data varies strongly in spatiotemporal detail due to vastly uneven sampling in raw

data, requiring the integration of multiple types of information for EBV capture. Available data and modelling procedures, together with ancillary data on environmental conditions from remote sensing, have been improving strongly, increasingly facilitating a capture of the SD EBV that approaches a coverage that may enable first near-global syntheses. Information on changes in the sizes and structure of local populations – the Population Abundance EBV (PA EBV) - offers unrivalled opportunities for demographic analyses and is key for the rigorous, mechanistic capture of individual population trends of species and their interactions with one another. Spatially explicit data on the abundances of single and multiple species are getting increasingly mobilized, with plant plots and avian census data as leading examples. These are beginning to offer inference and prediction opportunities beyond national scales and in some cases, have enabled near-continental extent trend assessments. However, limits to the spatial, taxonomic, and temporal coverage of available abundance data continue to impose constraints on the comparison and aggregate use of the Species Abundance EBV across many nations or taxa.

In 2015 and 2016, a GEO BON expert group has progressed a first conceptualization of the Species Distribution EBV and charted out next steps to advance its empirical capture and use. Over the same time period GEO BON supported the development of essential variables for invasion monitoring. This effort identified the availability of occurrence data for alien species as central to their successful management and highlighted the importance of advances in sharing and integration of such data. The Species Populations working will further develop those EBVs and identified a set of activities to that purpose (Table 4).

Table 4. Summary of the activities of the Species Populations Working Group

SPECIES POPULATIONS		EBVs		Development approach			
		Species Distributions	Population Abundances	Monitoring	Data Mobilization	Modelling	Applications
Advance, generalize, and implement the EBVs	SP1. Methods, Models, Scale, Uncertainty	■	■		■	■	
	SP2. Completing, visualizing, and communicating the SD EBVs	■			■	■	
	SP3. Example implementations and use cases	■			■	■	■
SD EBV strategic applications	SP4. Implementing essential variables for invasion monitoring	■	■		■	■	■
	SP5. Known-unknowns for alien and invasive species distributions	■			■	■	■
	SP6. Distribution and population changes in rare species	■	■		■	■	■
	SP7. Predicting plan abundances and their dynamics	■	■		■	■	
Engaging with countries and BONs	SP8. Incentives for sharing species occurrence data	■	■		■	■	

3.2.1.Composition of the Working Group and key objectives

Leads: Walter Jetz, Melodie McGeoch
Composition: 19 registered members, as of July 2017[2]
http://data.geobon.org/networks/pages/spepop.php

Key objectives:
1. Advance **concepts and methodology** for a generalizable capture of the distributions and abundances of species in space and time from regional to global scales
2. Advance the distribution and abundance data **integration** through the development of **standards, models, and infrastructure**.
3. Document key **data and knowledge gaps** and develop mechanisms to support the community in **mobilizing data** to help close them
4. Support the development of **example applications** of the species population EBV for policy and management across local to national and global scales

3.2.2. Advance, generalize and implement the Species Distribution (SD) EBV

Recent work by a GEOBON expert group has provided a first conceptualization of the species distribution EBV (Fig. 7) that was endorsed by the broader community in the 2016 GEO BON Open Science Conference. The SD EBV concept has at its heart the combination of different types of raw data - incidental point records, more comprehensive inventories, and expert-described distributions - which each offer species occurrence information that differs in spatiotemporal specificity, reliability of absences inference, and availability. The sparseness, biases, and heterogeneity in spatiotemporal extent and resolution require the use of models and covariates such as environmental data to inform species distributions in space and time. Given sufficient data, this enables the characterization of probabilistic species occurrences over contiguous spatiotemporal units over large extents. Conceived as a space-time cube addressing multiple species, this SD EBV is thus able to form the basis for the monitoring of status and trends for single spatial units, can support regional and global aggregations, and can be extended to estimate abundance.

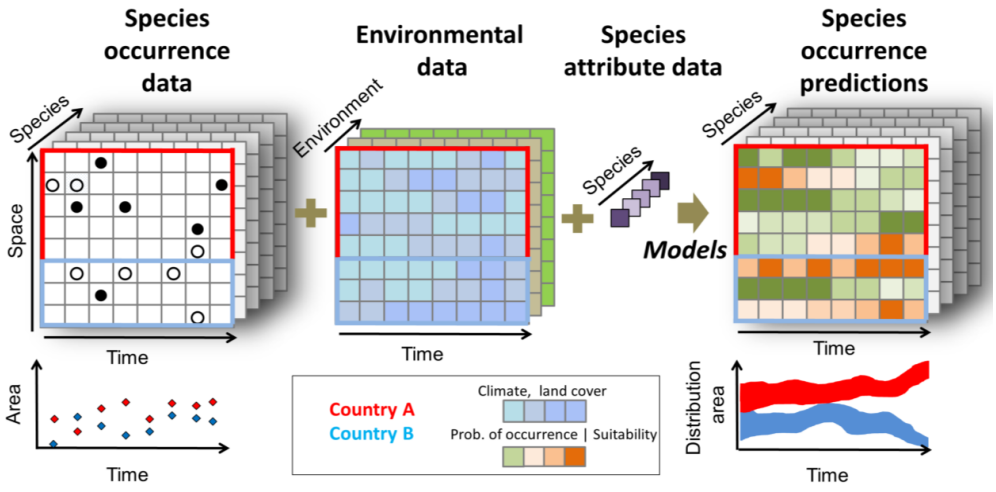


Figure 7. Developing the species distribution EBV with data and models (from WG MS in prep.)

[2] The network webpage is still being developed and not all active members have yet registered.

A core activity of the Species Populations working group will be to apply this concept in practice. This includes filling of the raw space-time-species cube with different data types, evaluating SD EBV sensitivity to data availability and methodological choices, advancing infrastructure implementing the SDV EBV, and testing its application for different taxa and regions. These efforts will provide core R & D for the strategic implementation activity (Section 3.2.3) and aim to establish the methods, guidelines, and infrastructure for the operationalized SD EBV.

SP1	**Methods, models, scales, uncertainty**			
Lead(s)	Bill Kunin, Cory Merow (tbc)			
Team	Antoine Guisan, Yoni Gavish, Petr Keil, Aidin Niamir, Carsten Meyer, Manuela D'Amen, Jorge Ahumada, Melodie McGeoch			
Development approach	Monitoring	**Data mobilization**	**Modelling**	Application
EBVs	**Species Distribution**		**Population Abundance**	
Description	A first project area will develop key explorations regarding methodological aspects of the SD EBV and the goal of modelling best-possible realized species distributions. This group will engage closely with the more empirically focused projects and use their and other datasets to address the following example questions: ● How does scale (spatial grain of sampling or reporting units) affect SD EBV capture and metrics? ● Which modelling approaches are ideal for a given combination of data types, for specific taxa, which are most generally suited overall? ● How can uncertainty be accounted for, propagated into SD EBV predictions? ● How can spatial and environmental data gaps, and their underlying socioeconomic drivers, be better accounted for in species distribution predictions? ● How can biotic information be included in predictions? ● How can available abundance help inform the SD EBV?			
Timeline	**2017**	**2018**	**2019**	2020
Milestones or Deliverables		Workshop	Workshop	
Resources	NASA AIST (informatics) grant awarded.			
Link with other activities	This activity will support the activities SP4. to SP7. ("SD EBV strategic applications").			

SP2	**Completing, visualizing, and communicating the SD EBV**			
Lead(s)	TBD			
Team	Carsten Meyer, Ingolf Kuhn, Walter Jetz, Simon Ferrier, Rob Guralnick, Melodie McGeoch, Tatsuya Amano			
Development approach	Monitoring	Data mobilization	**Modelling**	Application
EBVs	**Species Distribution**		Population Abundance	
Description	This project will advance populations EBV capture in practice, with particular focus on the SD EBV, and develop software and workflows to integrate and communicate these variables. Including taxon experts and data partners across terrestrial, freshwater and marine realms, this project will ● explore the availability of different data types for different regions and taxa, ● quantify and visualize data gaps, ● explore the aggregation of SD EBV to other compound change metrics (e.g. temporal changes in assemblage attributes such as species richness), ● advance infrastructure addressing global, integrated species distributions to demonstrate the development and communication of the SD EBV in practice, ● and develop effective visualizations for communicating SD EBV trends.			
Timeline	**2017**	**2018**	**2019**	2020
Milestones or Deliverables	MS: Conceptualizing the SD EBV Submission summer 2017	Workshop, Project: Conceptualizing the SP EBV.	Tools for BON in a Box inclusion	
Resources				
Link with other activities	Support from and/or collaboration with EBV Data Task Force, National, Regional and Thematic BONs.			

SP3	Example implementations and use cases			
Lead(s)	TBD			
Team	Eric Le Tortorec, Eugenie Regan, Chhaya Chaudhary, Mark Costello, Eren Turak, Sami Domisch, Dirk Schmeller, Haigen Xu, Walter Jetz			
Development approach	Monitoring	**Data mobilization**	**Modelling**	Application
EBVs	**Species Distribution**		Population Abundance	
Description	This project will develop example applications and uses cases of the SD and PA EBVs. While the efforts envisioned here will often address a specific question or hypotheses, the specific applications are not of the overarching nature as the strategic applications listed below (but some of them may well grow into that stature). The overarching goal of this project is to demonstrate the SD EBV for very specific cases (region-taxon combinations) that are driven by different questions or motivations and additionally vary in data availability, complexity, and realm. We have to date discussed the following examples or comparisons: ● Dedicated example implementations for freshwater, marine, and different terrestrial biomes ● A comparison of SD EBV results across freshwater, marine, and terrestrial for different taxa ● Migrants in all three realms as a particularly interesting test case ● Contrasting SD EBV outcomes for poorly and well-sampled taxa ● Comparing privately vs. publicly held datasets in their SD EBV contributions.			
Timeline	2017	**2018**	**2019**	2020
Milestones or Deliverables		Workshop, Prototype implementations	3-5 strong use cases completed; linked to BON in Box, national BONs	
Resources				
Link with other activities	Support from and/or collaboration with Thematic BONs.			

3.2.3. SD EBV Strategic Applications

The purpose of this strategic application of the Species Populations EBV is to 1) use alien species as a case to test and advance the conceptual and infrastructural developments underpinning the SD EBV (as in application SP3 above), and 2) to further the goals of the vision for global invasion monitoring[3] by promoting harmonized progress across the key stakeholders.

As pointed out in Latombe et al. (2016)[3], "Managing biological invasions relies on good global coverage of species distributions. Accurate information on alien species distributions, obtained from international policy and cross-border co-operation, is required to evaluate trans-boundary and trading partnership risks. However, a standardized approach for systematically monitoring alien species and tracking biological invasions is still lacking". The dynamics of species ranges, captured by occurrence data, lie at the heart of understanding and tracking biological invasions. As a result, alien and invasive species present a highly strategic subset of taxa with which to further develop and test the SP EBV (Fig. 8). This model will be used, inter alia, to demonstrate the value and power of good quality distribution data.

[3] Latombe, G., P. Pyšek, J. M. Jeschke, T. M. Blackburn, S. Bacher, C. Capinha, M. J. Costello, et al. 2016. "A vision for global monitoring of biological invasions". *Biological Conservation.* (1).

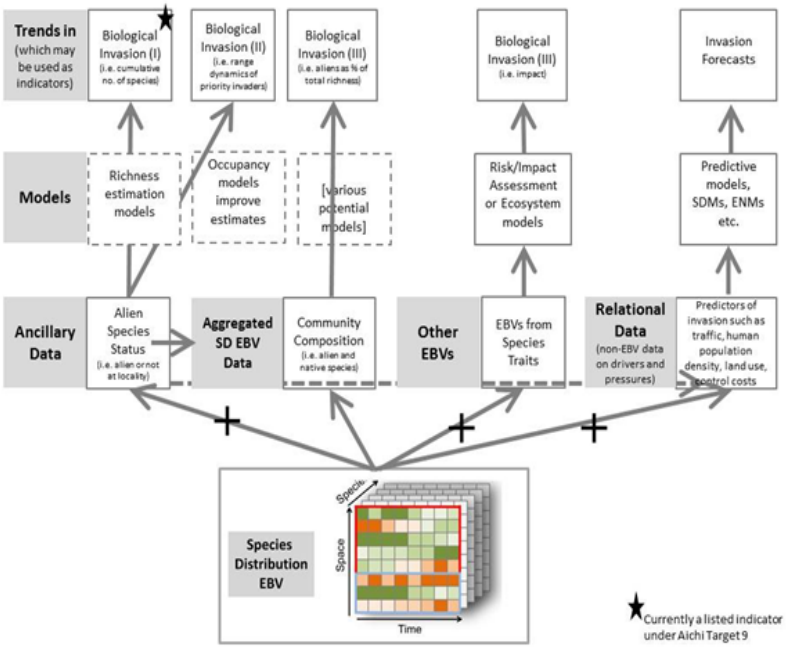


Figure 8. Implementing the species distribution EBV for application to biological invasions

SP4	Implementing essential variables for invasion monitoring			
Lead(s)	Melodie McGeoch, John Wilson, Greg Ruiz			
Team	Peter Bellingham, Quentin Groom, John Wilson, Diana Bowler, Livia Schaeffler, Daniel Kissling, Aidin Niamir, Marten Winter, Walter Jetz, Rob Guralnick, Eric Le Tortorec, Alex Hardisty, Kristen Williams, Donald Hobern, Rebecca Pirzl, Lee Belbin, Daniel Kissling, Miles Nicholls, Nick dos Remedios, Shyama Pagad, Piero Genovesi, Ingolf Kuhn, Maria Londono			
Development approach	Monitoring	Data mobilization	**Modelling**	Application
EBVs	**Species Distribution**		**Population Abundance**	
Description	This activity will include conceptual development, a focus on country BONs, workflows and infrastructure to support applications, and development of novel indicators for alien and invasive species. Its aims include ● Using an invasive species exemplar based on GBIF and ALA data to determine what is required from the process, workflow and associated informatics/ICTs (Hardisty et al.) ● Extend the outputs of implementing species population EBVs to structure observation systems that seek to inform conservation measures. ● Build on the work of Global Naturalised Alien Flora (GLoNAF) and the IUCN Invasive Species Specialist Group (Global Register of Introduced and Invasive Species) to develop the links between EBVs to deliver novel indicators of biological invasion for estimating and monitoring invasion-relevant trends. ● Use test case countries to demonstrate the application of the global vision of invasion monitoring using EVs. ● Advance information platforms to accommodate the multiple EBV and multiple information types required for invasion policy and management. ● Demonstration of the value and power of good quality spp distribution data.			
Timeline	**2017**	**2018**	**2019**	2020
Milestones or Deliverables	Workshop at CSIRO January 2017 BON Development Meeting in Stanford - March 2017	Workshop, Dashboard prototype implementation.	Workshop, Publication BON in a Box outputs	
Resources				
Link with other activities	Activity SP5. GLoBIS B Project (European Commission Funded, Project Horizon 2020, Project Task 3.3) Support from and/or collaboration with National, Regional and Thematic BONs.			

SP5	Known-unknowns for alien and invasive species distributions			
Lead(s)	Carsten Meyer, Gregory Ruiz			
Team	Aidin Niamir, Melodie McGeoch, Quentin Groom, GBIF DFFU_IAS Task Group, Mark Costello, Marten Winter, Franz Essl, Tiffany Knight			
Development approach	**Monitoring**	Data mobilization	**Modelling**	Application
EBVs	**Species Distribution**		Population Abundance	
Description	This project will conduct a gap analysis to quantify the adequacy of occurrence data for alien and invasive species, with the purpose of establishing priorities to improve data quality and outputs for end users. Further chapters of the PhD thesis supporting this activity (e.g related to alien distribution modelling) will depend on skills and interests of the student.			
Timeline	**2017**	**2018**	**2019**	**2020**
Milestones or Deliverables	Recruitment of the PhD student.			
Resources	PhD grant funded through iDiv Flexpool.	PhD grant funded through iDiv Flexpool.	PhD grant funded through iDiv Flexpool.	PhD grant funded through iDiv Flexpool.
Link with other activities	Activity SP4.			

SP6	Distribution and population changes in rare species			
Lead(s)	Walter Jetz, Hjalmar Kuhl (TBC)			
Team	Petr Keil, Jon Paul Rodriguez, Marta Jarzyna, Antoine Guisan, Mark Costello, Tatsuya Amano			
Development approach	Monitoring	Data mobilization	Modelling	Application
EBVs	**Species Distribution**		**Population Abundance**	
Description	A key innovation envisioned for the remote-sensing supported SD EBV predictions is the cross- and fine-scale capture of potential changes in species distributions over relatively short, e.g. annual time scales. This provides an important complement to expert-based evaluations of changes in species threat status that are temporally more coarsely resolved. In this strategic application, we will target a suite of species worldwide that are of particular conservation interest, e.g. due to their rarity, and that offer data that are sufficient, if likely heterogeneous in scale and quality, to demonstrate the use of SD EBV approaches (methods, infrastructure, reporting) for model-based monitoring of focal species. We will strategically focus on species or species groups that have already rich data and/or a community of experts that engages as partners. This will generally include selected species of rare vertebrates, invertebrates and plants, and specifically existing databases and efforts such as the APES (addressing primates globally) or similar expert groups. This project will for select taxa and species implement integrative and cross-scale modelling procedures to provide fine-grain predictions of spatial distributions, population sizes and their changes. These predictions are aimed at directly informing conservation and threat assessments.			
Timeline	**2017**	**2018**	**2019**	2020
Milestones or Deliverables		Workshop	Products	
Resources	Proposal submitted to the NASA A.50 funding call			
Link with other activities	Remote Sensing Task Force			

SP 7	Predicting plant abundances and their dynamics			
Lead(s)	Adam Wilson			
Team	Cory Merow, Jasper Slingsby, Walter Jetz, John Silander			
Development approach	Monitoring	**Data mobilization**	**Modelling**	Application
EBVs	**Species Distribution**		**Population Abundance**	
Description	One specific project, focused on South Africa, will use data from this region to develop remote-sensing informed abundance EBVs for hundreds of species in the charismatic Proteaceae plant family using the new generalized joint attribute modelling framework.			
Timeline	**2017**	**2018**	**2019**	2020
Milestones or Deliverables				
Resources	Proposal submitted to the NASA A.50 funding call			
Link with other activities				

3.2.4. Engaging with countries and BONs

The species populations EBVs and their manifold applications and uses critically rely on data, such as primary observations. The usefulness of this data for informing the EBVs in turn strongly depends on the nature of the sampling and associated documentation. Furthermore, all collection of primary data benefits tremendously from visible incentives and appropriate attribution and use. Close and effective two-way communication between potential data providers and the Species Populations EBV Working Group of GEO BON is thus key. For example, insights from SP EBVs methods and workflow developments and gap analysis tools will hold an array of important messages to primary data collection efforts about highest (and lowest) value data and help guide the development of their monitoring programs. In turn, prominent attribution of primary data providers in SP EBVs reporting will incentivise further contributions and benefit overall SP EBV development. Finally, data providers and other stakeholders may directly benefit from SP EBVs products which enrich their own data with other information and modelling.

The objective of this type of activities is to support this important communication and increase both contributions to as well as benefits from the Species Populations EBVs work. Planned projects include a study that lays out and demonstrates the many benefits, or 'business' case, for collecting and sharing spatial biodiversity data. The group will explore new avenues for incentivizing primary data contributions and highlight examples of how health, agriculture, and various industry can benefit from SP EBVs. The activity will also engage directly with selected country and the various BONS to advise on contribution to and use of the SP EBVs infrastructure and tools and facilitate their engagement in the Species Populations Working Group.

SP8	Incentives for sharing species occurrence data			
Lead(s)	Eugenie Regan, Donald Hobern (TBC)			
Team	Carsten Meyer Dirk Schmeller, Haigen Xu, Gary Geller, Hannu Saarenmaa, Rob Guralnick, Mark Costello			
Development approach	Monitoring	Data mobilization	**Modelling**	**Application**
EBVs	**Species Distribution**		**Population Abundance**	
Description	This project aims to explore and provide examples for the different benefits for data holders to share their data. The proposed plan is to write a paper on "Why share species occurrence data?".			
Timeline	**2017**	**2018**	2019	2020
Milestones or Deliverables		Scientific publication		
Resources				
Link with other activities	EBV Data Task Force			

3.2.5.Calendar of activities

Table 5. Timeline of the activities of the Species Populations WG

SPECIES POPULATIONS		Timeline							
		2017		2018		2019		2020	
Advance, generalize, and implement the Species Distribution (SD) EBV	SP1. Methods, Models, Scale, Uncertainty	■	■	■	■	■	■		
	SP2. Completing, visualizing, and communicating the SD EBVs	■	■	■	■	■	■		
	SP3. Example implementations and use cases			■	■	■	■		
SD EBV strategic applications	SP4. Implementing essential variables for invasion monitoring	■	■	■	■	■	■		
	SP5. Known-unknowns for alien and invasive species distributions		■	■	■	■	■	■	■
	SP6. Distribution and population changes in rare species	■	■	■	■	■	■		
	SP7. Predicting plan abundances and their dynamics	■	■	■	■	■	■		
Engaging with countries and BONs	SP8. Incentives for sharing species occurrence data	■	■	■	■				

3.3. Ecosystem Structure

The Ecosystem Structure EBV class encompasses the condition of the structural components of ecosystems that lead to, and maintain, biodiversity characteristics (Table 6). The Ecosystem Structure WG focuses on the monitoring of the relevant EBVs, and how they are changing in time.

Table 6. Definitions of the candidate EBVs within the Ecosystem Structure EBV class, and links identified with specific Aichi targets, and Sustainable Development Goals

Ecosystem Structure EBVs	Definition, measurement & feasibility	Link with Aichi targets	Link with SDGs
Habitat Structure	Remote sensing measurements of cover (or biomass) by heights (or depth) classes globally or regionally, to provide a 3-dimentional description of habitats. Habitat structure can be measured by e.g. structural traits such as height, crown cover and density, SLA & LAI; structural biochemical such as lignin, cellulose & protein; coral rugosity etc.	5,11, 14,15	2,6, 11, 14, 15
Ecosystem extent and fragmentation	Local (aerial photo and in situ monitoring) to global mapping (satellite observations) of natural/semi-natural forests, wetlands, free running rivers, coral reed live cover, benthos cover etc.		
Ecosystem composition by functional type	Functional types can be directly inferred from morphology (in situ) or from remote sensing.		
Land Cover	Categorical description of the land cover.		

Candidate Ecosystem Structure EBVs and their ties to the CBD Aichi Targets and the SDGs are listed in Table 6. The list contains EBVs that are continuous and biophysical such as vegetation height, leaf area index and specific leaf area, as well as others that are categorical, such as land cover. With this list as a starting point, the next steps in the process can begin to put a plan in place for acquiring the needed observations and generating the related EBVs.

3.3.1. Composition of the working Group and key objectives

Leads: Andrew Skidmore and Matt Hansen.
Composition: All members of the WG3 which operated from 2008-2016, and others expressing interest at the GEOBON All-Hands meeting in Leipzig, are invited to participate in the reformed WG focused on Ecosystem Structure.
64 members were registered in July 2017: http://data.geobon.org/networks/pages/ecostr.php

Key objectives:
1. Identify and agree on a set of EBVs that characterize the structure of ecosystems, its relationship to biodiversity, and that facilitate monitoring change. Develop an explicit definition for each EBV, including any sub-variables.
2. Identify the *in situ* and remotely sensed observations needed to generate these EBVs, and facilitate the acquisition of and access to these observations.
3. Facilitate mechanisms to generate the identified EBVs and sub-variables and make them accessible.
4. Work with the various BONs to provide guidance on the observation systems and facilitate the acquisition of *in situ* data pertinent to ecosystem structure.
5. Relate the Ecosystem Structure EBVs to policy relevant outputs, particularly indicators for the CBD targets and SDGs.

The different activities of the Ecosystem Structure Working Group are summarized in Table 7.

Table 7. Summary of the Activities of the Ecosystem Structure Working Group

ECOSYSTEM STRUCTURE	EBVs				Development approach			
	Habitat structure	Ecosystem extent and fragmentation	Ecosystem composition by functional type	Land Cover	Monitoring	Data Mobilization	Modelling	Applications
EST1. Remote sensing for Ecosystem Structure EBVs	■				■	■	■	
EST2. Global monthly vegetation cover		■			■	■	■	■
EST3. LandScen		■		■		■		
EST4. SilviNat		■		■	■		■	

3.3.2. Activities

The activities of this new working group are derived from those of the former WG3 but with a specific focus on characterizing and monitoring Ecosystem Structure. In addition to identifying and defining the relevant EBVs the WG develops new techniques and algorithms for earth observation from space in characterizing ecosystem structure and its change over time. Because of the relationship between ecosystem structure and function and the important role that remote sensing plays in characterizing these attributes, this WG will closely coordinate its activities with those of the Ecosystem Function WG.

EST1	Remote sensing for EBVs			
Lead(s)	Andrew Skidmore and Brian O'Connor			
Team				
Development approach	Monitoring	**Data mobilization**	Modelling	Application
EBVs	Habitat Structure	Ecosystem Extent and fragmentation	Ecosystem composition by functional type	Land cover
Description	The Remote Sensing for Essential Biodiversity Variables (RS4EBV) project is funded by the European Space Agency (ESA) under Innovators III and aims to establish a monitoring and modelling framework around the use of Sentinel-2 imagery for the retrieval of Essential Biodiversity Variables (EBVs). Direct RS derives EBVs such as Leaf Area Index (LAI), leaf chlorophyll and vegetation phenology, as well as a higher-level indirect EBV, namely Functional Diversity (FD) (the range and relative abundance of traits within a plant community) will be retrieved.			
Timeline	**2017**	2018	2019	2020
Milestones or Deliverables	**1.**Final delivery (2nd Q) **2.**Scientific article (3rd Quarter)			
Resources	ESA funded RS-EBV Innovators project.			
Link with other activities	This activity will be supported by the Remote Sensing TF.			

EST2	Global monthly vegetation cover (percentage of cover)			
Lead(s)	Emiliana Valentini and Carlos Guerra			
Team				
Development approach	Monitoring	Data mobilization	Modelling	Application
EBVs	Habitat Structure	Ecosystem Extent and fragmentation	Ecosystem composition by functional type	Land cover
Description	We propose to create and validate a global layer of vegetation cover (as percentage of cover) based on MODIS images with monthly variation that can be used as a critical support for several indicators related to hydrologically based environmental modelling.			
Timeline	**2017**	2018	2019	2020
Milestones or Deliverables	- Jan-Jun 2017: Validation activities - Aug-Nov 2017: Testing and assimilation - Dec 2017: publication of the dataset.			
Resources				
Link with other activities	The output of this activity will feed into the EBV Data TF			

EST3	LandScen: Land Use and Land Cover change scenarios portal			
Lead(s)	Isabel Rosa			
Team				
Development approach	Monitoring	Data mobilization	Modelling	Application
EBVs	Habitat Structure	Ecosystem Extent and fragmentation	Ecosystem composition by functional type	Land cover
Description	Existing scenarios of land use and land cover change (LULCC) are sparsely distributed amongst the literature with no central platform that facilitates the access to this information. In this activity, a database of existing scenarios of LULCC across the globe will be created. Several characteristics of these scenarios will be recorded, such as: spatial and temporal resolutions, extent, location, model used, and contact information. Such database of metadata, and whenever possible the data itself, will be the basis of a web portal, to facilitate the access to existing LULCC by policy and decision makers, thus contributing to a more comprehensive view and a greater utility of these scenarios in supporting policy- and decision-makers.			
Timeline	**2017**	**2018**	2019	2020
Milestones or Deliverables	- 1st Q 2017: Initial set-up - mid-/end- 2017: Mid-term review	- 1st Q 2018: Final delivery		
Resources	Marie Sklodowska-Curie grant agreement No 703862 for the LCCMcons project	Marie Sklodowska-Curie grant agreement No 703862 for the LCCMcons project		
Link with other activities				

EST4	SilviNat: an automated tool for monitoring natural forest and forest plantations' dynamics			
Lead(s)	Isabel M.D. Rosa and João M.B. Carreiras			
Team				
Development approach	Monitoring	Data mobilization	Modelling	Application
EBVs	Habitat Structure	Ecosystem Extent and fragmentation	Ecosystem composition by functional type	Land cover
Description	Being able to monitor the dynamics of forest plantations (**Silvi**culture), primary forests and natural regeneration (**Nat**ural forests) is essential to have a clear picture on the overall forest cover change, and how it impacts the provision of ecosystem services such as timber production and carbon sequestration, among others. At the global scale, it is very challenging to distinguish natural forests from plantations (see Hansen et al. 2013), due to the great diversity of species used in silviculture which often mix their spectral signal with that of native forests. At the local to regional scales, however, it is possible to develop tools that are able to i) individualize the spectral signature of the most important tree species used in plantations and ii) evaluate over time the dynamics of forest loss and gain within natural forests (primary and regeneration) and plantations. Such comprehensive monitoring would allow decision-makers to assess not only the impact of changes in commodity prices (e.g. timber value), but also the success of implemented conservation actions (e.g. promote forest regeneration), and to tackle illegal deforestation activities, thus having a comprehensive picture on the dynamics of forest cover change. In this activity, a fully-automated tool will be developed to track forest dynamics in the Atlantic Forest of Brazil.			
Timeline	**2017**	**2018**	2019	2020
Milestones or Deliverables	- 1st Q 2017: Initial set-up mid-/end- 2017: Mid-term review	- 1st Q 2018: Final delivery		
Resources	Marie Sklodowska-Curie grant agreement No 703862 for the LCCMcons project	Marie Sklodowska-Curie grant agreement No 703862 for the LCCMcons project		
Link with other activities	The output of this activity will feed into the EBV Data TF			

3.3.3.Calendar of activities

Table 8. Timeline of the activities of the Ecosystem Structure Working Group

ECOSYSTEM STRUCTURE	Timeline							
	2017		2018		2019		2020	
EST1. Remote sensing for Ecosystem Structure EBVs								
EST2. Global monthly vegetation cover								
EST3. LandScen								
EST4. SilviNat								

3.4. Ecosystem function

Ecosystem functioning reflects the collective life activities of plants, animals, and microbes and the effects these activities (e.g., feeding, growing, moving, excreting waste) have on the physical and chemical conditions of their environment. Ecosystem functions (sometimes also referred to as ecosystem processes or ecological processes) are an integral part of biodiversity, and can thus be broadly defined as the biological, geochemical and physical processes that take place or occur within an ecosystem. Candidate EBVs within the Ecosystem Function class are described in Table 9. Note that one of the first activity of this WG being to revisit the candidate EBVs, this list is likely to be edited.

Table 9. Definitions of the candidate EBVs within the Ecosystem Function EBV class, and links identified with specific Aichi targets, and Sustainable Development Goals

Ecosystem Function EBVs	Definition, measurement & feasibility	Link with Aichi targets	Link with SDGs
Net Primary Productivity	Global mapping with modelling from remote sensing observations (FAPAR, ocean greenness) and selected in situ locations (eddy covariance).	5,8,14	2,6, 14,15
Secondary Productivity	Measurement of secondary productivity for selected functional groups, combining in situ, remote sensing, and models. Example functional groups include: fisheries, livestock, krill, and herbivorous birds.	6,7,14	
Nutrient Retention	Ratio of nutrient output from the system to nutrient input, measured at selected in situ locations. Can be combined with models and remote sensing to extrapolate regionally.	5,8,14	
Disturbance Regime	Type, seasonal timing, intensity and frequency of event-based external disruptions to ecosystem processes and structure. Examples: sea surface temperature and salinity (RS), scatterometry for winds (RS), trawling pressure (in situ), flood regimes (in situ), fire frequency (in situ, RS), cultivation/ harvest (RS), windthrow and pests (in situ).	5,7,9, 10,11, 14,15	

If we are to improve global biodiversity monitoring framework through the consideration of the different dimensions of biodiversity, we do need to advance, among other things, our understanding of ecosystem ecology. Furthermore, if we are to report on changes in ecosystem functions as part of a worldwide assessment of changes in biodiversity and ultimately improve our ability to predict future changes in biological diversity while doing so, we need to (1) be clear on what ecosystem functions are, and how best to monitor them; (2) understand the biotic and abiotic factors determining ecosystem functions, and assess the (local) sensitivity of each function to these factors; (3) quantify spatio-temporal uncertainties in our assessments and linkages; and (4) insure that the collected observations can adequately inform current prioritization schemes and global indicator initiatives.

3.4.1. Composition of the Working Group and key objectives

Leads: Nathalie Pettorelli and Emily Nicholson
Composition: 67 registered members as of July 2017.
http://data.geobon.org/networks/pages/ecofun.php

The different activities of the Ecosystem Function Working Group are summarized in Table 10.

Table 10. Summary of the Activities of the Ecosystem Function Working Group

ECOSYSTEM FUNCTION	EBVs				Development approach			
	Net Primary Productivity	Secondary Productivity	Nutrient Retention	Disturbance Regime	Monitoring	Data Mobilization	Modelling	Applications
EF1. Define ecosystem function and review monitoring options for each known function	■	■	■	■	■			
EF2. Identifying Ecosystem Function Essential Biodiversity Variables	■	■	■	■	■			
EF3. Improve our understanding of the links between biodiversity, functional traits, and ecosystem functioning	■	■	■	■	■			
EF4. Operationalizing EF EBV production: disturbance regime				■	■		■	
EF5. Characterize ecosystem function response to extreme climatic events	■	■	■	■				■
EF6. Complementary metrics for tracking change in regional ecosystem function related to fire				■	■	■		
EF7. Identification and reduction of uncertainties in the estimation of future ecosystem functions	■	■	■	■			■	■
EF8. The impact of phenological shifts on ecosystem functioning	■	■	■	■			■	
EF9. Conceptual models to link ecosystem function and remotely sensed data							■	■

Key objectives:

- Identify research opportunities supporting the identification/implementation of essential biodiversity variables relevant to the monitoring of ecosystem functions
- Derive/identify potential datasets supporting the implementation of essential biodiversity variables relevant to the monitoring of ecosystem functions
- Articulate and strengthen the links existing between essential biodiversity variables relevant to the monitoring of ecosystem functions and global indicators
- Provide guidance to national biodiversity networks in terms of in situ monitoring of essential biodiversity variables relevant to the monitoring of ecosystem functions

3.4.2. Activities

EF1	Define ecosystem function and review monitoring options for each known function			
Lead(s)	Nathalie Pettorelli			
Team				
Development approach	Monitoring	Data mobilization	Modelling	Application
EBVs	Net primary productivity	Secondary Productivity	Nutrient Retention	Disturbance Regime
Description	If we want to identify EBVs that can be relevant to ecosystem function monitoring, we need a clear definition of what ecosystem functions are, and how these are currently being monitored. This first activity will result in a scientific publication and the lead to the proposal of a revised set of candidate EBVs for the Ecosystem Function class.			
Timeline	2017	2018	2019	2020
Milestones or Deliverables	- Review of available information - Article submission - EF EBVs monitoring guidelines published			
Resources				
Link with other activities	The outcome of this activity will be relevant to all activities of the Ecosystem Function WG. Collaboration with and/or support from EBV Framework Task Force			

EF2	Identifying Ecosystem Function Essential Biodiversity Variables			
Lead(s)	Ilse geijzendorffer, Néstor Fernández, Nathalie Pettorelli			
Team				
Development approach	Monitoring	Data mobilization	Modelling	Application
EBVs	Net primary productivity	Secondary Productivity	Nutrient Retention	Disturbance Regime
Description	Revising the list of EBVs and identifying possible new EBVs for the Ecosystem Function class, based on recent progress in defining ecosystem functions and agreeing on a typology.			
Timeline	2017	**2018**	2019	2020
Milestones or Deliverables	Members of the working group agree on a revised list of EV EBVs	Article submission		
Resources				
Link with other activities	Activities EF1 and EF3 Collaboration with and/or support from EBV Framework Task Force			

EF3	Improve our understanding of the links between biodiversity, functional traits, and ecosystem functioning			
Lead(s)	Simon Brandl, Jon Lefcheck			
Team				
Development approach	**Monitoring**	**Data mobilization**	**Modelling**	**Application**
EBVs	**Net primary productivity**	**Secondary Productivity**	**Nutrient Retention**	**Disturbance Regime**
Description	Species-based information could be highly relevant to ecosystem function monitoring, but for now little is being understood as to how species richness functional traits and ecosystem functions correlate. To that extent, a literature review and data re-analysis on the link between species information and functions will be conducted, with a focus in animal communities. A parallel analysis will investigate the sensitivity of inferences based on methodological and trait choices.			
Timeline	2017	2018	2019	2020
Milestones or Deliverables	- Identification of potential project partners - Literature review - Paper submitted			
Resources				
Link with other activities	This activity (and/or its outcome) will be linked with the work of the Species Traits WG, once created.			

EF4	Operationalizing Ecosystem Function EBV production: Disturbance Regime			
Lead(s)	Dr. Pedro Leitao (HU Berlin, Germany), Dr. Néstor Fernández (iDiv, Germany)			
Team	Patrick Hostert, Domingo Alcaraz-Segura, Jean-Baptiste Feret, Maria João Santos, Jaime Garcia Márquez, Kate He, João Honrado, PD Dr. Angela Lausch, Miguel Mahecha, Catalina Munteanu, Markus Reichstein, Duccio Rocchini, Michael E. Schaepman, Andrew Skidmore			
Development approach	**Monitoring**	**Data mobilization**	**Modelling**	**Application**
EBVs	**Net primary productivity**	**Secondary Productivity**	**Nutrient Retention**	**Disturbance Regime**
Description	Disturbances are a major driver of ecosystem dynamics influencing many structural and functional ecosystem properties such as vegetation and soil structure, species composition, water and CO2 fluxes, etc. Disturbance regimes are being widely modified by anthropogenic activities, affecting the exposure of ecosystems to fires, floods, extreme weather events, etc., as well as their capacity to buffer these events. The operationalization of the Disturbance Regime EBV needs to resolve many different conceptual and methodological challenges, involving, for example, contrasting views on whether disturbances should be monitored focusing on the external drivers (fire, floods, etc) or on ecosystem responses. In addition, several remote sensing products can be used for monitoring both drivers and responses, but the transition from these readily available datasets to a derived EBV needs to be operationalized. This activity aims to explore opportunities for current and future satellite remote sensing data to inform on disturbances and on their effects of ecosystems. It includes a systematic review of the concepts; examination of the availability of data for monitoring disturbances; testing and applying EBV production workflows; and finally, the production of a review paper on the opportunities and challenges for the global monitoring of disturbance regimes.			
Timeline	2017	2018	2019	2020
Milestones or Deliverables	- KOSMOS Workshop (30-31.03) - Design of the EBV production workflow	- Design and testing of the EBV production workflow - First draft of publication		
Resources	Funding through the KOSMOS Programme (Humboldt-Universität zu Berlin).			
Link with other activities	Activity EF2 and EF5. Collaboration with and/or support from EBV Data Task Force			

EF5	Characterize ecosystem Function response to extreme climatic events			
Lead(s)	Franziska Schrodt and Shovonlal Roy			
Team				
Development approach	**Monitoring**	**Data mobilization**	**Modelling**	**Application**
EBVs	**Net primary productivity**	**Secondary Productivity**	**Nutrient Retention**	**Disturbance Regime**
Description	Higher frequency and length of extreme events expected in the near future can severely alter ecosystem structure and function, but so far, we lack suitable approached to quantify likely changes in a comprehensive manner. Multiple ecological factors and environmental stressors influence ecosystem function across the land and oceanic ecosystems. While the individual effects of these factors are often studied, little is known about their combined effects on ecosystem function. Identifying and understanding the controlling factors and stressors for ecosystem function would be a precursor to understanding and predicting how the interlinks would respond in a gradually changing environment and extreme events. Moreover, understanding these across the land and aquatic ecosystems would be very useful, and one can think of investigating a common framework to study these changes			
Timeline	**2017**	**2018**	2019	2020
Milestones or Deliverables	- identification of potential project partners - Data acquisition - Organisation of a special session at the BES general meeting (Dec). - Preparation of a perspective paper	- Submission of the perspective paper.		
Resources				
Link with other activities				

EF6	Complementary metrics for tracking change in regional ecosystem function related to fire			
Lead(s)	Ayesha Tulloch			
Team				
Development approach	**Monitoring**	**Data mobilization**	**Modelling**	**Application**
EBVs	**Net primary productivity**	**Secondary Productivity**	**Nutrient Retention**	**Disturbance Regime**
Description	Fire is a major driver of ecosystem disturbance and can both improve and reduce function depending on how far the current regime diverges from historical conditions. Different components related to fire history include area burnt, fire patchiness, intensity and frequency. Variation in these components lead to different outcomes for ecosystem function. We need a set of multiple complementary ecosystem condition metrics to effectively monitor change over time. This project will test existing and new metrics across a range of ecosystems with different levels of disturbance. Note that while the activity will first consider the fire disturbance, it will then be expanded to other types of disturbances.			
Timeline	**2017**	**2018**	2019	2020
Milestones or Deliverables	- identification of potential project partners and case study systems	- analysis of datasets and metrics - Preparation of a scientific publication		
Resources				
Link with other activities	Activity EF4.			

EF7	Identification and reduction of uncertainties in the estimation of future ecosystem functions			
Lead(s)	Ghada El Serafy, Antonello Provenzale			
Team				
Development approach	**Monitoring**	**Data mobilization**	**Modelling**	**Application**
EBVs	**Net primary productivity**	**Secondary Productivity**	**Nutrient Retention**	**Disturbance Regime**
Description	Identifying, quantifying and reducing uncertainty is a crucial issue in any prediction system or modelling application. The ramifications of uncertainty yield significant impacts on meteorological forecast ensembles, ecosystem response estimates, and reach as far as future social-economic scenarios. Uncertainty is relevant to the concept of environmental status reporting; it is an inherent property of system observation and furthermore, has far reaching implications when considering a system's future status. Along these lines, acknowledgement and the subsequent management of uncertainty can significantly influence the optimal decision pathway of managerial officials.			
Timeline	2017	2018	2019	2020
Milestones or Deliverables	- identification of potential project partner - Workshop			
Resources	ECOPOTENTIAL			
Link with other activities	ECOPOTENTIAL (http://www.ecopotential-project.eu)			

EF8	The impacts of phenological shifts on ecosystem functioning			
Lead(s)	Kate S. He, Jeffery Masek			
Team	Ben Somers			
Development approach	**Monitoring**	**Data mobilization**	**Modelling**	**Application**
EBVs	**Net primary productivity**	**Secondary Productivity**	**Nutrient Retention**	**Disturbance Regime**
Description	Climate–induced phenological shifts have been observed in multiple ecosystems over the past decades. However, the impacts of phenological shifts on ecosystem structure and function have not been well studied. The aim of this project is to using long-term satellite time series (reflectance and temperature) which record inter- and intra-annual changes indicative of such shifts in habitats to determine consequential changes in ecosystem functioning.			
Timeline	**2017**	**2018**	2019	2020
Milestones or Deliverables	- identification of potential project partner - Workshop - Preparation of a manuscript			
Resources				
Link with other activities	Link with the Ecosystem Structure Working Group and Remote Sensing Task Force.			

EF9	Conceptual models to link ecosystem function and remotely sensed data			
Lead(s)	Emily Nicholson			
Team				
Development approach	**Monitoring**	**Data mobilization**	**Modelling**	**Application**
EBVs	**Net primary productivity**	**Secondary Productivity**	**Nutrient Retention**	**Disturbance Regime**
Description	Conceptual models of ecosystem dynamics support ecosystem risk assessment (including the IUCN Red List of Ecosystems), the identification of key variables and indicators for measuring change, and diagnosing threats to ecosystem persistence and management strategies for ecosystem functioning. A range of conceptual models have been proposed for different ecosystem types around the world, but tend to be inconsistent in their purpose and formulation. In this project, we seek to develop a library of conceptual models for broad ecosystem types, which can be adapted for specific ecosystems or situations, to support risk assessment and threat diagnosis. In particular, we seek to link key ecological processes with indicators for measuring change in these processes, with a focus on identifying remotely sensed data that can contribute to measuring change in ecosystem function. The results will facilitate the use of remotely sensed data in ecosystem risk assessment and management around the world, at global, national and local scales.			
Timeline	**2017**	2018	2019	2020
Milestones or Deliverables	Workshop for grant-writing and conceptual framing			
Resources				
Link with other activities	Link with the Ecosystem Structure Working Group and Remote Sensing Task Force.			

3.4.3.Calendar of Activities

Table 11. Timeline of the activities of the Ecosystem Function Working Group

ECOSYSTEM FUNCTION	Timeline							
	2017		2018		2019		2020	
EF1. Define ecosystem function and review monitoring options for each known function	■	■						
EF2. Identifying Ecosystem Function Essential Biodiversity Variables	■	■	■	■				
EF3. Improve our understanding of the links between biodiversity, functional traits, and ecosystem functioning	■	■						
EF4. Operationalizing EF EBV production: disturbance regime	■	■	■	■				
EF5. Characterize ecosystem function response to extreme climatic events	■	■						
EF6. Complementary metrics for tracking change in regional ecosystem function related to fire	■	■	■	■				
EF7. Identification and reduction of uncertainties in the estimation of future ecosystem functions	■							
EF8. The impact of phenological shifts on ecosystem functioning	■	■	■	■				
EF9. Conceptual models to link ecosystem function and remotely sensed data		■						

3.5. Ecosystem Services

In the past 20 years, work on ecosystem services has focused primarily on recognizing the multiple types of services that exist, in trying to quantify their temporal and spatial variations, and recognizing the numerous trade-offs that emerge when considering more than one service. More recently, however, in addition to these perspectives we are acknowledging that ecosystem services are often the result of complex and intertwined co-production between natural and human systems which shift - not only across space and time - but also across social dimensions such as demography, culture, and institutions. Understanding these additional components of socio-ecological systems as they relate to ecosystems services will be fundamental for developing appropriate policy and practices that can ensure their sustainable use and long-term supply.

3.5.1 Working Group and key objectives

Leads: Ilse Geijzendorffer, Tuyeni Heita Mwampamba, and Patricia Balvanera
Members: 60 members registered as of July 2017.
http://data.geobon.org/networks/pages/ecoserv.php

The challenge that the Ecosystem Services WG faces is going beyond quantification of the natural system that forms the basis for ecosystem service provision, to incorporation of multiple trade-offs, multiple scales and a wide range of social dimensions. This requires a broad interdisciplinary team from science and humanities fields that can jointly identify and explore the most crucial components of the systems that need to be observed.

The primary audiences of the WG are national, regional and global decision makers, who, through their policies, can influence institutional structures, management practices and human behaviours that eventually affect the status of ecosystems and components of human well-being to which they are linked. Specifically, the WG aims to work closely with governments and NGOs, for instance in the European Union, or within the context of the Intergovernmental Platform for Biodiversity and Ecosystem Services (IPBES), UN SDGs, UNFCCC, Ecosystem Services Partnership, and the Convention of Biological Diversity. Given the strong science basis of its work, the WG also aims to influence and inform the academic and scientific community addressing similar issues.

Key objectives:
1. To foster the development of a scalable observation system of ecosystem services that can operate from sub-national to global levels, that takes into account the socio-ecological systems in which ecosystem services are generated and appropriated
2. To identify the essential ecosystem service variables for effective observation of ecosystem services status and trends, including their supply, use, value and contributions to well-being
3. To conduct and facilitate trend assessments and monitoring of ecosystem services at different spatial scales, including the exploration trade-offs between ecosystem services and across temporal and spatial scales
4. To work closely with national, regional and global decision makers to identify priority exploration, synthesis, and outputs that the WG can deliver
5. To inform on progress towards Sustainable Development Targets, and other global and regional environmental policy targets taking into account essential ecosystem service variables
6. To contribute to important policy-science processes such as IPBES and to the appropriate conventions

The work plan for the next implementation period consists of three major components (Table 12). For each of those components, one priority product that is the result of long-term interactions

among the members of the WG was identified. Other products that result from opportunities of collaboration between WG members and other ongoing initiatives and teams were also identified.

Table 12. Summary of the activities of the Ecosystem Services working group

ECOSYSTEM SERVICES		Development approach				
		Concepts	Monitoring	Data Mobilization	Modelling	Applications and tools
Concepts and guidance on Ecosystem Services	ES1.1. Essential Ecosystem Services variables	■	■			
	ES1.2. Dialogue with Policy bodies					■
	ES1.3. Global framework on Ecosystem Services	■				
	ES1.4. Ecosystem Services in Global Sustainability Policies					■
SD EBV strategic applications	ES2.1. Ecosystem Services and remote sensing		■	■	■	■
	ES2.2. Metadata and data standards for RS		■	■		
	ES2.3. Cultural Ecosystem Services	■	■			
	ES2.4. Social ecological indicators for IPBES					■
	ES2.5. Relational values	■	■			
	ES2.6. Multi-scale assessments of ES			■	■	■
	ES2.7. Trade-offs among ecosystem services	■	■			■
	ES2.8. Social ecological dynamics and ES	■				■
Ecosystem Services in Practice						■

3.5.2 Concepts and guidance on Ecosystem Services

This includes the development/proposal of a set of Essential Ecosystem Services Variables (EESV) unified by a shared conceptual framework, agreed-upon definitions and example indicators (priority), undertake a dialogue with national, regional, global decision-makers to identify user needs and to offer guidance, and finally, the development of a network of ecosystem services networks organized into a Global Framework for Ecosystem Services, that can maximize collaboration and complementarity between ongoing observations and analyses on ecosystem services towards contributing to address decision-making for linking between and across ES operational programs.

ES1.1	Essential Ecosystem Services Variables				
Lead(s)	Patty Balvanera and Ilse Geijzendorffer				
Team	Tuyeni Mwampamba, Berta Martin-Lopez, Mike Gill , Anna Cord, Matthias Schröter, HyeJin Kim, Carlos Zambrana-Torrelio, Danny Karp, Domingo Alcaraz-Segura, Carlos Guerra, Vânia Proença, Guy Ziv, Alessandro Gimona Nicolas, Artur Gil, Bruno Locatelli, María Vallejos, Antonio J. Castro, Valia Drakou, Kate Brauman, Elena Bennett, Cornelia Krug, Cristina Domingo.				
Development approach	**Concepts**	**Monitoring**	Data Mobilization	Modelling	Application and tools
Description	This activity aims at developing a conceptual paper of a first draft of Essential Ecosystem Services Variables similar to the initial proposition of the EBVs as a starting point for improvements and harmonization efforts across national and international assessments.				
Timeline	**2017**	**2018**	2019	2020	
Milestones and/or Deliverables	Discuss and finalise framework; Submission of the manuscript	Publication of a scientific article			
Resources					
Link with other activities	ES2.7. Trade-offs among ecosystem services; ES3.2. Test EESV at national & sub-national level EBV Framework Task Force				

ES1.2	Dialogue with policy bodies				
Lead(s)	Tuyeni Mwampamba				
Team	Patty Balvanera, Haejin Bae, Benoit, HyeJin Kim, Artur Gil (for the case of Small Islands Developing States), Claire Brown, Cornelia Krug				
Development approach	Concepts	Monitoring	Data Mobilization	Modelling	**Application and tools**
Description	The purpose of this activity is to ensure that the WG is responding to real needs and pertinent issues relevant for policy and decision-making related to ecosystem services. Specifically, the WG will reach out to the CBD, IPBES and other global and national bodies to solicit their needs. The activity will include identifying needs that the WG can respond to in the short, medium and long-term, and working with policy bodies to outline work plans, and where necessary, finance mechanisms to be able to deliver on those. This activity is organised in four phases: I. Identification of all relevant policy processes related to ES that WG members are involved in II. Assessment of needs to determine extent to which WG can deliver III. Contact key policy actors to propose partnership and collaboration IV. Execute strategy for delivery (multiple processes may be occurring at the same time)				
Timeline	**2017**	**2018**	**2019**	2020	
Milestones and/or Deliverables	**Phase I:** Survey of WG 6 and other GEOBON members to obtain list of policy processes & their specific needs (Nov 2017)	**Phase II:** List of needs that WG members are sure they can deliver and outline of strategy on how to deliver on them (April 2018); **Phase III:** Discuss and refine strategy with policy actors; outline approach and venues for delivery (Nov 2017)	**Phase IV.** Execute strategy for delivery (multiple processes may be occurring at the same time**); Develop a manuscript of key outcomes of the experience**		
Resources					
Link with other activities	ES1.1. Essential Ecosystem Services Variables; ES1.4. Ecosystem services in Global Sustainability Policies This activity will also be supported by the BON Development WG (BD1) and Policy TF				

ES1.3	Global Framework of Ecosystem Services				
Lead(s)	Patty Balvanera and Gary Geller				
Team	HyeJin Kim, Carlos Zambrana, Carlos Guerra, Artur Gil, CLaire Brown, Ciara Raudsepp-Hearne, Cornelia Krug				
Development approach	**Concepts**	Monitoring	Data Mobilization	Modelling	Application and tools
Description	Deliver conceptual paper and proof of concept of how the ecosystem services community can link to facilitate data sharing, standardization of concepts, cooperation and collaboration.				
Timeline	2017	**2018**	**2019**	2020	
Milestones and/or Deliverables					
Resources					
Link with other activities	ES2.2. Metadata and data standards for remote sensing; ES2.6. Multi scale assessments of ecosystem services; ES3.4. Directory of ecosystem services assessments; ES3.1. BON-in-a-Box for ecosystem services; EBV Data Task Force				

ES1.4	Ecosystem Services in Global Sustainability Policies				
Lead(s)	Ilse Geijzendorffer				
Team	Emmanuelle Cohen-Shacham, Anna Cord, Wolfgang Cramer, Carlos Guerra, Berta Martín-López, Kai Chan Partners: TdV, IUCN, UFZ, IMBE, iDIV and Leuphana University				
Development approach	Concepts	Monitoring	Data Mobilization	Modelling	**Application and tools**
Description	This activity aims at linking ecosystem services with Aichi targets and SDGs and explore how indicators can help to monitor policy goals. EESVs should be relevant for decisions makers and could be used to identify highlight knowledge gaps that create biases in how political reports and decisions are informed. To generate a first estimation of this knowledge gap for the EEVs related to ES flows, we determined 1) which services are currently being mentioned in SDGs and Aichi targets; 2) which EESV flow variables are currently being demanded for reporting on global policy targets on sustainability; 3) which of these knowledge demands is already being provided upon in national ecosystem assessments.				
Timeline	**2017**	2018	2019	2020	
Milestones and/or Deliverables	Geijzendorffer, IR, Cohen-Shacham, E., Cord, A., Cramer, W., Guerra, C., Martín-López, B. 2017 *Ecosystem Services in Global Sustainability Policies.* Environmental Science and Policy 74:40-48				
Resources					
Link with other activities	ES1.2. Dialogue with policy bodies Policy Task Force				

3.5.3 Spatially explicitly observations on Ecosystem Services

This includes outlining the challenges and opportunities for the development of spatially explicit observations of ecosystem services using remote sensing (priority), the development of data standards for remote sensed data of ecosystem services, identifying the challenges and opportunities for monitoring cultural ecosystem services, the development of indicators of the dynamics of social-ecological systems and social-ecological indicators for IPBES, and identifying the challenges and opportunities for monitoring relational values and developing multi-scale assessments of ecosystem services.

ES2.1	**Ecosystem Services and remote sensing**				
Lead(s)	Anna Cord				
Team	Guy Ziv, Ralf Seppelt, Becky Chaplin-Kramer, Kate Brauman, Andreas Huth, Matthias Schröter, Karla Locher, Domingo Alcaraz-Segura, Valia Drakou, Ana Stritih, Maria Vallejos, Daniela Braun, Petteri Vihervaara, Alessandro Gimona,Artur Gil (in islands), Ivette Serral, María Vallejos, Elena Bennett, Cristina Domingo				
Development approach	Concepts	**Monitoring**	**Data Mobilization**	**Modelling**	**Application and tools**
Description	This activity aims at outlining the challenges and opportunities for assessing and monitoring ecosystem services using remote sensing. Managing ecosystem services in the context of global sustainability policies requires reliable monitoring mechanisms, and satellite Earth observation offers great promise to support this need. Significant challenges, however, remain in quantifying connections between ecosystem functions, the concomitant ecosystem services they underpin and human well-being benefits. The aim of this activity is to synthesize in which respect Earth observation together with socio-economic information and model-based analysis can support assessments and monitoring of ecosystem service supply, demand and benefit, and illustrate this for selected services. We argue that the full potential of satellite Earth observation is not yet realized in ecosystem service studies. To provide guidance for priority setting and to spur research in this area, we propose five priorities to advance the capabilities of Earth observation-based monitoring of ecosystem services in the future.				
Timeline	**2017**	**2018**	2019	2020	
Milestones and/or Deliverables	Cord, A.F., Brauman, K.A., Chaplin-Kramer, R., Huth, A., Ziv, G., Seppelt, R. (2017). *Priorities to advance monitoring of ecosystem services using Earth observation.* Trends in Ecology & Evolution, 32(6), 416-428.				
Resources					
Link with other activities	Remote Sensing Task Force BON Development Working Group (BD3).				

ES2.2	Metadata and data standards for remote sensing				
Lead(s)	Valia Drakou, Joan Maso, Jan Philipp Schägner				
Team					
Development approach	Concepts	**Monitoring**	**Data Mobilization**	Modelling	Application and tools
Description	Ecosystem Service assessment, mapping and quantification takes place in different spatio-temporal scales, socio-political context and for different policy objectives, which leads to an immense variety of approaches, methods, tools, modelling and mapping outputs. This group acknowledges the significance of maintaining this diversity, but also the need to bring these different approaches together, in order to facilitate data and information sharing for ecosystem services. The aim of this activity is to propose a set of data standards that can be used for monitoring ecosystem services. Until now, the need for setting up data standards for ecosystem services has been expressed among researchers, but such an attempt hasn't been made yet. The group will work together on three major objectives: i) making an overview of existing data standards and ontologies that can be used for ecosystem service assessments; ii) identifying the gaps and proposing a set of data standards for ecosystem services (linked initially with EESVs); iii) validate those data standards before their final establishment as an ontology. The final output of this work, will be used to bring together in a systematic way the work done within Bon-in-a-Box (activity 3.1), but also to facilitate the process of data collection through remote sensing within the GEOBON community. After the test phase, the goal is to promote the use of those data standards to the global ES research community.				
Timeline	**2017**	**2018**	**2019**	**2020**	
Milestones and/or Deliverables	**Overview of data standards and ontologies for RS & link with ES classification systems**: Data standard overview ES classification systems overview	**Synthesis and proposal of data standards with existing ontological systems**: Submission of proposed ontology **Use/Testing/Validation of data standards by the rest of the Working Group**	**Publication of proposed data standards**	promote the use of those data standards to the global ES research community	
Resources					
Link with other activities	ES1.1 Essential Ecosystem Services Variables; ES3.1. BON-in-a-Box for ecosystem services; ES3.2. Test EESV at national and sub-national level This activity will also be supported by the EBV Data Task Force.				

ES2.3	Cultural Ecosystem Services				
Lead(s)	Guy Ziv				
Team	Anna Cord, Matthias Schröter, Jan, Roland Krämer, Artur Gil, Bruno Locatelli, Kai Chan, Valia Drakou, Philipp Schaegner				
Development approach	**Concepts**	**Monitoring**	Data Mobilization	Modelling	Application and tools
Description	Challenges and opportunities for monitoring cultural ecosystem services using remote sensing or other global datasets (e.g. social media big data). Cultural ecosystem services are linked to widely recognized benefits people gain from nature, yet has been traditionally under-studied because they are intangible and perceptions on them are highly subjective, leading to difficulties in working with public, stakeholders and experts to quantify these. Given the need for more standard, regional- or global-scale monitoring of Ecosystem Services in general - there is clear need to develop science and tools to harness remote sensing and geolocated social media "big data" to cultural ecosystem services. This activity will produce one or two review / agenda-setting peer-reviewed publications on the topic.				
Timeline	2017	2018	**2019**	**2020**	
Milestones and/or Deliverables			**Conceptual framing**: Development of a skeleton structure for literature review **Literature review on CES and EO**: Manuscript submission to Ecosystem Services journal or similar	**Literature review on CES and Social Media/Participatory Science**: Manuscript submission to Ecosystem Services journal or similar	
Resources					
Link with other activities	Remote Sensing TF				

ES2.4	Social Ecological Indicators for IPBES				
Lead(s)	Patty Balvanera				
Team	Tuyeni Mwampamba, Berta Martin-Lopez, Ilse Geijzendorfer, Domingo Alcaraz-Segura, María Vallejos, Carlos, Artur Gil, Antonio J. Castro, Vânia Proença, Cornelia Krug, HyeJin Kim				
Development approach	Concepts	Monitoring	Data Mobilization	Modelling	**Application and tools**
Description	Regional and global assessment of the status and trends of biodiversity and ecosystem services that are currently underway have been led by silo approaches that fail to expose the complex interactions between social and ecological processes that contribute to those trends. Working closely with the IPBES Knowledge TSU, this effort consists of identifying those indicators that help complete our understanding of how other factors such as institutions, governance, values and preferences determine current status and future projections. The final expected outcomes are a set of key indicators that assessments will use to facilitate development of narratives that give a more complete assessment of where we are, why, future projections and the social-political contexts that have led to current status and which could contribute to future sustainable pathways.				
Timeline	**2017**	**2018**	**2019**	2020	
Milestones and/or Deliverables	• Complete list of key SE indicators approved by IPBES executive board • authors of global assessments applying indicators to their work	- Assessment of extent of use of the indicators and insights they provide - survey of global assessment authors for experience with their application	Development of manuscript of the indicators and experiences with their application		
Resources					
Link with other activities	ES1.2. Dialogue with policy bodies; ES2.8. Social ecological dynamics and ecosystem services This activity will also be supported by the Policy TF and contribute to the EBV Framework TF.				

ES2.5	Relational Values				
Lead(s)	Kai Chan				
Team	Berta Martín-López, Tuyeni Mwampamba, Patricia Balvanera				
Development approach	**Concepts**	**Monitoring**	Data Mobilization	Modelling	Application and tools
Description	Relational values have been little explored in the ecosystem services literature and they present unique challenges in terms of monitoring and reporting. This activity will explore the implications of including relational values in assessments ecosystem services, the opportunities and challenges that exist for monitoring relational values.				
Timeline	2017	2018	**2019**	**2020**	
Milestones and/or Deliverables					
Resources					
Link with other activities					

ES2.6	Multiscale assessments of Ecosystem Services				
Lead(s)	Elena Bennett				
Team	Nicolas, Artur Gil (in islands), Bruno Locatelli, Claire Brown, Ilse Geijzendoffer, Guy Ziv, Anna Cord; María Vallejos, Becky Chaplin-Kramer, Ciara Raudsepp-Hearne				
Development approach	Concepts	Monitoring	**Data Mobilization**	**Modelling**	**Application and tools**
Description	Challenges and opportunities for developing multi-scale assessments of ecosystem services. Using ecosystem services to assess global and local sustainability will require multi-scale assessments that take into account relationships between demand and supply at multiple scales, including assessments of the role of trade and other teleconnections in the provision of multiple, interacting services and their sustainability. We will develop (and potentially test) a method for assessing demand and supply of a set of ecosystem services at multiple scales.				
Timeline	**2017**	**2018**	**2019**	2020	
Milestones and/or Deliverables	-Conceptual framing: What would one need to measure for demand, supply of multiple services at multiple scales; How to incorporate trade and other teleconnections; Best methods for those measurements (including models) -Workshop to discuss, and frame out paper -Development of conceptual paper	-Testing of method (ideally, in multiple locations) -Writing of analytical papers -Writing proof of concept paper	-Testing of method (ideally, in multiple locations) -Writing of analytical papers -Writing proof of concept paper		
Resources					
Link with other activities	Link to be developed with National, Regional and thematic BONs to develop case studies across scales.				

ES2.7	Trade-offs among ecosystem services				
Lead(s)	Becky Chaplin-Kramer, Ciara Raudsepp -Hearne, Patty Balvanera				
Team	Anna Cord, Artur Gil (in islands), Bruno Locatelli, Daniel Karp, Antonio J. Castro, Guy Ziv, Elena Bennett, Alessandro Gimona				
Development approach	**Concepts**	**Monitoring**	**Data Mobilization**	**Modelling**	**Application and tools**
Description	Monitoring tradeoffs of ecosystem services through space and time. Assessments of changes in ecosystems need to account for the ability of ecosystems to supply and deliver services to societies but also on tradeoffs and synergies among services. Yet, little is known about how services are related to each other and which services can be delivered in the same spatial areas. Moving observation systems beyond single services to the full bundle of services (a set of services that tend to co-occur in space or time), to quantify and reflect the synergies (positive interactions) and trade-offs (negative interactions) is a major challenge for current research efforts. Also, an understanding of the interactions among stakeholders that have differential preferences for the traded-off services is needed. This activity will explore conceptual approaches and analytic methods for assessing how trade-offs among ecosystem services change through space and time resulting from biophysical and societal changes.				
Timeline	**2017**	**2018**	2019	2020	
Milestones and/or Deliverables	**Conceptual approach:** Develop outline of conceptual approach to accounting for trade-offs/synergies at different scales **Analytic paper:** Re-examine draft of previously developed paper on this topic and reframe to match conceptual outline above	**Conceptual approach:** Development of conceptual paper **Analytic paper:** Development of analytic paper comparing tradeoffs and synergies across case studies			
Resources					
Link with other activities					

3.5.4 Ecosystem Services in practice

The working group will be developing activities in the near future, which includes developing BON-in-a-Box for ecosystem services (priority) and the parametrization of indicators of ecosystem services at global scales through time for IPBES.
Suggested activities (to be discussed and potentially developed in the second half of 2017):

- BON-in-a-Box for ecosystem services
- Testing the EESV at the national and sub-national level
- Ecosystem Services at Global Scales
- Directory of ecosystem services assessments

3.5.3. Calendar of activities

Table 13. Timeline of the activities of the Ecosystem Services working group

ECOSYSTEM SERVICES		Timeline							
		2017		2018		2019		2020	
Concepts and guidance on Ecosystem Services	ES1.1. Essential Ecosystem Services variables								
	ES1.2. Dialogue with Policy bodies								
	ES1.3. Global framework on Ecosystem Services								
	ES1.4. Ecosystem Services in Global Sustainability Policies								
SD EBV strategic applications	ES2.1. Ecosystem Services and remote sensing								
	ES2.2. Metadata and data standards for RS								
	ES2.3. Cultural Ecosystem Services								
	ES2.4. Social ecological indicators for IPBES								
	ES2.5. Relational values								
	ES2.6. Multi-scale assessments of ES								
	ES2.7. Trade-offs among ecosystem services								
	ES2.8. Social ecological dynamics and ES								
Ecosystem Services in Practice									

4. Developing Biodiversity Observation Networks

4.1. Strategy for BON Development

Biodiversity Observation Networks (BONs) that are formally connected to GEO BON can be national (e.g. Colombia), regional (e.g. the Circumpolar Biodiversity Monitoring Program) or thematic (e.g. Marine BON) in scope (Fig.5). The role of the Biodiversity Observations Networks is to develop, apply and test the concepts, methods and tools to implement and enhance operational networks; collecting observations and providing data to the community and users. In this capacity, they are recipients of the outputs of the EBV Working Groups (e.g. EBV monitoring frameworks and tools) but also contributors via the development and contribution of useful tools for EBV generation and application at national, regional and thematic scales. This two way interaction via the GEO BON network serves to continually improve the process by which BONs are designed and implemented.

To further support the development of Biodiversity Observation Networks, Colombia's Humboldt Institute, on behalf of GEO BON, has led on developing the first prototype of **BON in a Box: Improving Capacity for Biodiversity Conservation**. BON in a Box is a customizable and continually updated online toolkit that connects scientists and tool developers around the world and lowers the threshold for the start-up or enhancement of a national, regional or local biodiversity observation system. It serves as a technology transfer and capacity building mechanism that ensures researchers around the world have access to the latest technologies and can build and implement biodiversity observation systems that are interoperable using international standards[4].

BON in a Box is primarily designed to serve the needs and interests of national governments and institutions who need high quality biodiversity data to inform their domestic and international reporting requirements and conservation commitments. The beta version of BON in a Box is accessible online: https://boninabox.geobon.org

BON in a Box is being continually updated with a full version ready since the end of 2016 and is being used to support the development of a national BON in Colombia.

4.1.1. The BON Development Working Group

The development of Biodiversity Observation Networks, or BONs, will be carried out by the BON Development Working Group. The Key Objectives of the WG are to facilitate the development or enhancement of BONs across different scales and themes by working with the BONs and EBV Working Groups to:

1. Identify, document and deliver best practices in the process of development and implementation of existing and developing BONs and using them as examples for other BONs development and enhancement;
2. Provide a flexible framework for designing a user-driven BON recognizing the diversity of objectives and users from different BONs;
3. Work with the EBV Working Groups and EBV Framework Task Force in the development of guidelines for applying the EBV framework for BON development and utilize national, regional and global pilots.
4. Provide easy access to state-of-the-art tools for biodiversity observations and EBV implementation.
5. Promote and facilitate cooperation and communication for knowledge and technology transfer between national and thematic BONs.

[4] For more information on BON in a Box (including videos) go to: www.geobon.org/bon-in-a-box

To meet the above objectives will require the BON Development Working Group keeping the BON and the EBV Working Groups fully aware of each other's progress and providing a conduit by which the outputs of these developments can be applied via BON development guidance and frameworks and via BON in a Box (Fig.2 and Fig.4).

Our approach to guiding the development and/or enhancement of a national, regional or thematic biodiversity observation network involves three key approaches and core activities:

- Developing a Consistent but Flexible Biodiversity Observation Network Design Process
- Strengthening Biodiversity Observation Networks through improved discovery, access and use of best practices and tools for biodiversity observation
- Building communities of practice for BON development and EBV operationalization at national and regional scales

The 2017-2019 GEO BON Implementation Plan identifies synergies between the BONs and EBV WGs. These synergies will be topics of common interest that the BON Development WG, in many cases, will be able to assist with. The GEO BON Secretariat and its task forces will also provide support in prioritizing topics that should be addressed to enhance the overall implementation of an interoperable network of BONs. This includes implementation of best practices and recommendations from the Policy and the EBV Data Task Forces (see sections 5.1 and 5.3).

4.1.2.Composition of the Working Group

Lead Coordinators: Maria Cecilia Londoño (Humboldt Institute, Colombia), Mike Gill (GEO BON, Canada) and Petteri Vihervaara (Finnish Environment Institute SYKE)

Members: 40 registered members as of July 2017.
http://data.geobon.org/networks/pages/bondev.php

4.1.3.Activities

4.1.3.1. Developing a Flexible Framework for BON Design

Lead and partners: Mike Gill (Lead), Partners (TBD)

Purpose: Developing a national, regional or thematic BON that improves data and information for decision making in management of living resources requires a systematic, open and inclusive process to ensure the BON is directly serving policy needs and is feasible and thus, sustainable. GEO BON has drafted, based on regional and national examples, a 9-step BON design process (Figure 9). This 9-step process is based on biodiversity observation design theory, previous experiences in developing the Arctic BON, recent experiences in designing a BON for Australia's New South Wales and is currently being piloted and refined in Colombia. Through the work of the BON Development Working Group, this design process will be refined and improved based on further user-case applications where the societal background may demand different approaches (potential further national test cases include Brazil, several African countries and some southeast Asian countries).

Phase	Step	Methods	Participants
Engagement	1. Authorizing Environment	Meetings	Senior officials and/or politicians.
	2. Design and Implementation Team	Meetings	Combination of decision-makers and scientists
Assessment	3. User Needs Assessment and Choose Regional Assessment Units	Surveys, meetings, and/or workshops	Decision and policy makers and scientists.
	4. Inventory of Data, Tools and Platforms	Surveys, literature search, etc.	Design and Implementation Team led with contractor or student help
Design	5. Focal Ecosystems, Conceptual Models, EBVs and Primary Observations	Workshop	Design and implementation team and scientific community
	6. Data Collection Methods	Workshop	Design and implementation team and scientific community
	7. Sampling Framework	Workshop	Design and implementation team and scientific community
	8. Data Management, Analysis and Reporting	Workshop	Design and implementation team and scientific community
Implementation	9. Implementation Plan	Meeting	Design and implementation team

Figure 9. Summary of Steps to Designing and Implementing a Biodiversity Observation Network

Moreover, it is important that a national, regional or thematic BON does not develop and operate in isolation, but rather draws from and contributes to broader regional and global biodiversity observation efforts while, at the same time, allowing flexibility and customization to respond to regional, national and/or local needs. Through the application of consistent tools and design approaches, we aim to utilize a 'bottom-up' approach where local to regional-scale observation networks are designed to, first and foremost, effectively meet decision-makers needs at these scales whilst also allowing for the development of a globally integrated observation network.

<table>
<tr><th>BD1</th><th colspan="4">Developing a Flexible Framework for BON Design</th></tr>
<tr><td>Lead(s)</td><td colspan="4">Mike Gill</td></tr>
<tr><td>Team</td><td colspan="4">TBD</td></tr>
<tr><td>Description</td><td colspan="4">This activity will be organized in three tasks:

1. BON Development Manual:
This manual would document best practices in the development and implementation of BONs. It would build upon the 9-step design process and draw from the proposed paper for evaluating existing BONs. This would be a more detailed extension of the GEO Handbook on Biodiversity Observations.

2. Ensuring BONs support IPBES Assessments:
BON Position paper presenting the idea of integration between IPBES assessment and GEOBON Observation Systems and stating what is needed to contribute from BONs to IPBES. This would include the idea of integrating the PSBIR model to BON design.

3. Assessment of existing BONs:
This task will have three core objectives:
• The development of an interactive map on the GEO BON website indicating key attributes including EBVs used
• The production of a paper on the current state of BONs: review of their maturity, (spatio-temporal) data coverage, resources, key ecosystems, readiness to apply remote sensing data for monitoring etc.
The identification of current efforts collecting simple but useful biodiversity observations across BONs and participating nations, and which of these observations could be considered an EBV candidate.</td></tr>
<tr><td>Timeline</td><td>2017</td><td>2018</td><td>2019</td><td>2020</td></tr>
<tr><td>Milestones or Deliverables</td><td>Manuscript on the support of BONs for IPBES Assessments is submitted</td><td></td><td>Delivery of the BON Development manual</td><td></td></tr>
<tr><td>Resources</td><td>Funding needed for the organisation of a workshop on the BON Development Manual</td><td></td><td>Funding needed for publication costs</td><td></td></tr>
<tr><td>Link with other WG, BONs, TF</td><td colspan="4">BON Development Manual: Include BONs (national, regional and thematic in its production), select test cases and ask the EBV WGs to write specific sections for BON design to serve specific EBVs.
Ensuring BONs support IPBES Assessments: Use the Colombian BON process as the basis for this paper and bring in key GEO BON/IPBES members for development.</td></tr>
</table>

4.1.2.2 Development of Bon in a Box

Lead: Maria Cecilia Londoño (Lead), Partners (TBD)
Purpose: Better information on the status, trends and drivers of biodiversity change is needed to assist governments in developing more effective and timely policy responses. There are many excellent tools, protocols and software in use and continual technological advancements that facilitate effective biodiversity monitoring but these are not easily discoverable or available to all regions of the planet. Furthermore, current efforts to monitor biodiversity are not interoperable, thereby limiting our ability to detect change in biodiversity and its underlying driving mechanisms. With this in mind, GEO BON has developed BON in a Box as a technology and knowledge transfer and capacity-building mechanism to improve the quantity, quality and interoperability of biodiversity observations. It is a customizable and continually updated online toolkit that connects scientists and tool developers around the world ensuring access to latest technologies and methodologies. Implementation of Bon in a Box through the BON development working group will guarantee that the best tools produced by the WG on EBVs are accessible worldwide, facilitating their use in regional, thematic and national BONs.

BD2	Development of Bon in a Box			
Lead(s)	Maria Cecilia Londoño			
Team	Mike Gill, Eduarso Dalcin, Peter Benton, Andrew Skowno, GEO BON MC			
Description	This core activity will be organized in four tasks: **1. Preparation of the BON in a Box paper**: This task will lead to the production of a concept paper presenting Bon in a Box, and describing the functionalities of version 2.0. **2. BON in a Box Version 1.0:** The group will produce Guidelines for the selection of tools for BON in a Box. This implies communication with WG, thematic BONs and tools providers to identify the tools to be included, review and edition of tools metadata for incorporating in the database of Bon in a Box. Working Groups and BONs will be asked for a full update on the available tools that they selected for the platform. **3. Communication Strategy and Business Plan:** This task will develop a plan to promote the discovery and use of BON in a Box and a plan that details its ongoing maintenance and confirms roles and responsibilities in this regard. **4. Development of BON in a Box version 2.0:** This task will develop the necessary upgrades to the search interface to allow for more functionality for the users of the platform.			
Timeline	**2017**	**2018**	**2019**	**2020**
Milestones or Deliverables	Publication of the BON in a Box concept paper All selected tools are added to the online platform		Release of BON in a Box version 2.0	
Resources	Support hired by the Humboldt institute to help in the management and incorporation of tools in the version 1.0	Financial resources needed to develop the version 2.0 of BON in a Box	Financial resources needed to develop the version 2.0 of BON in a Box	
Link with other WG, BONs, TF	By nature, this activity will involve interactions with all WGs and BONs in order to identify the relevant tools, and review their metadata. This activity will be also supported by the Policy TF.			

4.1.2.3 Building communities of practice for BON development and EBV operationalization at national and regional scales creating a direct link between the EBV working groups and the Biodiversity Observation Networks.

Lead: Petteri Vihervaara and partners (TBD)
Purpose: One of the key objectives of this activity is to keep the BON development network fully aware of the latest thinking in the EBV WGs, and scanning the opportunities on how EBVs could be operationalized. Basically, that flow between the BON and EBV WGs is aimed to be two-way, which means that in-situ observations and biodiversity indicators collected by the BONs can be used in verification of, for instance, remotely sensed EBVs. Both the 9-step BON design process (Fig.9) and BON in a Box are structured around the EBV classes to ensure that the design and implementation of BONs and the selection of tools is done using the EBV concept as a conceptual and operational framework. Additionally, the BON Development Group will integrate new methodologies for implementation of the EBVs in an adaptive management context in order to ensure we have guidelines to enhance the use of EBVs at multiple scales (from sub-national to global scales). The BON Development Working Group will serve as a conduit between the EBV Working Groups and the BONs through the delivery and application of EBV concepts and observation tools (experimental

design, data collection, data management, data analysis and reporting) as pilot operational efforts or "proof of concept". In addition, the BON Development Working Group will provide feedback and describe users' information needs to the EBV Working Groups regarding desired guidance on practical steps for implementation of EBVs across BONs. As mentioned above, this will be mainly accomplished through structured webinars, use of the online forum for BON in a Box and through pilot EBV implementation, from small communities to entire regions.

BD3	Building communities of practice for BON development			
Lead(s)	Petteri Vihervaara			
Team	Andrew Skowno, Mao-Ning Tuanmu, Peter Benton, Eduardo Dalcin, Mike Gill			
Description	The main aim of this activity is to build communities of practice for BON development and EBV operationalization at national and regional scales by creating a direct link between the EBV working groups and the Biodiversity Observation Networks. This activity is divided in six tasks: **1. Detecting intersection points with EBV WGs, selecting priorities for pilots.** **2. EVB Pilots for operationalization:** identifying which actors are running long-term biodiversity observation programs and what their protocols are. **3. "Matchmaking":** Build tool(s) and approaches for matchmaking/discovering experts in regions and globally, identifying mechanisms for supporting such data collection efforts **4. Webinars on EBV data collection, analysis and data management** **5. Publications:** Publication demonstrating the value and need for interoperable biodiversity observation systems in order to promote this to the consumers of this information to solicit support. Promote this to get the resources to work on specific products and actions that could be scaled up and show cause and effect on having time series data that have led to effective and informed decisions.			
Timeline	2017	2018	2019	2020
Milestones or Deliverables				
Resources				
Link with other WG, BONs, TF	By nature, this activity will involve interactions with all WGs and BONs.			

4.2. Regional BONs

4.2.1. Asia Pacific BON

The Asia Pacific BON, or AP-BON, was organized by the participants of the International Workshop for Networking Biodiversity Observation Activities in Asia Pacific Region held from July 21-22 2009, in Nagoya University, Japan. It was established as a regional network related to GEO BON, covering most countries of the Asia-Pacific region and covering all levels of biodiversity and ecosystems. As of 2017, some BONs are already operational at the national and sub-regional levels but there remains a need to organize more National BONs and organize their network, with the support of the GEO BON Secretariat and BON Development Working Group. Training courses were organized and are available through GBIF as funded by BIFA. There is however still a need to expand to other areas and parts of Asia and Pacific[5].

The AP BON has been working on the identification of threats to biodiversity, in particular, drivers of biodiversity loss, mangrove loss, wetland loss, and anthropogenic actions that hamper the achievement of Sustainable Development Goals. The AP BON makes the use of various technology for biodiversity monitoring at high resolution and providing large coverage such as Forest Crane, Drones and LIDAR that facilitate assessments in various ecosystems. Biodiversity databases have been established through various accessible platforms such as GBIF, ABCDNET, National Clearing House Mechanisms and the ASEAN Clearing House Mechanisms. In addition, related databases specific to certain taxa have been established.

The biodiversity data shared within the AP BON have until now been used to:

- **Monitor** amphibians, reptiles, inland water fish, insects, soil animal and microbe diversity, and to conduct long term monitoring such as **ILTER.**
- **Contribute** to global data holdings including such as CForBio.
- **Increase** data paper publications
- **Populate** databases, contribute to regional platforms such as the ABCDNet, GBIF and prepare Species Distribution maps.
- **Conduct** surveys and **Prepare assessments** (e.g. regional mangrove assessment)
- **Develop models** to predict Climate Change impacts, DRR, inform decision making and prepare ecosystem service evaluation
- **Develop policies and guidelines**

4.2.1.1. Composition of the BON

AP BON Chair: Tetsukaza Yahara (Japan)
Department of Biology, Faculty of Sciences Kyushu University Japan
AP BON co-chair: Kim Eun-Shik (Korea)
College of Forest Science Department of Forestry, Environment, and Systems Kookmin University Songbuk-gu, Seoul Korea
AP BON co-chair: Vergara Sheila (ACB)
ASEAN Centre for Biodiversity

[5] The AP BON is still in the process of developing its work plan for the 2017-2020 period. A meeting of AO GEOSS, to be held in Hanoi in September 2017, will be the occasion to refine the current list of activities.

4.2.1.2. Key objectives for the 2017-2020 period

The core objective of the APBON for the 2017 – 2020-time period is to move toward developing a broader network of biodiversity observations (Table 14). To that extent, AP BON will promote data sharing to increase access to biodiversity related information that will enable the effective monitoring of changes in biodiversity. Gaps in available information will be addressed by improving collaboration among researchers in observation sites, designing incentives for data publications and deriving solutions to relevant science questions. AP BON also highlighted the need to improve communication and collaboration among BONs, to identify more national, thematic and regional BONs and to reach out to other parts of Asia and the Pacific. The future of AP BON relies on the participation of young scientists and will thus endeavour to engage them in participating in deriving solutions to conservation issues and in preparing joint publications.

Table 14. Summary of the activities of the APBON

ASIA PACIFIC BIODIVERSITY OBSERVATION NETWORK	EBV classes						Ecosystem Services	Development approach				
	Genetic composition	Species Populations	Species Traits	Community Composition	Ecosystem Function	Ecosystem Structure		Capacity building	Monitoring protocol design	Data collection	Modelling	Assessments and Policy support
APB1. Biodiversity Observations in the AP region		■						■	■	■		
APB2. Networking in the AP region								■	■			

4.2.1.3. Activities

APB1.	Biodiversity Observations in the Asia Pacific Region					
Lead(s)	AP BON Chairs					
Team/Partners	TBD					
EBV Class	Genetic Composition	**Species Populations**	Species Traits	Community Composition	Ecosystem Function	Ecosystem Structure
Ecosystem Services	YES			NO		
Development approach	**Capacity Building**	**Monitoring Protocol design**	**Data Collection**	Modelling	Assessments and Policy Support	
Description	The Asia Pacific BON will continue to hold dialogues with the member organizations and partners in order to exchange biodiversity information, improve access to technology and improve the utility of shared data. AP BON will also continue to encourage the organization of National BONs, and further networking between those BONs, with the support of the GEO BON Secretariat and BON Development WG. As a result, a coordinated and integrated observation system will be promoted in each country. Components of these systems also include access support for training courses and collaborations with GBIF in order to improve skills for the development for data archiving, and the cultivation of a culture of data sharing. Finally, the AP BON will contribute to the maintenance of data platforms established through GBIF, ABCDNET, and related other databases.					
Timeline	**2017**	**2018**	**2019**	**2020**		
Milestones and/or Deliverables						
Resources						
Link with other activities	This activity will be linked with activities of the BON Development WG, particularly BD1 and BD3. In addition, this activity will be supported by the EBV Data Task Force.					

APB2.	Networking in the Asia Pacific Region					
Lead(s)	AP BON Chairs					
Team/Partners	TBD					
EBV Class	Genetic Composition	Species Populations	Species Traits	Community Composition	Ecosystem Function	Ecosystem Structure
Ecosystem Services	YES			NO		
Development approach	**Capacity Building**	**Monitoring Protocol design**	Data Collection	Modelling	Assessments and Policy Support	
Description	The Asia Pacific Bon will promote the communication and collaboration among biodiversity monitoring networks, initiatives and associate networks. Particular attention will be given to acknowledging difference in monitoring approaches, methods and the difficulty of standardizing methods. The AP BON will hence work towards deriving solutions to certain science questions from which common goals and indicators can be identified. The AP BON will also encourage the participation of researchers working in various ecosystems and facilitate their engagement in discussions and collaboration in joint publications of data papers					
Timeline	**2017**	**2018**	**2019**	**2020**		
Milestones and/or Deliverables						
Resources						
Link with other activities	This activity will be linked with activities of the BON Development WG, particularly BD1 and BD3.					

4.2.2.Arctic BON - CBMP

The Circumpolar Biodiversity Monitoring Program (CBMP) is an international network of scientists, government agencies, Indigenous organizations and conservation groups working together to harmonize and integrate efforts to monitor the Arctic's living resources. The CBMP facilitates Arctic biodiversity conservation and the sustainable use of the region's natural resources. Its goal is to facilitate more rapid detection, communication, and response to significant biodiversity-related trends and pressures. It does this by (1) Harmonizing and enhancing Arctic monitoring efforts, thereby improving the ability to detect and understand significant trends; and (2) Reporting to, and communicating with, key decision makers and stakeholders, thereby enabling effective conservation and adaptation responses to changes in Arctic biodiversity.

4.2.2.1. Composition of the BON

The CBMP is the monitoring programme of Conservation of Arctic Flaura and Fauna (CAFF) which is the biodiversity working group of the Arctic Council[6]. CAFF serves as a vehicle to cooperate on species and habitat management and utilization, to share information on management techniques and regulatory regimes, and to facilitate more knowledgeable decision-making. It provides a mechanism to develop common responses on issues of importance for the Arctic ecosystem such as development and economic pressures, conservation opportunities and political commitments.

CAFF consists of National Representatives assigned by each of the eight Arctic Council Member States, representatives of Indigenous Peoples' organizations that are Permanent Participants to the Council, and Arctic Council observer countries and organizations. The CAFF Working Group operates by the Arctic Council Rules of Procedures.

CAFF is governed by a Chair and Management Board[7], with support and coordination provided by the International CAFF Secretariat[8]. The CBMP is co-lead by the Kingdom of Denmark and the U.S. with Steering Groups for each ecosystem (see here for members of each steering group: coastal (https://caff.is/coastal), freshwater (https://caff.is/freshwater), marine (https://caff.is/marine), terrestrial (https://caff.is/terrestrial)).

The CBMP is comprised of various members and partners[9] associated with Arctic biodiversity and monitoring. To ensure coordination and integration[10] with related global initiatives, the CBMP is strategically linked to other international conservation programs and research and monitoring initiatives, including:

- CAFF's Arctic Biodiversity Assessment (ABA) - https://caff.is/aba
- Arctic Monitoring and Assessment Programme (AMAP) - http://www.amap.no/
- UNEP's Biodiversity Indicators Partnership - http://www.twentyten.net/
- Sustaining Arctic Observing Networks (SAON) - http://www.arcticobserving.org/
- The United Nations Convention on Biological Diversity (UN CBD) through the Cooperative Strategy for the Conservation of Biological Diversity in the Arctic Region.

[6] https://caff.is/arcticcouncil
[7] https://caff.is/management-board
[8] https://caff.is/secretariat
[9] https://caff.is/index.php?option=com_content&view=article&id=481:our-partners&catid=385:about-the-cbmpnew&Itemid=1187
[10] https://caff.is/cbmp-coordination

4.2.2.2. Key objectives for the 2017-2020 period

The CBMP focuses its efforts on five key program areas:

- Data management (the Arctic Biodiversity Data Service)
- Capacity building
- Reporting
- Coordination and integration of Arctic monitoring
- Communication, education and outreach

CBMP have in recent years had a particular focus on developing State of The Arctic Biodiversity Reports. In May 2017 the State of The Arctic Marine Biodiversity Report was published. The report identifies trends in key marine species and points to important gaps in biodiversity monitoring efforts across key ecosystem components in: sea ice biota, plankton, benthos, marine fishes, seabirds and marine mammals. In 2018, two reports on terrestrial Biodiversity and Freshwater biodiversity are planned.

CBMP experts are implementing four coordinated and integrated Arctic Biodiversity Monitoring Plans to help guide circumpolar monitoring efforts. Results will be channelled into effective conservation, mitigation and adaptation policies supporting the Arctic. These plans represent the Arctic's major ecosystems: Marine, Freshwater, Terrestrial, and Coastal. The activities of the Arctic BON are summarized in Table 15.

Key objectives for the 2017-2020 period include:

1. Implementation of CBMP Strategy for 2017-2020
2. Completion of the State of the Arctic Freshwater Biodiversity Report
3. Completion of the State of the Arctic Terrestrial Biodiversity Report
4. Completion of the State of the Arctic Coastal Biodiversity Monitoring Plan
5. Continued development and implementation of CBMP suite of indices and indicators
6. Continued development of the Arctic Biodiversity Data Service (ABDS)
7. Contribute to and support of the second Arctic Biodiversity Congress
8. Inform efforts to consider how the Arctic as a region is contributing to the Sustainable Development Goals and the UNCBD Aichi targets as related to the Arctic
9. Contribute to and support implementation of the recommendations of the Arctic Biodiversity Assessment

Table 15. Summary of the activities of the Arctic BON

ARCTIC BIODIVERSITY OBSERVATION NETWORK	EBV classes						Ecosystem Services	Development approach				
	Genetic composition	Species Populations	Species Traits	Community Composition	Ecosystem Function	Ecosystem Structure		Capacity building	Monitoring protocol design	Data collection	Modelling	Assessments and Policy support
AB1. Arctic Freshwater Biodiversity Monitoring Plan - implementation												
AB2. Arctic Terrestrial Biodiversity Monitoring Plan - implementation												
AB3. Arctic Marine Biodiversity Monitoring Plan - implementation												
AB4. Arctic Coastal Biodiversity Monitoring Plan - implementation												
AB5. CBMP suite of indices and indicators - implementation												

4.2.2.3. Activities

Below is the for summary of main CBMP activities, further details on timelines and budgets can be found in the annual reports and work plans for each of the CBMP Monitoring Plans[11].

AB1.	Arctic Freshwater Biodiversity Monitoring Plan: implementation					
Lead(s)	Leads rotate: current leads are Sweden and Canada					
Team/Partners	See here for list of all members: https://caff.is/freshwater/freshwater-steering-committee					
EBV Class	**Genetic Composition**	**Species Populations**	**Species Traits**	**Community Composition**	**Ecosystem Function**	**Ecosystem Structure**
Ecosystem Services	**YES**			NO		
Development approach	Capacity Building	Monitoring Protocol design	**Data Collection**	**Modelling**	**Assessments and Policy Support**	
Description	Pan-Arctic freshwater biodiversity monitoring plan developed by the CBMP to improve the detection and understanding of the causes of long-term change in the composition, structure and function of Arctic freshwater ecosystems.					
Timeline	**2017**	**2018**	**2019**	**2020**		
Milestones and/or Deliverables	Development of the State of the Arctic Freshwater Biodiversity Report	Completion of the State of the Arctic Freshwater Biodiversity Report	Release and follow-up of the State of the Arctic Freshwater Biodiversity Report	Development of next steps and refinement of monitoring plan as needed		
Resources	Supported by Arctic states	Supported by Arctic states	Supported by Arctic states	Supported by Arctic states		
Link with other activities						

AB2.	Arctic Terrestrial Biodiversity Monitoring Plan: implementation					
Lead(s)	Leads rotate: current leads are Iceland and Sweden					
Team/Partners	See here for list of all members: https://caff.is/terrestrial/terrestrial-steering-group					
EBV Class	**Genetic Composition**	**Species Populations**	**Species Traits**	**Community Composition**	**Ecosystem Function**	**Ecosystem Structure**
Ecosystem Services	**YES**			NO		
Development approach	Capacity Building	Monitoring Protocol design	**Data Collection**	**Modelling**	**Assessments and Policy Support**	
Description	Pan-Arctic terrestrial biodiversity monitoring plan developed by the CBMP to improve the detection and understanding of the causes of long-term change in the composition, structure and function of Arctic terrestrial ecosystems.					
Timeline	**2017**	**2018**	**2019**	**2020**		
Milestones and/or Deliverables	Development of the State of the Arctic Terrestrial Biodiversity Report	Completion of the State of the Arctic Terrestrial Biodiversity Report	Release and follow-up of the State of the Arctic Terrestrial Biodiversity Report	Development of next steps and refinement of monitoring plan as needed		
Resources	Supported by Arctic states	Supported by Arctic states	Supported by Arctic states	Supported by Arctic states		
Link with other activities						

[11] https://caff.is/monitoring-publications

AB3.	Arctic Marine Biodiversity Monitoring Plan: implementation					
Lead(s)	Leads rotate: current leads are US					
Team/Partners	See here for list of all members: https://caff.is/marine/marine-steering-group					
EBV Class	**Genetic Composition**	**Species Populations**	**Species Traits**	**Community Composition**	**Ecosystem Function**	**Ecosystem Structure**
Ecosystem Services	**YES**			NO		
Development approach	Capacity Building	Monitoring Protocol design	**Data Collection**	**Modelling**	**Assessments and Policy Support**	
Description	Pan-Arctic Marine biodiversity monitoring plan developed by the CBMP to improve the detection and understanding of the causes of long-term change in the composition, structure and function of Arctic terrestrial ecosystems.					
Timeline	**2017**	**2018**	**2019**	**2020**		
Milestones and/or Deliverables	Follow-up on the State of the Arctic Marine Biodiversity report	Refinement of the State of the Arctic Marine Biodiversity report	Continued implementation of the Arctic Marine Biodiversity Monitoring Plan	Continued implementation of the Arctic Marine Biodiversity Monitoring Plan		
Resources	Supported by Arctic states	Supported by Arctic states	Supported by Arctic states	Supported by Arctic states		
Link with other activities						

AB4.	Arctic Coastal Biodiversity Monitoring Plan: implementation					
Lead(s)	Leads rotate: current leads are US					
Team/Partners	See here for list of all members: https://caff.is/coastal/coastal-expert-monitoring-group					
EBV Class	**Genetic Composition**	**Species Populations**	**Species Traits**	**Community Composition**	**Ecosystem Function**	**Ecosystem Structure**
Ecosystem Services	**YES**			NO		
Development approach	Capacity Building	Monitoring Protocol design	**Data Collection**	**Modelling**	**Assessments and Policy Support**	
Description	Pan-Arctic coastal biodiversity monitoring plan developed by the CBMP to improve the detection and understanding of the causes of long-term change in the composition, structure and function of Arctic terrestrial ecosystems.					
Timeline	**2017**	**2018**	**2019**	**2020**		
Milestones and/or Deliverables	Development of the State of the Arctic Coastal Biodiversity Monitoring Plan	Completion of the Arctic Coastal Biodiversity Monitoring Plan	Release and implementation of the Arctic Coastal Biodiversity Monitoring Plan	Development of the State of the Arctic Coastal Biodiversity report		
Resources	Supported by Arctic states	Supported by Arctic states	Supported by Arctic states	Supported by Arctic states		
Link with other activities						

AB5.	CBMP suite of indices and indicators: implementation					
Lead(s)	Leads rotate: US and Kingdom of Denmark					
Team/Partners	See here for list of all members: https://caff.is/indices-and-indicators					
EBV Class	**Genetic Composition**	**Species Populations**	**Species Traits**	**Community Composition**	**Ecosystem Function**	**Ecosystem Structure**
Ecosystem Services	**YES**			NO		
Development approach	Capacity Building	**Monitoring Protocol design**	Data Collection	Modelling	**Assessments and Policy Support**	
Description	Continued implementation of the CBMP strategy for developing indices and indicators for monitoring Arctic biodiversity in the Circumpolar Biodiversity Monitoring Program (CBMP).					
Timeline	**2017**	**2018**	**2019**	**2020**		
Milestones and/or Deliverables	Development of Arctic Biodiversity indices and indicators	Development of Arctic Biodiversity indices and indicators	Development of Arctic Biodiversity indices and indicators	Development of Arctic Biodiversity indices and indicators		
Resources	Supported by Arctic states	Supported by Arctic states	Supported by Arctic states	Supported by Arctic states		
Link with other activities	This activity will be supported by the Policy TF.					

4.3. National BONs

4.3.1. Colombia BON

4.3.1.1. Coordinators, members and governance

Coordinator: Maria Cecilia Londoño (Alexander von Humboldt Institute)

While the Colombia BON has started to be known by biodiversity observation experts in Colombia, there has been a direct interest from specific researchers to become part of Colombia BON, mainly by organizing specific working groups or in producing strategic products. During the next years, Colombia BON membership will be grown and a governance structure established[12].

4.3.1.2. Overview and key objectives

Since 2015, GEO BON directly works with Colombia's Alexander von Humboldt Institute to design a Colombian National BON. During 2015, and with the cooperation of GIZ (Germany), an assessment of the national capacities for Biodiversity Observation Systems in Colombia was undertaken. Following the Bon in a Box components (i.e. collection, management, analysis and reporting), an inventory of the tools produced and used by National Environmental Information System (SINA) institutions was consolidated.

In 2016, a core team from the SINA produced a Conceptual and Methodological Framework for Biodiversity Regional Assessments that was based on the 9 steps proposed by GEO BON to establish an Observation System (Fig. 9) and the Conceptual Framework for Regional Assessment of IPBES. The focus of this Framework is to link decision-makers' information needs with biodiversity indicators and observation systems.

The work on the development of the Colombian BON has served as an example for other countries, namely Brazil and South Africa, in order to establish their National BONs. The overall process and approach for designing the national BON will be communicated as a CBD Technical Publication that will be used by GEO BON to serve as an applied provider of biodiversity observation expertise to the Parties of the CBD.

The **key objectives** of the Colombia BON are to:

1. Build and maintain active a Community of Practice for developing Biodiversity Information Systems at National and Subnational scales.
2. Guide biodiversity assessment process to support decision-making.
3. Develop guidelines for enhancing biodiversity observation systems in data collection, management and analysis.
4. Develop synthesis of existing information around specific research questions or policy/management problems.

[12] As of July 2017, 6 members were registered: http://data.geobon.org/networks/pages/colombia.php

Table 16. Summary of the activities of the Colombia BON

COLOMBIA BIODIVERSITY OBSERVATION NETWORK	EBV classes						Ecosystem Services	Development approach				
	Genetic composition	Species Populations	Species Traits	Community Composition	Ecosystem Function	Ecosystem Structure		Capacity building	Monitoring protocol design	Data collection	Modelling	Assessments and Policy support
ColB1. Establishing a Colombian Landscape Ecology WG					■	■		■	■			■
ColB2. Developing the first sub-national Biodiversity Assessments		■		■	■	■	■		■		■	■
ColB3. Monitoring functional traits handbook			■		■		■	■	■			
ColB4. Implementation of the Colombia Datacube for Biodiversity analysis				■	■	■					■	

4.3.1.3. Activities

ColB1.	Establishing a Colombian Landscape Ecology working group					
Lead(s)	Camilo Correa and Paola Isaacs					
Team/Partners	TBD					
EBV Class	Genetic Composition	Species Populations	Species Traits	Community Composition	**Ecosystem Function**	**Ecosystem Structure**
Ecosystem Services	YES			NO		
Development approach	**Capacity Building**	Monitoring Protocol design	Data Collection	Modelling	**Assessments and Policy Support**	
Description	Landscape Ecology in Colombia is a field of great interest for researchers and conservation practitioners, and can lead to results and outputs that are explicitly incorporated into decision-making instruments such as Land Planning policies. Building and maintaining an active Community of Practice for understanding ecosystem structure and process applying concepts and methods from Landscape Ecology is urgently needed, as well as identifying best practices in the field that allows government and consultants to develop more robust analysis on their territories. During the next three years, and as part of GEOBON, a specialist group on Landscape Ecology in Colombia will be organized addressing issues related with the implementation of an Observation System that aims to understand landscape transformations in Colombia. This activity will be organized around several tasks: **1. Define the objectives, membership and implementation plan of the working group** **2. Review on the state of landscape ecology in Colombia**: This review will lead to the production of a directory of experts, a publication on the historic and recent theoretical approaches to Landscape Ecology, a gap analysis on information and capacity in the country, the identification of opportunities and priorities of basic and applied research (e.g. connectivity, impact assessment, conservation planning, landscape social values). **3. Identify best practices for monitoring and data analysis in landscape ecology in support of policy making**: Landscape ecology results are explicitly incorporated into decision-making instruments in Colombia. A review of information (mainly indices and indicators) demanded by decision makers will be performed, and publications and capacity building activities will be developed in order to share best practices in the field for monitoring and analysis.					
Timeline	**2017**	**2018**	**2019**	2020		
Milestones and/or Deliverables	Meeting with experts in landscape ecology	Meeting with experts in landscape ecology Organisation of a Symposium on Landscape Ecology in Colombia Publications on the state of the art in Landscape Ecology in Colombia	Meeting with experts in landscape ecology			
Resources	Secured: $6000 for the first workshop (Humboldt Institute) Needed: $5000	Needed: $32000	Needed: $12000			
Link with other activities	This activity will be connected with the development of EBVs by the Ecosystem Function and Ecosystem Structure working groups					

ColB2.	Developing the first subnational Biodiversity Assessments					
Lead(s)	Maria Cecilia Londoño and José Manuel Ochoa					
Team/Partners	TBD					
EBV Class	Genetic Composition	**Species Populations**	Species Traits	**Community Composition**	**Ecosystem Function**	**Ecosystem Structure**
Ecosystem Services	**YES**			NO		
Development approach	Capacity Building	**Monitoring Protocol design**	Data Collection	**Modelling**	**Assessments and Policy Support**	
Description	The main objective of this activity is to develop a Biodiversity Observation Systems that improves data and information for national and subnational environmental authorities that are responsible for biodiversity management and ecosystem services. Members of the ColombiaBON have define a conceptual and methodological framework for integrating information needs from decision makers with biodiversity observation systems thorough the development of subnational biodiversity assessments. During the next three years, we aim to implement this assessment in at least two different regions of Colombia. Humboldt Institute will lead the implementation of this framework in the Orionoquia Region. This activity will be organized around several tasks: 1. **Meetings of regional assessment group**: Regional stakeholders will be invited to meetings where the approach for regional assessment will be explained and their roles identified. A first version of a causal diagram showing the most important biodiversity issues related to the region sustainability will be discussed. **2**. **Causal diagrams, indicators and variables identification:** causal models will be developed and will be used to identify the set of biodiversity indicators and variables that are needed to be measured in each region. **3. Assessment of observation systems and development of dynamic models**: An assessment of the actual observation system of each region will be performed based on the indicators and variables defined in the previous task. Recommendations for enhancement of the observation system will be delivered to the regional stakeholders. Synthesis and analysis of the available information will be done to report on the current state of biodiversity and its scenarios for sustainability. Opportunities for the implementation of actions for enhancing the observation system will be discussed with regional stakeholders.					
Timeline	**2017**	**2018**	**2019**	2020		
Milestones and/or Deliverables	Meeting of the Orinocco regional assessment group	Meeting of the second test case regional assessment group Assessment for the Orinocco region Production of a Technical Publication for the CBD	Assessment for the second test case region			
Resources	Needed: $17000 for meetings with experts and regional stakeholders	Needed: $27000 for meetings with experts and regional stakeholders	Needed: $10000 for meetings with experts and regional stakeholders			
Link with other activities	This activity will be supported by the EBV Development TF and the Policy TF					

ColB3.	Developing the publication: Monitoring Functional Traits Handbook					
Lead(s)	José Nicolas Urbina, Lilia Roa-Fuentes and Jairo Perez-Torres					
Team/Partners	TBD					
EBV Class	Genetic Composition	Species Populations	**Species Traits**	Community Composition	**Ecosystem Function**	Ecosystem Structure
Ecosystem Services	**YES**			NO		
Development approach	Capacity Building	**Monitoring Protocol design**	**Data Collection**	Modelling	Assessments and Policy Support	
Description	The objective of this activity is to develop guidelines for enhancing biodiversity observation systems in data collection, management and analysis, by producing a series of handbooks that complement the existing monitoring protocols in Colombia. We aim to accomplish this activity by having a close cooperation with the different GEOBON EBV working groups and with other international specialist groups. In 2016, the first handbook for monitoring functional diversity (for plants, amphibians, fishes and birds) was publish but several taxonomic groups were missing. Due to the importance of understanding functional diversity for maintaining ecosystem process, the Colombian BON wants to produce the second volume for measuring functional traits in mammals, reptiles, fungus, algae, aquatic invertebrates, bacteria and ecological restoration. Other handbooks and capacity building activities to implement data collection, management and analysis will be identified in the following years. Their implementation will be subject to the availability of funds, personnel and other resources as well as to the working plans of the researchers and institutions involved. At the moment, nine potential chapters have been identified for this handbook.					
Timeline	**2017**	**2018**	**2019**	2020		
Milestones and/or Deliverables	Design of the editorial project Delivery of the first order draft of the chapters Peer review process	Peer review process Delivery of the final version of the chapters Graphic design	Publication of the handbook			
Resources		Needed: $13000 (for editor and graphic designer)				
Link with other activities	This activity will be linked with activities of the Ecosystem Function WG and the Species Traits WG, pending on the establishment of the latter.					

ColB4.	Implementation of the Colombia Datacube for Biodiversity analysis					
Lead(s)	Miguel Mahecha and Lina M. Estupiñan-Suarez					
Team/Partners	TBD					
EBV Class	Genetic Composition	Species Populations	Species Traits	**Community Composition**	**Ecosystem Function**	**Ecosystem Structure**
Ecosystem Services	YES			NO		
Development approach	Capacity Building	Monitoring Protocol design	Data Collection	**Modelling**	Assessments and Policy Support	
Description	A first step to synthesize existing information, around specific research questions or policy/management, is to develop tools that facilitate the integration and analysis of large amount of data (in space and time). Our aim is to develop a first data cube for Biodiversity Dimensions which is a platform that supports the analysis and the development of indicators of the status and trends of biodiversity in Colombia. This activity is also connected with the Ecological Observatory System for Colombia, an initiative lead by the Max Planck Institute for Biogeochemistry and the Universidad Nacional de Colombia Medellin and discussed by several Academic Colombian Institutions during a workshop in November 2016. The first Data Cube development for Colombia will support biosphere/atmosphere variables (first version) and is based on the Earth System Data Cube from Max Planck Institute[13]. The development of the data cube will be done in 4 phases: **Phase 1 – Production of the first version of biodiversity dimensions data cube**: The first Biodiversity Dimension Data Cube (BD-DC) is developed at 1 km pixel size, and holds open access data derived from satellite devices or interpolation methods. Its main focus is to store and analysis efficiently time series to characterize biological large scale process. Additionally, it can be used to detect extreme events. The first version will support vegetation indexes (EVI, NDVI), leaf area index (LAI), Fraction of Absorbed Photosynthetically Active Radiation (fPAR), among others. Other variables integrated in the cube are clouds, precipitation and temperature. **Phase 2 – Analysis of the Colombian biotic units**: The Biotic Units of Colombia have been define based on beta diversity of species composition and incorporated in the Ecosystem National map. The assessment of BD-DC variables trend for each biotic unit will bring out a new perspective of biological process and function at larger scales. The outcomes will improve our understanding of biotic unit's dynamics on species distribution. **Phase 3 - Inclusion of new variables and previous ones updated**: The data cube design allows to ingest the system with not only biosphere/atmosphere, and biodiversity variables but also social data. While human activities affect biodiversity in multiple dimensions, they are also vulnerable to the environmental variability. The inclusion of social, spatially explicit, data to the data cube will hence be crucial to study these relationships. **Phase 4 – Change detection analysis:** Land use change, natural disasters, among others, are phenomena that generate significant variations on the cube variables. Their detection may be used as inputs in a monitoring biodiversity system at landscape scales. **Phase 5 – Update of the BD-DC:** The data will have to be uploaded frequently in order to perform analysis within short time lags.					

Timeline	2017	2018	2019	2020
Milestones and/or Deliverables	Delivery of the first version of the BD-DC Analysis of the Colombian biotic units Inclusion and update of variables	Inclusion and update of variables	Inclusion and update of variables Change detection analysis Updated version of the BD-DC	
Resources	Research grant from the DAAD (Germany) Needed: $7000 for workshops and meetings	Needed: $7000 for workshops and meetings	Needed: $7000 for workshops and meetings	
Link with other activities	Support from and/or collaboration with EBV Data Task Force			

[13] http://earthsystemdatacube.net/idea/

4.3.2.French BON - ECOSCOPE

ECOSCOPE is a national "biodiversity (meta)data hub" dedicated to "Observation for Research on Biodiversity". It is led by the Foundation for Research on Biodiversity (FRB) - a science-support & science-policy interface founded by eight French research institutions: CNRS, INRA, IRSTEA, IRD, IFREMER, BRGM, MNHN, CIRAD. The overall objective of the French BON is to contribute to document the state and to understand the trends of the biodiversity and to build scenarios for the future.

From 2018 onward, ECOSCOPE will join the national Data Synthesis Centre (CESAB) in a common joint venture, covering data analysis and scientific topics (including EBVs). The technical part may be transferred to the national node of GBIF (GBIF-France) with the following requirements: to widen the coverage of the levels of organization of biodiversity in the French information system and to allow management of metadata, not only specific biodiversity data.

4.3.2.1. Coordinators, members and governance

Scientific manager: Denis Couvet, National museum of natural history (MNHN)
Executive coordinator: Aurélie Delavaud, Fondation for research on biodiversity (FRB)
Members: The BON involves more than 40 research observatories and networks (about 120 at the national level). They are academic research observation systems working on several topics, from (wild and domesticated) genetics to ecosystems. They cover terrestrial, marine and freshwater ecosystems from the metropolitan to overseas territories.

Among these observation systems, two major national networks have expressed their interest in further participating in GEO BON activities. The French "Citizen BON" coordinated by Romain Julliard (MNHN) is dedicated to terrestrial in-situ observation for species monitoring and manages structured data. This network builds on experience gained at the National Museum of Natural History through several majors projects (Vigie-Nature, 65 MO) and has demonstrated that it is possible to collect high quality data with unskilled amateurs – provided that this activity remains entertaining and well-coordinated. The French "Phenology BON" (TEMPO) coordinated by Isabelle Chuine (CNRS) and Inaki Garcia-De-Cortazar-Auturi (INRA) is dedicated to understanding and forecasting how climate change impacts the seasonal rhythms of living organisms - and what are the consequences on ecosystem functioning and production, as well as on population dynamics. The community has been structured in the past years and is now recognized by the French Ministry of Research. TEMPO mainly collects data of the Phenology EBV and has now reached maturity and critical mass to contribute to EBVs at international scale.

In addition some "unit" members (some of which are organized in networks) are already providing information on the datasets and biological samples that they manage, along with the conditions to apply for access and use (Table 17). RARe-AgroBRCs, coordinated by Michèle Tixier-Boichard (INRA) is another research infrastructure that may contribute to the development of some EBVs (e.g. genetic level for domesticated plant, forests, animal, micro-organisms).

Table 17. Metadata on initiatives and datasets

Already published (EML format)	
Centre de Ressources Biologiques Arabidopsis	CRB Arabidopsis
Centre de Ressources Biologiques Caféiers	CRB Coffea
Ifremer BIOCEAN database (Deep Sea Benthic Fauna)	Ifremer database
Centre de Ressources Biologiques Céréales à paille	CRB Céréales à paille
Centre de Ressources Biologiques Medicago truncatula L.	CRB Medicago
Centre de Ressources Biologiques Vignes	CRB Vignes
Centre de Ressources Biologiques Levures IFV	CRB Levures IFV
Commission des Ressources Génétiques Forestières	CRGF
Centre de Ressources Biologiques Brassica - Allium - Cynara - Solanum	CRB BraCySol
Centre de Ressources Biologiques des espèces fourragères et à gazon	CRB Fourrages et gazon
Services Ecosystemiques assures par la BIOdiversite dans les Paysages Agricoles	SEBIOPAG
Vigie-Nature	link
Centre de Ressources Biologiques Moisissures IFV	CRB Moisissures IFV
Centre International de Ressources Microbiennes - Bactéries phytopathogènes	CIRM - CFBP
Cryobanque nationale	Cryobanque
Observatoire de Recherche en Environnement des poissons diadromes sur les Fleuves Côtiers - Ecological Research Observatory on Diadromous Fish in coastal streams	ORE DiaPFC
Données bIodiversité Macroalgues PacifiquE de la base de données des plongeurs de l'IRD LagPlon	DIMPIE - LagPlon
Centre de Ressources Biologiques pour les animaux domestiques @BRIDGe	CRB @BRIDGe
Observatoire Pérenne de l'Environnement	OPE
Observatoire Des Saisons	Phénologie
Wildlife, Behaviour and Ecology Research Unit (Comportement et Ecologie de la Faune Sauvage)	C.E.F.S.
Centre de Ressources Biologiques Plantes Tropicales	CRB-PT
Observation de la biodiversité littorale et côtière	OBLiC
Centre International de Ressources Microbiennes - Levures	CIRM - Levures
In progress	
Grand Observatoire de l'environnement et de la biodiversité terrestre et marine du Pacifique Sud	GOPS
Environmental research and tropical ecology in the Senegal River Low Delta	Tropical ecology in Senegal River Low Delta
Environmental research and tropical ecology in various freshwater ecosystems in West Africa	Tropical aquatic ecology in West Africa
Système d'Observation pour la Conservation des Mammifères et Oiseaux Marins	Observatoire PELAGIS
ONCFS Réseau Ours brun	ROB
ONCFS Réseau Loup-Lynx	ONCFS Réseau Loup-Lynx
Services Ecosystemiques assures par la BIOdiversite dans les Paysages Agricoles	SEBIOPAG
Office National de la Chasse et de la Faune Sauvage	ONCFS
Système national d'information génétique	SNIG
Syndicat des Sélectionneurs Avicoles et Aquacoles Français	SYSAAF
Systèmes d'Observation et d'Expérimentation au long terme pour la Recherche en Environnement : Agro-écosystèmes, Cycles Biogéochimique et Biodiversité	SOERE ACBB
Labogena	
Observatoire thonier	
Florilège - La Biodiversité pour l'Agriculture en France	Florilège
Ecoscope (mer)	
Centre de ressources biologiques canin Cani-DNA	Cani-DNA
Centre de Ressources Génétiques d'île de France	
Centre de Ressources Biologiques Tropicales	CRB-T
Centre Régional de Ressources Génétiques du Nord-Pas-de-Calais	CRRG 59-62
Réseau d'Observation de la Biodiversité de la Loire et de ses Affluents	OBLA
Observatoire Des Saisons	ODS
Observatoires Régionaux de la Chorologie des Espèces et des Traits d'histoire de vie de la région Nord-Pas-de-Calais	ORCHEsTr

Governance: the governance has two levels. The BON level is organized with a Scientific and Technical Advisory Board (advises), a Stakeholders' Forum (express needs, meets once a year), a Steering Committee (decides) and a Coordination Team (proposes, executes) which mobilizes Working Groups (bring expertise) and/or develops Services and Tools. Moreover, the ministry of Research - through the "infrastructures working group" of its Alliance for Research on environment - and the FRB's board of directors lead the whole project with a strategic view.

4.3.2.2. Overview and Key objectives

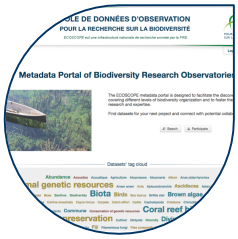
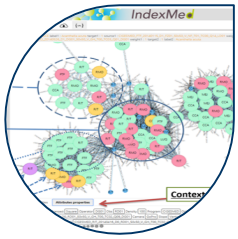
Biodiversity data are collected by several initiatives with their methods, scientific background and concepts, funding's constraints, and users' history. This results, inter alia, in plethora of heterogeneous data, managed in dispersed information systems, which are sometimes not documented.

In this context, the French BON was built to address the scientific challenge of documenting and understanding the state and trends of biodiversity, while building scenarios for the future. In particular, the proposed approach was to set up a national e-research infrastructure in order to foster the complementarity of observations, encompassing several degrees of organizations from the intra-specific level to the ecosystem level; and set up an entry point of access to observations and datasets on biodiversity. The French BON/ECOSCOPE makes its contribution to academic researchers while also facilitating access to non-academic biodiversity data producers and/or users.

To reach the overall objective (i.e. to contribute to document the state and to understand the trends of the biodiversity), the French BON addresses 3 key objectives leading to actions:

1. **To facilitate access and data sharing, to promote services for researchers and products for policy makers**. The strategy adopted is to incubate a metadata portal as it is impossible to gather, in a single database, all biodiversity data covering all the biodiversity organization level and to co-develop services based on expertise from researchers.
2. **To encourage the complementarity of observation** through all the levels of life organization (not only the species level) and through a holistic approach, allowing actors to join forces while respecting aims and constraints of each. The strategy adopted is to use the EBVs concept to discuss, harmonize, and co-organize joint events with wildlife experts, policy-makers, researchers from other domains (abiotic, socio-eco…).
3. **To promote collaboration with national and international existing initiatives**. The strategy adopted is to identify and/or develop collaborations with biodiversity data producers and users' initiatives, with other data hubs dedicated to ocean, Earth's surfaces, atmosphere and solid Earth to promote their actions and best practices for data management.

4.3.2.3. Activities[14]

FB1.	Provide access to metadata and biodiversity observations datasets, to services and tools for visualizing and analysing data					
Lead(s)	From FRB [2017] to another national structure [2018] with high-level information system capabilities.					
Team/Partners	Coordination team (cf. Anna Cohen-Nabeiro, FRB) + CESAB team (cf. Baptiste Laporte, FRB) + IndexMEED coordinator (cf. Romain David, CNRS) + Networks of observatories.					
EBV Class	**Genetic Composition**	**Specie Populations**	**Species Traits**	**Community Composition**	**Ecosystem Function**	**Ecosystem Structure**
Ecosystem Services	YES			**NO**		
Development approach	**Capacity Building**	Monitoring Protocol design	**Data Collection**	Modelling	Assessments and Policy Support	
Description	In 2016, the **metadata portal** [http://ecoscope.fondationbiodiversite.fr/ecoscope-portal/] was launched. Observatories are now describing their activities and datasets following EML and ISO standards. This portal was incubated by the FRB and will be transferred to other structure with high-level information system capacities to speed up its improvement and development. The next steps will be: - To address the **interoperability** with GBIF-France, national research infrastructures (AnaEE-France, LTER-France zones-atelier based on EU GeoCatalogue), and, at the international level with the information systems of GEO BON, DataONE and possibly LTER. - **Capacity building and training** on tools for data management, data sharing and analysis, which are organized in routine. During this implementation plan, ECOSCOPE, with the IndexMEED consortium, will investigate **graphs** as new tools to mine and visualize data through uses-cases, workshops and national seminars. - Starting from 2018, ECOSCOPE will join the national **Data Synthesis Center** (CESAB) in a common joint venture, covering scientific topics (including EBVs) and data management approaches and tools (covering thesaurus). **National metadata portal (EML, ISO19115, NCD)**  **Graphs for data mining and visualization (with IndexMeed)**  **Trainings on data management and data publication (co-organized)**  					
Timeline	**2017**	**2018**	**2019**	**2020**		
Milestones and/or Deliverables	• Last workshops and first outcomes of the French case studies of research on biodiversity using graphs + annual seminar.	• Transfer of the metadata portal. • CESAB partnership.	• Implementation of biodiversity thesaurus developed by the community.	• Full interoperability with other national and international information systems.		
Resources[14]						
Link with other activities	This activity will collaborate with the BON Development WG, particularly with BON-in-a Box (BD2) The activity is also strongly linked with activities of GBIF-France.					

[14] The resources for all the activities of the French BON are about 250 k€/y + external human resources bringing expertise.

FB2.	Encourage joint and integrated approach to develop the complementarity of observations					
Lead(s)	FRB through ECOSCOPE & CESAB teams.					
Team/Partners	Coordination team (cf. Aurélie Delavaud, FRB) + CESAB team (cf. Alison Specht, FRB) + Researchers & experts from laboratories (incl. Jean-Baptiste Mihoub, UPMC; Cyrille Viole, CNRS; Sébastien Barot, IRD) + Networks of observatories (incl. Romain Julliard, MNHN; Isabelle Chuine, CNRS; Inaki Garcia-de-Cortazar-Auturi, INRA).					
EBV Class	**Genetic Composition**	**Specie Populations**	**Species Traits**	**Community Composition**	**Ecosystem Function**	**Ecosystem Structure**
Ecosystem Services	**YES**			NO		
Development approach	**Capacity Building**	**Monitoring Protocol design**	Data Collection	Modelling	Assessments and Policy Support	

Description

The Workshops on **EBVs & observation at the ecosystem level** (structure, function), started in 2016, will continue and EBVs dedicated to genetic resources will be explored. This should help to structure a shared vision about scientific concepts, to engage conversation and debate on methods, to explore ways to organize data. Moreover, using a graph approach, a focus should be placed on the combination of variables to explore functional biodiversity.

Those concepts still need to be popularized within the research community and within other stakeholders' groups such as protected areas managers and policy makers. ECOSCOPE is thus engaging in a reflection to establish a **partnership with the new French Biodiversity Agency (AFB)** that federates the French Environment community (protected areas managers, naturalists and indicators/reports for policy-support teams).

ECOSCOPE organizes or co-organizes **seminars covering a scientific topic and gathering different communities** (same questions, different concepts, approaches and methods).

Finally, ECOSCOPE provides research institutions and ministries with **situational analysis** of national observatories.

Encouraging exchanges on EBVs concept (meetings, workshops…)

Situational analysis of the national structuration of research observatories (forces, gaps, data…)

Meetings on common issues but different communitites (co-organized)

Timeline	2017	2018	2019	2020
Milestones and/or Deliverables	• Organisation of a scientific seminar on EBVs and Ecosystem Services. • National networks involvement (TEMPO, SC).	• AFB partnership (tbd). • Seminar on domesticated and wild population management. • Workshop on EBVs and observation at the ecosystem level. • National networks operation (TEMPO, SC).	• First outcome of case studies on combinations of EBVs through graphs.	• Update of the Situational analysis.
Resources[14]				
Link with other activities	This activity will be linked with the EBVs Development TF and BON development WG. In addition, **TEMPO (phenology) and Citizen science national networks** will develop their contribution to GEO BON (monitoring protocol design, data collection, modelling approach).			

FB3.	Contribution to national and international initiatives and openness					
Lead(s)	FRB through ECOSCOPE & CESAB teams.					
Team/Partners	National initiatives working on data management and/or involved in international initiatives.					
EBV Class	Genetic Composition	Specie Populations	Species Traits	Community Composition	Ecosystem Function	Ecosystem Structure
Ecosystem Services	YES			NO		
Development approach	**Capacity Building**	Monitoring Protocol design	Data Collection	Modelling	Assessments and Policy Support	

Description

The components of this activity are integrated with previous initiatives in a "win-win" relationship:
- ECOSCOPE establishes links with others **national initiatives promoting best practices for data management** and with others major infrastructures. This include GBIF-France, the Databases network RBDD, INRA-datapartage, INPN, and **others national data hubs** – organizing themselves as a research infrastructure: ODATIS / oceans, Form@Ter / solid earth, THEIA / lands and Earth's surface (remote sensing) and ACTRIS / atmosphere.
- The success of this activity will rely on the establishment of new links with the AFB (cf. previous activities)
- This activity will also be reflected by the involvement of ECOSCOPE in several **working groups coordinated by international initiatives** (RDA, DataONE, LifeWatch…).
- ECOSCOPE will spread information about its activities and partners' tools and results – through a **newsletter**.

« BON » labeling: recognition and dialogue with the international level

Dissemination of information about the work of the infrastructure and observatories

Timeline	2017	2018	2019	2020
Milestones and/or Deliverables			• Integrated data hub for research on biodiversity and environment.	
Resources				
Link with other activities				

4.3.3.China BON

4.3.3.1. Coordinators, members and governance

Lead: Dr. Haigen Xu (NIES)
Membership: More than 400 universities, research institutes, protected areas and civil societies.
Governance: Coordinated by Nanjing Institute of Environmental Sciences affiliated to Ministry of Environmental Protection of China (MEP), and supported by MEP.

4.3.3.2. Overview and Key objectives

China BON has received wide support from the Central Government, Ministry of Environmental Protection (MEP), Ministry of Finance (MF) and the scientific community from China, with an annual financial allocation of approximately US$ 5.8 million from MEP and MF. Under the planning and coordination of Nanjing Institute of Environmental Sciences, China BON has attracted approximately 3500 trained biologists, protected area managers and volunteer citizen scientists from over 400 universities, research institutes, protected areas and civil societies to get involved in field monitoring of biodiversity, currently consisting of mammals, birds, amphibians and butterflies. China BON adopted national standards and field protocols for biodiversity monitoring promulgated by MEP. 441 target regions (counties) were selected and applied for monitoring with >9000 line transects and point transects.

In China BON, raw data were systematically collected, including the name of species, location and number of individuals, type and vegetation of habitats, weather conditions, and categories of anthropogenic disturbance (e.g. infra-structure development, resources exploitation, pollution, hunting, tourism, agriculture, husbandry and fishery) and extent (strong, moderate, low or none). The corresponding EBVs that can be generated by China BON encompass abundance and distribution, taxonomic diversity, habitat structure and quality, and phenology.

To enhance the sustainability of China BON, trained biologists were coupled with volunteer citizen scientists. At least one professional biologist was included in each monitoring team while well trained volunteers are also involved to extend limited staff and budgets for the long-term monitoring goal. At present, China BON's Work Plan (Table 18) has been approved by the State Council of China. In particular, the operationalization of biodiversity monitoring networks based on this study has been listed as one of the key action plans by China National Economy and Social Development Planning in the 13th Five-Year Plan and approved by the National People's Congress in 2016.

Table 18. Summary of the activities of the China BON

CHINA BIODIVERSITY OBSERVATION NETWORK	EBV classes						Ecosystem Services	Development approach				
	Genetic composition	Species Populations	Species Traits	Community Composition	Ecosystem Function	Ecosystem Structure		Capacity building	Monitoring protocol design	Data collection	Modelling	Assessments and Policy support
CB1. Mammal monitoring		■	■	■				■	■	■	■	■
CB2. Bird monitoring		■	■	■				■	■	■	■	■
CB3. Amphibian monitoring	■	■	■	■				■	■	■	■	■
CB4. Butterfly monitoring		■	■	■				■	■	■	■	■

Key objectives: Detect changes in species composition, distribution and population dynamics, assess major threats to target species and evaluate the efficiency of conservation policy

4.3.3.3. Activities

Currently, China has experienced a very rapid growth in population and economy. Biodiversity monitoring can provide timely and accurate data for regional or national management needs and policy making. Lack of monitoring data can reduce the capacity for informed decision-making and timely reporting on progress towards conservation targets. Hence, the activities of the China BON for the 2017-2020-time period will focus on the monitoring of mammals, birds, amphibians, and butterflies.

CB1.	Mammal monitoring (China BON-Mammals)					
Lead(s)	Prof. Haigen Xu, Dr. Jiaqi Li					
Team/Partners	Over 30 partners from relevant universities, research institutes and protected areas					
EBV Class	Genetic Composition	Species Populations	Species Traits	Community Composition	Ecosystem Function	Ecosystem Structure
Ecosystem Services	YES			NO		
Development approach	Capacity Building	Monitoring Protocol design	Data Collection	Modelling	Assessments and Policy Support	
Description	Mammal monitoring network, one of the key components of China BON, was initiated in 2016 based on stratified random sampling, covering representative ecosystems such as forests, grasslands, deserts, wetlands and farmlands. The main raw data were systematically collected, including the name of species, location and number of individuals, type and vegetation of habitats, weather condition, and categories (infra-structure development, resources exploitation, pollution, hunting, tourism, agriculture, husbandry and fishery, etc.) and extent (strong, moderate, low or null) of anthropogenic disturbance. The recorded EBVs encompass abundance and distribution, taxonomic diversity, habitat structure and quality, and phenology. Under the coordination of the Nanjing Institute of Environmental Sciences affiliated to the Ministry of Environmental Protection, China BON-Mammals is now covering **70 target regions** (counties) with **4200 camera traps**, has attracted approximately 150 trained biologists, protected area managers and volunteer citizen scientists from over 30 universities, research institutes, protected areas and civil societies to get involved in field monitoring of biodiversity.					
Timeline	2017	2018	2019	2020		
Milestones and/or Deliverables	Monitoring protocols; training courses; annual monitoring report	Training courses; annual monitoring report	Training courses; annual monitoring report	Training courses; annual monitoring report		
Resources	USD 1.4 million	USD 1.4 million				
Link with other activities	All relevant EBV Working Groups, BON Development Working Group, EBV Data Task Force.					

CB2.	Bird monitoring (China BON-Birds)					
Lead(s)	Prof. Haigen Xu, Dr. Peng Cui, Mr. Fang Yong, Ms Wenwen Zhang					
Team/Partners	Over 150 partners from relevant universities, research institutes, protected areas and civil societies					
EBV Class	Genetic Composition	Species Populations	Species Traits	Community Composition	Ecosystem Function	Ecosystem Structure
Ecosystem Services	YES			NO		
Development approach	Capacity Building	Monitoring Protocol design	Data Collection	Modelling	Assessments and Policy Support	
Description	Bird monitoring network, one of the key components of China BON, was initiated in 2011 based on stratified random sampling, covering representative ecosystems such as forests, grasslands, deserts, wetlands, farmlands and human settlement. Main raw data were systematically collected, including the name of species, location and number of individuals, type and vegetation of habitats, weather condition, and categories (infra-structure development, resources exploitation, pollution, hunting, tourism, agriculture, husbandry and fishery, etc.) and extent (strong, moderate, low or null) of anthropogenic disturbance. The recorded EBVs encompass abundance and distribution, taxonomic diversity, habitat structure and quality, and phenology. Under the coordination of the Nanjing Institute of Environmental Sciences affiliated to the Ministry of Environmental Protection, China BON-Birds covering **338 target regions** (counties) with **3500 line transects/point transects** and 850 recorded bird species, has attracted approximately 850 trained biologists, protected area managers and volunteer citizen scientists from over 150 universities, research institutes, protected areas and civil societies to get involved in field monitoring of biodiversity.					
Timeline	2017	2018	2019	2020		
Milestones and/or Deliverables	Monitoring protocols; training courses; annual monitoring report	Training courses; annual monitoring report	Training courses; annual monitoring report	Training courses; annual monitoring report		
Resources	USD 1.3 million	USD 1.3 million				
Link with other activities	All relevant EBV Working Groups, BON Development Working Group, EBV Data Task Force.					

CB3.	Amphibian monitoring (China BON-Amphibians)					
Lead(s)	Prof. Haigen Xu, Prof. Jianping Jiang, Mr. Jiangnan Li					
Team/Partners	Over 65 partners from relevant universities, research institutes and protected areas					
EBV Class	Genetic Composition	Species Populations	Species Traits	Community Composition	Ecosystem Function	Ecosystem Structure
Ecosystem Services	YES			NO		
Development approach	Capacity Building	Monitoring Protocol design	Data Collection	Modelling	Assessments and Policy Support	
Description	Amphibian monitoring network, one of the key components of China BON, was initiated in 2011 based on stratified random sampling, covering representative ecosystems such as forests, grasslands, wetlands and farmlands. Main raw data were systematically collected, including the name of species, location and number of individuals, type and vegetation of habitats, weather condition, and categories (infra-structure development, resources exploitation, pollution, hunting, tourism, agriculture, husbandry and fishery, etc.) and extent (strong, moderate, low or null) of anthropogenic disturbance. The recorded EBVs encompass abundance and distribution, taxonomic diversity, habitat structure and quality, and phenology. Under the coordination of the Nanjing Institute of Environmental Sciences affiliated to the Ministry of Environmental Protection, China BON-Amphibians covering **114 target regions** (counties) with **1385 line transects**, **166 pitfall traps** and **37 artificial refuges**, and 240 recorded amphibian species, has attracted approximately 500 trained biologists, protected area managers and volunteer citizen scientists from over 65 universities, research institutes and protected areas to get involved in field monitoring of biodiversity.					
Timeline	2017	2018	2019	2020		
Milestones and/or Deliverables	Monitoring protocols; training courses; annual monitoring report	Training courses; annual monitoring report	Training courses; annual monitoring report	Training courses; annual monitoring report		
Resources	USD 1 million	USD 1 million				
Link with other activities	All relevant EBV Working Groups, BON Development Working Group, EBV Data Task Force.					

CB4.	Butterfly monitoring (China BON-Butterflies)					
Lead(s)	Prof. Haigen Xu, Dr. Fangzhou Ma, Ms Yaping Hu					
Team/Partners	Over 53 partners from relevant universities, research institutes and protected areas					
EBV Class	Genetic Composition	Species Populations	Species Traits	Community Composition	Ecosystem Function	Ecosystem Structure
Ecosystem Services	YES			NO		
Development approach	Capacity Building	Monitoring Protocol design	Data Collection	Modelling	Assessments and Policy Support	
Description	Butterfly monitoring network, one of the key components of China BON, was initiated in 2016 based on stratified random sampling, covering representative ecosystems such as forests, grasslands, wetlands and farmlands. Main raw data were systematically collected, including the name of species, location and number of individuals, type and vegetation of habitats, weather condition, and categories (infra-structure development, resources exploitation, pollution, hunting, tourism, agriculture, husbandry and fishery, etc.) and extent (strong, moderate, low or null) of anthropogenic disturbance. The recorded EBVs encompass abundance and distribution, taxonomic diversity, habitat structure and quality, and phenology. Under the coordination of Nanjing Institute of Environmental Sciences affiliated to the Ministry of Environmental Protection, China BON-Butterflies covering **111 target regions** (counties) with **582 line transects** and 1093 recorded butterfly species, has attracted approximately 500 trained biologists, protected area managers and volunteer citizen scientists from over 53 universities, research institutes and protected areas to get involved in field monitoring of biodiversity.					
Timeline	2017	2018	2019	2020		
Milestones and/or Deliverables	Monitoring protocols; training courses; annual monitoring report	Training courses; annual monitoring report	Training courses; annual monitoring report	Training courses; annual monitoring report		
Resources	USD 0.8 million	USD 0.9 million				
Link with other activities	All relevant EBV Working Groups, BON Development Working Group, EBV Data Task Force.					

4.4. Thematic BONs

4.4.1. The Marine Biodiversity Observation Network

MBON is a "coalition of the willing" who agree to share knowledge and know-how to evaluate changes of biodiversity in the ocean, including data, products, protocols and methods, data systems and software. The MBON seeks to establish a process for sustained, operational measurements of biodiversity around the globe. These observations should be collected in standardized ways, and the information shared, in order to understand how biodiversity is changing. The ultimate objective is to understand how and why life in the ocean is changing, how local changes relate to changes taking place over larger regions, and to provide information to help define options for government and intergovernmental policies relevant to the conservation and sustainable use of marine biodiversity.

4.4.1.1. Coordinators, members and governance

Co-chairs: Mark Costello, Isabel Sousa-Pinto, and Frank Muller-Karger
Interim coordinators: MBON has established an interim steering committee (Table 19) and is growing its membership. Some individuals have taken on responsibilities to liaise with GEO BON Working Groups and Task Forces, and other organizations.
Steering Committee: The Steering Committee (SC) (Table 19) will develop and update this Plan. Once sufficient membership has been established a more formal governance structure will be established. The initial SC is supported by people participating in GEO BON Working Groups, Task Forces and related GEO initiatives. The SC will continue to find people willing to communicate between MBON and related initiatives in GEO BON, regional MBON such as in the Americas.
In addition to expanding the MBON membership through personal contacts and networking, the SC will communicate its plans through the GEO BON website, MBON email list, presentations at meetings, and publications. The SC will report progress to GEO BON.

Table 19. MBON Steering Committee

Individual	Affiliation	Representation (role)
Frank Muller-Karger	University of South Florida, USA	Americas (Co-chair)
Mark Costello	University of Auckland, New Zealand	Asia and Pacific (Co-chair)
Isabel Souza Pinto	University of Porto, Portugal	Europe and Africa (Co-chair)
David Obura	CORDIO East Africa, Kenya	Global Coral Reef Monitoring Network (GCRMN)
Emmett Duffy	Smithsonian Institution, USA	marineGEO (Tennebaum Marine Observatories)
Amanda Bates	University of Southampton, UK	Time series data
Gabrielle Canonico	NOAA, Silver Springs, USA	US IOOS
Ward Appeltans	Intergovernmental Oceanographic Commission	OBIS
Patricia Miloslavich		GOOS Bio-Eco
Enrique Montes	University of South Florida, USA	Pole to Pole in Americas
Catherine (CJ) Reynolds	International Ocean Institute, Florida, USA	MBON webpages

Membership: MBON is a network rather than a legally-incorporated structure or organization. As a community of practice and collaboration, groups can engage in relatively informal or formal agreements. MBON members are anticipated to include government agencies, academic institutions, researchers, research and non-governmental organizations, and commercial organisations. During its initial phase its membership will be grown and a governance structure

established. Membership will be recognized on public documents such as websites. As of July 2017, 47 members of the MBON were registered (http://data.geobon.org/networks/pages/marine.php).

4.4.1.2. Overview and Key objectives

The goal of MBON is to develop a global community of practice for the collection, curation, analysis and communication of marine biodiversity data. This requires coordination and collaboration between countries, organisations and individuals involved in the Group on Earth Observations (GEO), the Intergovernmental Oceanographic Commission (IOC) of UNESCO, and many other organisations.

Overview:
A growing human population depends on healthy ocean ecosystems for a number of important economic and social benefits, including high quality food, pharmaceuticals and other materials, coastal protection, recreation, transportation, and renewable energy. Changes in ocean biodiversity threaten these benefits. These changes are driven both by natural variability and direct and indirect human impacts on the ocean. Governments and researchers worldwide have recognized the need for information to evaluate, respond and adapt to these changes in national plans and in a number of international treaties including the CBD, the U.N. Sustainable Development Goals (especially SDG 14 on oceans), the United Nations Law of the Sea (UNCLOS), and Ramsar Convention on wetlands. For example, SDG 14 provides 10 Targets, 6 of which are tied to biodiversity and ecosystems. Despite this recognition of its importance, sampling of marine biodiversity has been largely neglected in regular ocean observing programs due the complexity of its measurement. To address this need, the marine ecosystem Working Group 5 of GEO BON established an MBON task group in 2015, and formally proposed establishment of MBON to GEO BON in 2016.

MBON will build a community of practice by linking existing national and international research and monitoring efforts. It provides the marine biodiversity component of GEO (through GEO BON). MBON will work with the international community to promote the operational collection of biodiversity observations, working with the Global Ocean Observing System (GOOS) and other field sampling programmes ensure that biodiversity observations are complemented with physical and biogeochemical observations of the ocean and vice-versa.

EBVs will be developed through a series of regional and global activities. EBVs of interest include changes from the coast to deep-sea in the abundance of living resources, species of ecological and conservation importance, invasive species, in ecosystem structure (cover of particular species and habitat) and ecosystem function (i.e., the relationship between marine species and habitat), and the relationship and value of these variables to humans.

Key Objectives:
1. Develop an implementation plan that leads and coordinates institutions, organizations, existing networks, and people so as to build a community of practice to promote field, laboratory, statistical and reporting methods for the global community.
2. networking with the biodiversity and marine science communities, including within GEO, GEO BON, IOC, IABO, marine station networks, and national organizations;
3. Develop a common framework for Essential Biodiversity Variables (EBVs) within GEO BON and GOOS Essential Ocean Variables (EOVs, developed jointly with the GOOS Bio-Eco panel);
4. Support work led by UNEP-WCMC on development of marine indicators to support SDG 14 and Aichi Targets;
5. Foster the development of international and thematic MBON, including development of marineGEO and expansion of USA MBON projects to an all-Americas MBON;

6. Promote best practice in data management, including development of standards that aid interoperability and data integration, and publication of data through OBIS; including contributing to the GEO BON "BON in a Box" compendium of methodologies for biodiversity observations;
7. Support research that supports the development of MBON.

Table 20. Summary of the Activities of the Marine BON

MARINE BIODIVERSITY OBSERVATION NETWORK	EBV classes						Ecosystem Services	Development approach				
	Genetic composition	Species Populations	Species Traits	Community Composition	Ecosystem Function	Ecosystem Structure		Capacity building	Monitoring protocol design	Data collection	Modelling	Assessments and Policy support
MB1. Developing an MBON IP												
MB2. Data Management												
MB3. Developing EBVs												

4.4.1.3. Activities

MB1.	Developing an MBON Implementation Plan			
Lead(s)	Frank Muller-Karger, Mark Costello, Isabel Sousa Pinto			
Team/Partners	IOC-UNESCO (GOOS and OBIS)			
EBV Class	Genetic Composition; Species Populations; Species Traits; Community Composition; Ecosystem Function; Ecosystem Structure			
Ecosystem Services	YES	NO		
Development approach	Capacity Building; Monitoring Protocol design; Data Collection; Modelling; Assessments and Policy Support			
Description	To aid planning of a global network of marine biodiversity observations.			
Timeline	2017	2018	2019	2020
Milestones and/or Deliverables	**Management:** Publish MBON vision paper. Establish MBON Secretariat. **Networking:** Build MBON Network. **Demonstrations:** Pole to Pole in Americas. Smithonian's Marine GEO. **EBV and EOV development:** Publication comprehensive marine EBV as part of EOV.	**Management:** Formalise MBON network (membership, governance). **Networking:** EuroMBON. WCMB IV. **Demonstrations:** MBON portal operational, providing the first products. **EBV and EOV development:** Demonstration of EBV and EOV.	**Demonstrations:** GOOS conference. OceanObs2019. **EBV and EOV development:** Continued development methods and EBV with new research and technologies.	Operational network of observatories monitoring trends in marine biodiversity from local to global scales. **EBV and EOV development:** Continued development methods and EBV with new research and technologies.
Resources	At present, MBON is being built through support of individuals engaged in academic, government, and private sector projects. In the 2017-2018 time frame, MBON will develop a scope of resources needed as part of the implementation plan			
Link with other activities	The MBON plan by its nature links with all mentioned activities, other GEO BON activities, and through its members, wider activities in marine science.			

MB2.	Data Management					
Lead(s)	Ward Appeltans					
Team/Partners	OBIS					
EBV Class	**Genetic Composition**	**Species Populations**	**Species Traits**	**Community Composition**	**Ecosystem Function**	**Ecosystem Structure**
Ecosystem Services	**YES**			NO		
Development approach	**Capacity Building**	Monitoring Protocol design	**Data Collection**	Modelling	**Assessments and Policy Support**	
Description	OBIS is the world's premier open access, online data system on the diversity, distribution and abundance of marine species. At present, more than 20 OBIS nodes around the world publishing data. Collectively, they have provided over 47 million observations of nearly 120,000 marine species, from bacteria to whales, from the surface to 10,900 m depth, and from the tropics to the poles. The datasets are integrated and allow search and mapping by species name or any higher taxonomic level, geographic area, depth, time and environmental parameters. OBIS provides a powerful platform through which to share and archive relevant historical observations. MBON will encourage publication of data through OBIS and its continued development.					
Timeline	**2017**	**2018**	**2019**	**2020**		
Milestones and/or Deliverables						
Resources						
Link with other activities	This activity will be connected with the work of the EBV Data TF.					

MB3.	Developing EBVs					
Lead(s)	Mark Costello and GOOS representative					
Team	TBD					
EBV Class	**Genetic Composition**	**Species Populations**	**Species Traits**	**Community Composition**	Ecosystem Function	Ecosystem Structure
Ecosystem Services	**YES**			NO		
Development approach	**Capacity Building**	**Monitoring Protocol design**	**Data Collection**	**Modelling**	**Assessments and Policy Support**	
Description	MBON will follow guidelines of the Framework for Ocean Observing (FOO), working with GOOS to develop a common framework for biodiversity and biological EOVs. The GOOS Bio-Eco panel has identified EOVs for ocean biology based on a Drivers-Pressures-State-Impact-Response process that include the societal and scientific requirements of national programs, international treaties, and the scientific community. MBON facilitates the development of a common framework for EBV and EOV, informing GOOS on the integration of marine biodiversity observations within environmental variables. Working within this framework facilitates adoption of the biodiversity EOVs in existing international ocean observing systems and regional alliances that constitute GOOS. In developing the network, MBON also recognizes the important linkages between coastal habitats and the deep ocean as an environmental continuum within which many different species live, migrate, and reproduce. Therefore, the MBON network will link communities, including for example the GEO-Wetlands initiative, with the marine community. EBVs of interest include changes from the coast to deep-sea in the abundance of living resources, species of ecological and conservation importance, invasive species, in ecosystem structure (cover of particular species and habitat) and ecosystem function (i.e., the relationship between marine species and habitat), and the relationship and value of these variables to humans.					
Timeline	**2017**	**2018**	**2019**	**2020**		
Milestones and/or Deliverables	Draft marine EBV	Demonstration of mEBV				
Resources						
Link with other activities	This activity will be linked with the work of the EBV Framework TF, and with the relevant activities of the EBV Working Groups.					

In addition, the MBON, via the co-chairs, will remain active in:

1. **Fostering the development of international and thematic MBON**. In particular, MBON co-chairs and other members will actively contact potential new participants in MBON and promote the MBON vision at scientific meetings and otherwise through their community.

2. **Research to support MBON.** The MBON members are primarily from the marine research community. The SC Co-Chairs will encourage members to conduct research that contributes to the design, implementation and analysis of marine biodiversity data. Examples of resources produced by members include the Global Marine Environmental Datasets (GMED) and Ecological Marine Units (EMU), a 3D classification of the oceans. MBON participants are also engaged in research and product development that supports the implementation of MBON. This includes the development of EBVs, EOVs, field and laboratory methods, and delivery of data, publications and related products. "BON in a Box" will be used to disseminate such material and facilitate the integration of regional knowledge and observations. The SC will provide endorsement of research funding proposals that will contribute and commit to report progress to MBON. This will support research applications for national funding in countries that are GEO members.

4.4.2.The Freshwater Biodiversity Observation Network

Built on existing regional and global networks, the Freshwater Biodiversity Observation Network (FWBON) will be an important mechanism to collect, standardize and distil freshwater biological and ecosystem data and information into products that will improve the observation, reporting and protection of freshwater biodiversity. It will enable the global scientific community to describe the relationships between biodiversity, organism abundance, system productivity, and ecosystem services.

4.4.2.1. Coordinators, members and governance

The coordination of the FWBON is shared by the Co-chairs, Regional Coordinators, and Advisory Board members. The Coordination Committee is the governing body of FWBON, comprising the co-chairs and interim coordinators.

Co-chairs are responsible for the day to day running and coordination of FWBON and providing leadership to the group. They are accountable to the Coordination Committee. The priorities of co-chairs must be global. They need to be able to respond to needs of the network emanating from any region in the world. However, at least one co-chair will be based in Europe to ensure face-to-face liaison with the GEO BON Secretariat. A larger team of globally representative regional experts in freshwater biodiversity, the Interim Regional Coordinators, will serve to mobilise and coordinate FW BON members at a regional level. Together, the co-chairs and the Regional Coordinators make up the governing body of FWBON which will, from time to time, draw on the expertise of the Advisory Board, a small group of international freshwater biodiversity experts, who can provide advice on the strategic direction of FWBON and on emerging global issues that may arise.

FWBON currently counts 102 members[15] from 41 countries. There are active interim office bearers in all positions as follows: 3 co-chairs, 15 regional coordinators (2-3 from each continent) and 5 Advisory Board members. These bodies are already fully functional with the interim office bearers until FW BON transitions into a permanent governance arrangement.

Interim co-chairs

Eren Turak : NSW Office of Environment and Heritage & The Australian Museum, Australia
Aaike De Wever: Royal Belgian Institute of Natural Sciences, Belgium
Jeanne Nel : Vrije Universiteit, Netherlands & Nelson Mandela Metropolitan University South Africa

Interim Regional Coordinators

Europe
Astrid Schmidt-Kloiber, Institute of Hydrobiology and Aquatic Ecosystem Management
Adrian Strauch, Bonn University
Aaike De Wever, Royal Belgian Institute of Natural Sciences, Belgium
Africa
Mike Murray-Hudson, University of Botswana, Botswana
John Simaika, University of Stellenbosch, South Africa
South America
Mathias Kuemmerlen, Senckenberg Research Institute, Germany
Andrea Encalada, Universidad San Francisco de Quito, Ecuador
North America

[15] As of July 2017, 11 members were registered on the GEO BON website: http://data.geobon.org/networks/pages/freshwater.php

Erin Hestir, North Carolina State University, USA
Alex Bush, University of New Brunswick, Canada
Jennifer Lento, Canadian Rivers Institute, Canada
Asia-Pacific
Shin-Ichi Nakano, Kyoto University, Japan
Cathy Yule, Monash University Malaysia, Malaysia
Lu Cai, Beijing University of Forestry, China
Oceania
Simon Linke, Griffith University, Queensland, Australia
Bindiya Rashni, University Of South Pacific, Fiji

FW BON Advisory Board
Robin Abell, The Nature Conservancy, USA
Ian Harrison, Conservation International, USA
Carmen Revenga, The Nature Conservancy, USA
David Dudgeon, Hong Kong University, China
Jörg Freyhof, Leibniz-Institute of Freshwater Ecology Germany

4.4.2.2. Overview and Key objectives

The aim FWBON is to create a network of people and institutions that have the capacity to realise a comprehensive assessment of the Status of freshwater biodiversity across the world by 2020, provided that that the funds are available for such an operation. Hence the capital of the FWBON are people who have the knowledge, connections and motivation to secure and leverage the funds needed to achieve a global assessment. The connections and affiliations of the current membership of FWBON are such that the steps taken towards global assessments will inevitably be shaped by priorities set by the CBD, Ramsar Convention, IUCN, UNEP-WCMC, IPBES as and other major global partners as well as national governments and other regional partners.

FWBON will integrate a set of existing monitoring programs as well as assisting in developing new ones, as a stepping-stone toward a globally integrated observation of freshwater biodiversity. FWBON will also contribute to the integration of freshwater biodiversity priorities with those of other biodiversity observation systems to ensure that conservation and management is cross-cutting and landscape scale, and hence effective.

A successful FWBON is fundamental to (1) provide current benchmarks of biodiversity status and trends at the local to global scales that are useful to users in science, industry, policy and management, and (2) to improve each country's capacity to detect, forecast and respond to impacts due to human activities, climate change, invasive species, and other stressors on ecosystem services.

FW BON will contribute to the development and measurement of Essential Biodiversity Variables in freshwater environments and contribute methods and tools for BON in a Box, and thereby contribute to the further establishment of national FW BON programs.

FWBON will promote the establishment of best practices for global freshwater biodiversity observations by:
1. improving the collection of harmonized data
2. developing data standards and methodologies for data management and dissemination
3. facilitating data sharing without compromising national concerns
4. integrating biodiversity information with physical and chemical data

5. producing products useful for sound management of rivers and their catchments, lakes, wetlands and subterranean aquatic ecosystems
6. better integration and harmonization of freshwater science and practice with terrestrial and coastal objectives.

FW BON seeks to integrate independent historical and current biological/ecological surveys and databases and fill gaps with new observations that incorporate: new remote sensing methods; novel molecular (eDNA) technologies; traditional biodiversity and environmental research tools; citizen science and community based monitoring activities facilitated by advances in information and communication technologies; coordinated experiments and process studies. It will support modelling efforts aimed at estimating current, as well as future distribution and populations of freshwater biodiversity to support decision making by various stakeholders at various levels. FW BON will also develop the framework for integrating biodiversity with other essential environmental variables (Essential Water Variables) and databases by working with GEO Water, GEO Wetlands, GWOS, and other national and international groups.

Table 21. Summary of the Activities of the Freshwater BON

FRESHWATER BIODIVERSITY OBSERVATION NETWORK	EBV classes						Ecosystem Services	Development approach				
	Genetic composition	Species Populations	Species Traits	Community Composition	Ecosystem Function	Ecosystem Structure		Capacity building	Monitoring protocol design	Data collection	Modelling	Assessments and Policy support
FWB1. Operationalizing FW BON	■	■	■	■	■	■		■				■
FWB2. Global freshwater biodiversity assessment	■	■	■	■	■	■		■	■	■	■	■
FWB3. Inventorying global freshwater biodiversity for FIP		■						■		■		
FWB4. Classifying freshwater ecosystems	■	■	■	■	■	■	■					■

4.4.2.3. Activities

FWB1.	Operationalising FW BON					
Lead(s)	Eren Turak, Aaike De Wever, Jeanne Nel					
Team/Partners	All FW BON members					
EBV Class	Genetic Composition	Species Populations	Species Traits	Community Composition	Ecosystem Function	Ecosystem Structure
Ecosystem Services	YES			NO		
Development approach	Capacity Building	Monitoring Protocol design	Data Collection	Modelling	Assessments and Policy Support	

Description

1. Activate the group.

2. Mobilise the FW BON membership around activities mapped to the tasks and deliverables of Working Groups and Thematic BONs within the GEO BON network and entities within GEO to ensure that freshwater ecosystems and biodiversity are integrated into their work. This includes:

a. BON Development WG: Integration of Freshwater considerations in BON Design; freshwater focussed tools for BON in a BOX, and integration of operational EBVs across freshwater, terrestrial and marine realms.

b. Ecosystem Function WG: Using conceptual/qualitative ecosystem process models to prioritise ecosystem function EBVs, and in particular determine how satellite remote sensing can be applied to make observations to support the measurement of these variables (e.g. NPP) in freshwater ecosystems.

c. Ecosystem Structure WG: collaborate on global measurements of change in ecosystem extent and fragmentation for fresh water ecosystems e.g. semi-automated tracking of satellite RS based tracking of wetland extent, and river fragmentation.

d. Species Populations WG: Identifying opportunities to link the extensive work currently being done by FW BON members on species distribution models for freshwater species.

e. MBON: Continue joint meetings and progress exploration of conceptual and practical overlaps in the application of EBVs in freshwater and marine environments.

f. GEO Wetlands: Input of biodiversity measures to GWOS, State of the Worlds Wetlands, and Global Wetland Outlook.

g. GEO Ecosystems: Support GEO Ecosystems (GI-14) activity to develop methods, data, maps, publications, and web-based apps for a new set of standardized, rigorous, and practical global ecological freshwater units (EFUs) as a synthesis of existing global freshwater ecosystems resources.

h. GEO Water: Contribute to the Development of Essential Water Variables (EWV) ensuring complementarity between EWVs and EBVs.

3. Initiate the organisation of bimonthly or quarterly webinars, featuring work done by members.

4. Establish partnerships with organisations involved in observations of freshwater biodiversity at broad spatial scales and those who require freshwater biodiversity information including GEO-Wetlands, GEO Water, GEO Ecosystems, GLEON, GBIF, Freshwater Information Platform (FIP), Ramsar, IUCN, CBD, IPBES, Satellite Based Wetland Observatory Service (SWOS) and the Sustainable Water Futures Project (SWFP). The main objective is to explore what steps can be taken to raise the profile of freshwater biodiversity among global communities of experts, practitioners, and policy-makers in both the biodiversity and water and wetland management fields.

5. Disseminate FW BON news through ResearchGate and work out a joint dissemination strategies with the Freshwater Information Platform (FIP) for both reaching the freshwater community and raising the profile of freshwater biodiversity.

Timeline	2017	2018	2019	2020
Milestones and/or Deliverables	- List FW BON partners - Recruit new members based on gaps in knowledge and geographic representation - Commence planning for the 1st global conference on freshwater biodiversity observations	- Work out a joint dissemination strategy with FIP - Continue to recruit members to fill gaps - Map FW BON network and expertise	-Hold a global conference Freshwater Biodiversity Observations	Mobilise the FW BON network to collect and analyse biodiversity observations in freshwater ecosystems across the globe
Resources	Most of the liaison will be done by skype, webinars and meetings on the back of other meetings. We require travel funding for one face-to-face meeting for coordination of freshwater information portals. Major funding will be needed to organise the Global Conference freshwater biodiversity observations at the end of 2019. These funds will be raised through initiatives planned together multiple partners			
Link with other activities	Links have been identified with most WGs and BONs (see description).			

FWB2.	Connecting and mobilising people and resources towards comprehensive global freshwater biodiversity assessment by 2020					
Lead(s)	Eren Turak					
Team/Partners	To be established					
EBV Class	Genetic Composition	Species Populations	Species Traits	Community Composition	Ecosystem Function	Ecosystem Structure
Ecosystem Services	YES			NO		
Development approach	Capacity Building	Monitoring Protocol design	Data Collection	Modelling	Assessments and Policy Support	
Description	This activity will provide knowledge for the compilation, integration and synthesis of available information about freshwater biodiversity observations across the globe and communicate this widely to the scientific community. The information will be included in compiling materials that support BON in a Box. Specifically: 1. In each major region of the world, coordinate contributions from FW BON members towards global assessments of the condition of freshwater biodiversity, building on and complementing the IPBES led regional assessments and focussing on progress towards 2020 CBD targets and SDG goals and with explicit linkages to water stress, and resilience in the face of climate change. 2. Link biodiversity observations to conservation actions and improvements in biodiversity at the system-level, by contributing to the development of ecosystem process models for different types of freshwater ecosystems and by providing evidence on the effectiveness of specific conservation actions. 3. Coordinate the development of sampling manuals and protocols of freshwater biodiversity that would ensure the global harmonisation of species and assemblages-level data for freshwater macroinvertebrates and fish. 4. Initiate and coordinate projects at local to global scales for connecting Indigenous and local knowledge and citizen science activities to global assessments of freshwater biodiversity. 5. Develop summary materials for lay-people, decision- and policy-makers, based on the results of this activity.					
Timeline	2017	2018	2019	2020		
Milestones and/or Deliverables	- Steps are identified in each major region of the world (continents) to achieve a global assessment of the status of freshwater biodiversity by 2020. (complementing 2017 IPBES assessments). These will then be communicated in high profile publications during 2018	- Comprehensive and detailed evidence of the effectiveness of conservation actions for conserving freshwater species and ecosystems (What works in conservation in collaboration with Bill Sutherland). - Freshwater invertebrate observation protocols for collecting globally harmonized data.	- BON in a BOX tools for using Indigenous and Local knowledge to support observations of freshwater biodiversity. - Freshwater fish observation protocols for collecting globally harmonized data.	- A global network of connected people that have the capacity to meaningfully assess the status of freshwater biodiversity in every Freshwater Ecoregion of the World (FEOW regions).		
Resources		Project funds needed for a global workshop on freshwater invertebrate sampling	Project funds needed for a global workshop on freshwater invertebrate sampling			
Link with other activities	Support from and/or collaboration with Policy Task Force, National and Regional BONs, EBV Working Groups.					

FWB3.	Inventorying global freshwater biodiversity for Freshwater Information Platform (FIP)					
Lead(s)	Aaike De Wever					
Team/Partners	To be established					
EBV Class	Genetic Composition	**Species Populations**	Species Traits	Community Composition	Ecosystem Function	Ecosystem Structure
Ecosystem Services	YES			NO		
Development approach	**Capacity Building**	Monitoring Protocol design	**Data Collection**	Modelling	Assessments and Policy Support	
Description	This activity focuses on improving the availability of global freshwater biodiversity data. It will also contribute freshwater material for the BON in a Box toolkit. It will also establish a link to the Freshwater Information Platform (FIP) as a central hub for compiling and integrating species distribution data, exploring possibilities for exchanging and publishing data from freshwater observatories and monitoring institutes. **1.** Establish a FIP Advisory Board to decide on both scientific and technical direction of the Freshwater Information Platform developments involving representatives of among others GEO BON and GBIF **2.** Establish best practices for publishing and integrating data and information on freshwater biodiversity **3.** Collate material on freshwater biodiversity for integration in the BON in a Box toolkit, including globally standardised protocols for both data publication (previous point) and for monitoring community composition of e.g. fish, mammals, macroinvertebrates, algae, fungi (building on the outputs of FWB2) **4.** Actively follow-up on the implementation of the best practice guidelines for data publication and freshwater BON in a Box products following their promotion during the general meeting (planned under FWB1)					
Timeline	**2017**	**2018**	**2019**	**2020**		
Milestones and/or Deliverables	- FIP Advisory-GEOBON Board	- Organise workshop on monitoring protocols - Best practice guidelines for publishing and integrating data and information on freshwater biodiversity	- Produce freshwater specific material for the BON in a Box toolkit	- Encourage uptake/use of these guidelines		
Resources	Most of these activities can be done remotely or back-to-back to existing meetings. Although currently unfunded, the Freshwater Information Platform is looking into more sustainable funding options which could also cover specific activities under this FW BON task.					
Link with other activities	FWB1., FWB2. This activity will also be linked with and supported by the EBV Data TF.					

FWB4.	Classifying freshwater ecosystems and assessing their associate services					
Lead(s)	Jeanne Nel					
Team/Partners	To be established					
EBV Class	Genetic Composition	Species Populations	Species Traits	Community Composition	Ecosystem Function	Ecosystem Structure
Ecosystem Services	**YES**			NO		
Development approach	Capacity Building	Monitoring Protocol design	Data Collection	Modelling	Assessments and Policy Support	
Description	This activity focuses on using a hierarchical classification of freshwater ecosystems to derive a spatially consistent global product of ecological freshwater units. Such a product provides a vital resource for numerous processes, such as assessing and listing threatened ecosystems, ecosystem accounting, evaluating the capacity of different regions to supply ecosystem services. Activities include: **1.** Collaborating with the IUCN's Red List of Threatened Ecosystems group to develop a global hierarchical classification system of freshwater habitats. **2.** Incorporate into FW BON the GEO Ecosystems (GI-14) activity to develop methods, data, maps, publications, and web-based apps for a new set of standardized, rigorous, and practical global ecological freshwater units (EFUs) as a synthesis of existing global freshwater ecosystems resources. This effort would represent a collaboration between the U.S. Geological Survey and ESRI, advised by an expert steering committee comprised of FW BON members, and would produce open data resources intended to support global freshwater ecosystem distribution, condition, and valuation assessments. The EFUs would be developed in parallel to the development of a set of global ecological coastal units (ECUs), in association with Marine BON (MBON). **3.** Ensure that the Ecosystem Structure EBV Working Group of GEO BON is kept up to date with developments on ecosystem classification. **4.** Work with the Ecosystem Services Working Group of GEO BON to ensure infusion of new concepts and methodologies in the way freshwater-related ecosystem services are assessed, valued and managed, particularly in relation to IPBES.					
Timeline	**2017**	**2018**	**2019**	**2020**		
Milestones and/or Deliverables	- Develop an idea for joint publication with the Ecosystem Services Working Group of GEO BON	- Meeting with USGS on protocol for developing ecological freshwater units	- IUCN publication on hierarchical classification system of freshwater habitats	- Spatial global ecological freshwater units - Joint publication with the Ecosystem Services Working Group of GEO BON		
Resources	To be done at the PECS II workshop in Mexico in Nov 2017	Budget needed for inviting 10-15 experts	To be done remotely	To be done remotely		
Link with other activities	This activity will be linked with the Ecosystem Structure and Ecosystem Services WGs.					

5. Cross-cutting activities: From Data to policy support

5.1. The EBV Data standards and portal

A task force dedicated to data standards and the EBV data portal, the EBV Data TF, was created in 2017.

5.1.1. Composition of the task force and Key Objectives

Lead Coordinators: Néstor Fernández (iDiv, Germany), Robert P. Guralnick (University of Florida, USA) and W. Daniel Kissling (University of Amsterdam, The Netherlands).

Operative support: Christian Langer (iDiv, Germany)

An overarching goal of GEO BON is to promote more efficient ways of sharing, producing and communicating biodiversity observations and analyses. The EBV data taskforce will foster this goal through supporting the development of standards, protocols and workflows for producing EBV data, and through making these data freely available and easily accessible to scientists and stakeholders. This taskforce is transversal to the activities of the different GEO BON working groups and biodiversity observation networks and therefore requires close coordination with them.

Key objectives:

1. Develop, define and refine minimum requirements to evaluate which datasets are appropriate for building EBV data products
2. Development of standards, protocols and workflows for the production of EBV datasets
3. Mobilize biodiversity data and data sharing initiatives
4. Develop the GEO BON Data Portal as a hub for providing, accessing and linking EBV data and analyses.

5.1.2. Activities

Coordination and promotion of *EBV workflow and production development* for all EBV classes, following lessons learned from previous EBV operationalization initiatives such as the GLOBIS-B project: A major challenge for the production of EBVs and indicators is that it requires harmonizing heterogeneous sources of "Big Data" informing on the multiple dimensions of biodiversity structure, composition and function. Kissling et al. (2017) proposed that building EBVs requires that production workflows are designed informing on the necessary steps from the identification of candidate datasets to the elaboration of one or several consistent and reproducible final products. This activity will explore the applicability of this concept across the different EBV classes in coordination with the working groups. Production workflows for species-based EBVs and ecosystem-based EBVs will be promoted, evaluated and where possible harmonized in coordination with the Globis-B project, with EF WG activity EF3 and with other EBV production initiatives.

Development of *GEO BON EBV Data Standards and Guidelines* for the endorsement of EBV datasets: A publication on the minimum requirements and data standards for EBVs will be produced in support of a transparent process of EBV data endorsement by GEO BON. This activity will coordinate leaders of Working Groups and thematic BONs in order to define minimum requirements for their specific EBVs. A first draft will be produced during the first year for presentation in the GEO BON All-Hands Meeting 2018 and a final document should be ready by the end of 2018.
Deliverable: Report / paper / draft to be presented in the next all-hands meeting (2018)

Promotion of data mobilization initiatives: A fundamental step for the future development of more comprehensive and informative EBVs is the mobilization of critical biodiversity data that cannot be readily used to produce EBVs, e.g. datasets that are currently not available in biodiversity platforms and repositories or that do not comply with the necessary format and metadata standards. Promoting the mobilization of this data using adequate standards for producing EBVs will be a regular activity of the Data Task Force. A first outcome will be the co-organization of the *Symposium on the Mobilization of Structured Biodiversity Data* to be held in Leipzig, June 2017 and the promotion of a subsequent species population data mobilization initiative.

Development of the *GEO BON data portal*, including access to all EBV data produced / endorsed by working groups and biodiversity observation networks: The vision of the GEO BON Data Portal is to enhance the distribution of datasets that have been produced or endorsed by the GEO BON community as appropriate data for measuring biodiversity change. The Data Portal will provide discoverable EBV datasets that can be visualized, analyzed and downloaded easily from one unique location.

The components of the data portal will be:

- An **EBV Spatial Browser**, which would allow users to discover and interact with multiple datasets for each Essential Biodiversity Variable for any region in the world. These datasets could be published by different data providers using discoverable data standards. Candidate datasets will need to be endorsed before being published in the portal following the guidelines for the endorsement of EBV datasets (to be produced). These datasets can be provided by the different GEO BON partners. In many cases, no discoverable data standards exist and datasets (or at least the metadata) would need to be manually uploaded to a GEO BON database supporting the backend of the portal.
- An **EBV Analyzer**, including a set of tools to analyze EBV datasets and, eventually, produce indicators that can be used to inform the Aichi Targets, Sustainable Development Goals, Ramsar, etc.

5.2. Remote Sensing in support of EBVs

Note: This Task Force is still in development and will see its leadership, membership, and list of activities confirmed in the summer of 2017.

5.2.1. Composition of the task force and Key Objectives

Co-Leads: Andrew Skidmore (ITC, Netherlands), Nicholas Coops (UBC, Canada), and Allison Leidner (NASA, USA), GEO BON Secretariat (name tbc).
Membership*:* To be determined

An overarching goal of GEO BON is to promote more efficient ways of sharing, producing and communicating biodiversity observations and analyses at a global scale. The Remote Sensing Task Force's contribution to this goal is to link users (CBD, IPBES, conventions, companies, national and regional government) with space agencies (through CEOS, as well as space agencies) in order to provide high quality global Essential Biodiversity Variables (EBVs). Many of the GEOBON working groups (WGs), organized along the lines of EBV classes, plan to use remote sensing to deliver their EBVs. In other words, a number of the EBVs generated from remote sensing may be used by multiple working groups (EBV classes), encouraging and requiring a cross-cutting approach to the coordination and management of EBVs derived from remote sensing. This taskforce is transversal to the activities of the different GEO BON working groups and biodiversity observation networks and will draw its membership from all WGs and BONs who are particularly interested in EBVs generated from remote sensing.

Key objectives:

1. Define, and update, a priority list of EBVs that can be generated from remote sensing
2. Coordinate EBVs from remote sensing between users and space agencies using GEOBON as a hub
3. Coordinate and manage EBV data initiatives between WGs and BONs
4. Feed EBVs derived from remote sensing into the GEO BON Data Portal accessing to link EBV data and analyses from WG and BON activities to the broader community.

5.2.2. Activities

Define, refine and update, a priority list of EBV that can be generated from remote sensing: A major challenge for the production of EBVs and indicators is to produce globally contiguous estimates of biodiversity loss. This "filling in the gaps" is necessary as available in situ biodiversity data are usually widely spaced in time and space (and in many regions totally absent). The only feasible method to generate EBV layers is from remote sensing - producing global coverage of contiguous EBV layers, that can be routinely updated for monitoring purposes. The challenge is to agree on a list of EBVs on which users can agree and endorse, and which CEOS (space agencies) can implement through partner organizations.
Deliverables: The output from this activity will be a prioritized list of EBV retrievable from remote sensing that is periodically reviewed. A paper describing the prioritized list of EBVs from remote sensing will be written.

Coordinate between users and space agencies using GEOBON as the hub: The priority list of EBVs generated from remote sensing will need to be revised and endorsed as the needs (e.g., from users – CBD SBSSTA and IPBES, government, companies), the available assets (space agencies) and biological theory and capacity (GEOBON WG and BONs) evolve. The GEOBON Remote Sensing TF assists and coordinates initiatives and EBV products derived from remote sensing between WGs and

BONs by providing a forum for GEOBON members from all WGs and BONs to exchange information. The TF will engage user groups such as CBD SBSTTA, IPBES, NGOs, government and companies, on candidate EBVs, solicit feedback, and get "buy-in". Ensure the value of EBVs derived from remote sensing products to users is clear and well-communicated; relevance to the Aichi targets and SDGs is of particular importance.
Deliverables: Periodical review of the priority list of EBVs generated from remote sensing.

Feed EBVs derived from remote sensing into the GEO and GEOBON Data Portals: The Remote Sensing TF will ensure that the GEO and GEOBON Data Portals will be used to distribute EBVs derived from remote sensing datasets. The GEO and GEOBON Data Portals will provide publicly available EBVs derived from remote sensing that can be easily downloaded, and analyzed using the GEO sandbox and cloud computing facilities as well as the GEOBON Spatial Browser.

5.3. Policy Support

5.3.1. GEO BON's support to the Convention for Biological Diversity

The establishment of GEO BON was noted by the COP 9 at its 2008 meeting held in Bonn Germany, as a follow-up of the Millennium Ecosystem Assessment (Decision IX/15 in UNEP/CBD/COP/9/29). Parties and relevant organisations were invited to "support this endeavour", while the CBD Secretariat was requested to continue its collaboration with GEO BON. This support was renewed by the COP 10, two years later, when Parties where invited to support and/or collaborate with GEO BON in order to strengthen their ability to monitor biodiversity change (Decision X/7 in UNEP/CBD/COP/10/27). GEO BON was then invited to produce a report on the Adequacy of Biodiversity Observation Systems to support the CBD 2020 Targets[16] for an Ad Hoc Technical Expert Group on Indicators for the Strategic Plan for Biodiversity 2011- 2020. Continuing on this path, and with repeated support from the COP, in 2012, GEO BON and other partner organisations were more specifically asked to continue their work on the identification of Essential Biodiversity Variables and the development of the underlying datasets (Decision XI/3 in UNEP/CBD/COP/11/35). And since they were first brought up to the scientific community in 2013[17], there has been a continuous effort to link the EBVs with the tracking of progress towards the Aichi Targets (Table 22). More recently, at the COP 13, a set of indicators of global biodiversity change supported by GEO BON[18] was approved as part of a larger list of Indicators for the Strategic Plan for Biodiversity 2011-2020 and the Aichi Biodiversity Targets (Decision XIII/28 in CBD/COP/DEC/XIII/28). In addition, better access to biodiversity observations is directly linked with the objectives of Aichi Target 19.

Table 22. Contribution of the different EBV classes to the Aichi biodiversity Targets, and to indicators of biodiversity change

EBV class	Aichi Target[17]	GEO BON Indicator (2015)
Genetic Composition	12, 13	
Species Populations	4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15	Species Habitat Indices (SHI) Species Protection Index (SPI) Local Biodiversity Intactness Index (LBII) Species Status Information Index (SSII)
Species Traits	10, 15	
Community Composition	8, 10, 14	Biodiversity Habitat Index (BHI) Protected Area Representativeness and Connectedness (PARC) Local Biodiversity Intactness Index (LBII) Species Status Information Index (SSII)
Ecosystem Structure	5, 11, 14, 15	Species Habitat Indices (SHI) Biodiversity Habitat Index (BHI) Protected Area Representativeness and Connectedness (PARC) Global Ecosystem Restoration Index (GERI)
Ecosystem Function	5, 8, 14	Global Ecosystem Restoration Index (GERI)

The 2017-2020 Implementation Plan is no exception to the important linkages between GEO BON and the CBD. Indeed, the products of the different GEO BON activities are a follow up to the different mandates listed above, either when they address the set of biodiversity variables that needs to be monitored to document global biodiversity change, or when they allow countries and regions to set up their biodiversity observation systems in order to monitor such variables.

[16] http://geobon.org/Downloads/reports/GEOBON/2011/2011_cbd_adequacy_report.pdf
[17] Pereira et al. (2013). Essential Biodiversity Variables. *Science*, *339*(6117), 277–278. https://doi.org/10.1126/science.1229931
[18] http://www.geobon.org/Downloads/brochures/2015/GBCI_Version1.2_low.pdf

Concretely, several activities lead within the different Working Groups and/or BONs will be producing outputs of relevance to the CBD and its parties. This is the case for instance with **Activities SP4** and **SP5** (see section 3.2.3), which aim at both improving the data quality and availability on invasive and alien species, and use EBVs to develop indicators to monitor invasions at the national level, hence in support of Aichi Target 9. The Ecosystem Services WG is also developing most of its activities having the policy relevance of their outputs in mind. This is exemplified by **Activities ES1.2** ("Dialogue with policy bodies"), and **ES1.3** ("Ecosystem Services in Global Sustainability Policies" which already resulted in a scientific publication[19]). One of the objectives of the **Policy Task Force** will be to support the different partner institutes (e.g. CSIRO, Yale University) in the production and publication of the indicators (Table 22). In addition, the newly created **Remote Sensing Task Force** (see section 5.2) will position itself, and GEO BON, as a hub between the space agencies and the users of Remotely Sensed products, thus including the CBD COP and SBSTTA.

The development of processes and guidelines to set up Biodiversity Observation Networks at the national scale is, inter alia, meant to support Parties of the CBD to meet their reporting needs (e.g. 6th National reports due by 2018). The **BON Development WG** was precisely set up to respond to those needs, by documenting and delivering best-practices, linking with the EBVs working groups, and providing access to state-of-the-art tools via the BON in a Box platform. Hence, the CBD, via its Parties, is a key user of the outputs of all three activities of the BON Development WG (**BD1**, **BD2**, and **BD3**, in section 4.2.2).

Once established, the missions of the Biodiversity Observation Networks include the collection of biodiversity observations and provision of data to a larger community. Thus, the **National BONs** in **Colombia**, **France**, and **China** (see section 4.3.) will provide the basis to their government for their national and sub-national assessments and reporting needs, while supporting the assessment of the status and trends of biodiversity at the regional and global scale. At the regional scale, the **Arctic BON** (CBMP) is already involved with the CBD in a "Cooperative Strategy for the Conservation of Biological Diversity in the Arctic Region" while one of its key objectives for the 2017-2020-time period is to inform on the contribution of the Arctic region to both the SDGs and Aichi targets, while contributing to the assessment of the Arctic biodiversity (see section 4.2.2). The thematic BONs were also set up having in mind the policy relevance of their products. For instance, the Marine BON with its partners (e.g. GOOS, OBIS) is already engaged in the development of the Essential Ocean Variables (EOVs) needed to assess the status of marine ecosystems (and thus the progress towards Aichi Targets 6, 10, 11, and 14). Likewise, the **Freshwater BON** will establish partnerships with organisations needing freshwater biodiversity observations for assessment purposes, which include for example, the CBD, Ramsar Convention, and IUCN (Activities **FWB1** and **FWB2**).

5.3.2. GEO BON and Sustainable Development Goals

The EBVs can be related to several of the UN's Sustainable Development Goals, as illustrated in Tables 3,6, and 9. While GEO BON will continue a mapping exercise between EBVs and specific SDG targets and indicators (see the list of activities in 5.3.3), Working Groups and BONs are already involved in the production of indicators[20] of relevance to countries that want to track their progress towards the SDGs. The GEO BON Secretariat is in contact with the EO4SDG GEO initiative and will

[19] Geijzendorffer et al. (2017). Ecosystem services in global sustainability policies. *Environmental Science & Policy*, *74*, 40–48. https://doi.org/10.1016/j.envsci.2017.04.017

[20] **Tier definition used:**
Tier 1: Indicator is conceptually clear and has an internationally established methodology and standards are available. In addition, data are regularly produced by countries for at least 50 per cent of countries and of the population in every region where the indicator is relevant.
Tier 2: Indicator is conceptually clear, has an internationally established methodology and standards are available, but data are not regularly produced by countries.
Tier 3: No internationally established methodology or standards are yet available for the indicator, but methodology/standards are being (or will be) developed or tested.

continue investigating the potential of the GEO BON outputs to support GEO member states in monitoring their progress towards the achievement of the 2030 SGDs and their targets.

Goal 2. End Hunger, achieve food security and improved nutrition and promote sustainable agriculture

Target	Product	WG or BON	Tier
2.3 *By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment*	fishery yields from rivers and lakes	Freshwater BON	2
2.4. By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality	fishery yields from rivers and lakes	Freshwater BON	2

Goal 6. Ensure availability and sustainable management of water and sanitation for all

Target	Product	WG or BON	Tier
6.6 *By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes*	Automate high spatial and temporal resolution mapping of wetlands	Freshwater BON	2

Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development

Target	Product	WG or BON	Tier
14.2 By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans	**prototype product that integrates satellite Earth Observations** (seascapes, sea surface temperature, ocean colour, etc.), **OBIS data, and local surveys** (fisheries independent, coral reef cover that have taxonomic information).	MBON with US Sanctuaries and OBIS. Prototype will be tested in Australia and Canada. MBON is searching for other test countries.	3
14.3 Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels	Partnership with Global Ocean Acidification Observation Network (GOA-ON)	MBON	NA
14.4 By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics	Fishery yields from rivers and lakes assessed	Freshwater BON	2
14.5 By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information	Indicator **14.5.1 Coverage of protected areas in relation to marine areas** brought over from the global suite of indicators to track progress against the Aichi Targets (T11).	MBON with UNEP-WCMC, in collaboration with UN Environment and IUCN	1

Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Target	Product	WG or BON	Tier
15.1 By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements	The **BHI**[21] and **PARC**[22] indicators integrate data for the community composition and ecosystem structure EBV classes, along with protected area coverage, to derive refined indicators of **conservation and restoration of terrestrial ecosystems.**	(Future) Community Composition WG. Indicator developed by CSIRO.	2
15.4 *By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development*	**the PARC**[18] **indicator** integrates data for the community composition EBV class and protected area coverage to derive a **refined indicator of conservation of mountain ecosystems**.	(Future) Community Composition WG. Indicator developed by CSIRO.	2
15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species	A global baseline of red list assessments for selected freshwater species by 2020, repeated in 2030. the **BHI**[17] **indicator** integrates data for the community composition and ecosystem structure EBV classes to derive a refined indicator of **degradation of terrestrial ecosystems**.	Freshwater BON (Future) Community Composition WG. Indicator developed by CSIRO.	2 2
15.8 By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species	Indicator[23] for the CBD Target on Invasive and Alien Species: **Proportion of countries adopting relevant national legislation and adequately resourcing the prevention or control of invasive alien species.**	Species Populations WG, with IUCN SSC ISSG[24]	2

[21] Biodiversity Habitat Index
[22] Protected Area Representativeness & Connectedness
[23] Note that the current SDG indicator chosen for this target is not biodiversity based.
[24] Species Specialist Group - Invasive Species Specialist Group

5.3.3.Composition of the Policy task force and Key Objectives

The need for a task force dedicated to policy was identified when the new GEO BON structure was established in 2016. The task force and its main objectives were established following the in-person meeting of the Implementation Committee and Advisory Board of GEO BON, in June 2017.

Co-Leads: Laetitia M. Navarro (GEO BON/iDiv) and Corinne Martin (UNEP-WCMC)
Membership: As of July 2017 – Mike Gill (Polar Knowledge Canada/GEO BON co-chair), Lauren Weatherdon (UNEP-WCMC), Cornelia Krug (Future Earth), Melodie McGeoch (Monash University/Species Populations WG co-chair), Anne Bowser (Wilson Centre), HyeJin Kim (iDiv/GEO BON), Frank Muller-Karger (University of South Florida/MBON co-chair), Tuyeni Heita Mwampamba (Universidad Nacional Autonoma de Mexico).

One of the core focus of GEO BON is the production of policy relevant outputs. Indeed, a key users group are the national governments who are responsible for reporting on the status and trends in ecosystems and the biodiversity they support to meet their national mandates (e.g. national biodiversity plans, recovering species at risk, sustaining ecosystem services) and international obligations (e.g. Convention on Biological Diversity, RAMSAR Convention, Convention on Migratory Species, etc.). Since its inception, GEO BON has also been an important partner organisation of international policy bodies such as the CBD and the IPBES. A Task Force dedicated to Policy support will ensure that the needs of such users are reflected within the activities of the different working groups and BONs (e.g. activities dedicated to "applications" of EBVs), and that the outputs of the different WGs and BONs are also properly distributed to those users. In other words, the task force will guide the GEO BON Community in connecting and positioning itself in the policy sphere, so that GEO BON effectively influences policy processes, and the best biodiversity observation data are used in these processes.

Key objectives:
1. Support the activities of the IPBES and the CBD
2. Mapping the links between EBVs and reporting needs of various user groups at various scales (e.g. NBSAPs, CBD's Aichi targets, SDGs).
3. Support the publication of the GEO BON indicators
4. Support the participation of the network in regional and global biodiversity assessments (e.g. GBO, IPBES) by identifying and recommending experts.
5. Support the development of narratives with various stakeholders and work with the EBV development TF.

5.3.4. Activities of the Policy Task Force

Strengthening the links between GEO BON and IPBES: In 2017, a Memorandum of Understanding will be prepared between the GEO BON Secretariat and the IPBES, for approval at the IPBES VI Plenary in March 2018. An information Document on the contributions of GEO BON to IPBES will be prepared for this Plenary. Finally, the Secretariat will continue its effort to provide experts for the different IPBES assessments, and reviews. Regarding the latter, a consolidated review by GEO BON, of the various chapters of the IPBES assessments will be considered from 2018 onwards.

Strengthening the links between GEO BON and the CBD: An Information Document will be prepared for SBSTTA 21, following a direct invitation from the CBD Secretariat. The Policy TF will also coordinate the organisation of side-events for, when appropriate, COP and SBSTTA meetings.

The Policy Task Force will also coordinate, with the support of the working group and BON leads, the preparation of plenary interventions for delivery at key policy events (COP, IPBES Plenary etc...).

Mapping of EBVs to global/national targets and goals for reporting needs: Since they were first published in 2013, the Essential Biodiversity Variables were mapped to potential Aichi targets. Further efforts have been made in this mapping exercise since then. In 2016, the GEO BON Secretariat also initiated a mapping exercise between EBVs and Sustainable Development Goals, which will now be refined in partnership with the different working groups and BONs (and see section 5.3.2.). Furthermore, an activity, conducted by a master student hosted at the GEO BON Secretariat, will review the National Biodiversity Strategies and Actions Plans (NBSAPs) to link the different national targets of the Parties of the CBD to the EBVs. This activity will be particularly timely considering that Parties of the CBD need to report on their progress towards their national targets in their 6th National Reports to the CBD by the COP 14 in December 2018.

GEO BON indicators: In 2015, GEO BON and some of its partner organisations submitted a list of Indicators of Global Biodiversity Change directed at the Aichi Targets. Since then, the list of indicators has been approved by the CBD and IPBES. The Policy Support task force will ensure that those indicators are delivered and made available to the users while formalising a process for the development of the next generation of GEO BON endorsed indicators. A similar brochure to the one produced in 2015 on indicators will be produced for EBVs by the task force.

Finally, the Policy Support Task Force will assist in the **development of narratives** for the identification of Essential Biodiversity Variables in support of the EBV Development Task Force (see section 3.1, p.13).

6. Conclusion: Priority deliverables for 2018 and 2020

The Implementation Committee and Advisory Board of GEO BON were invited to reflect on the first version of the Implementation Plan and identify key deliverables and priorities for the network at the short (2018) and medium (2020) term. The following lists are the result of this discussion. This does not replace the timelines established within each Working Group and BON regarding their activities, but will instead, in addition, allow the network to identify common priorities and deliverables aligned with the GEO BON vision for 2020. For both 2018 and 2020, the priorities have been organised along the three-core focus of GEO BON: EBV Development, BON Development, Policy relevant outputs.

1. 6.1. Priorities for 2018

Outside of the scope of the three-core focus of GEO BON, an additional priority was identified that is related to the sustainability of the 2017-2020 Implementation Plan: The definition of a fundraising strategy for the listed priority deliverables that would be supported by a Funding Task Force (to be established in the last quarter of 2017). The establishment of a fundraising strategy will provide capacity for the achievement of the priority activities.

Table 23. Priorities for EBV Development for 2018

Deliverable	Responsible	Users	Use
Genetic Composition, Species Traits, and Community Composition WG are established	GEO BON Secretariat		
One or two EBVs per WG/EBV class with available datasets (one global data layer per EBV class on Data Portal) and links to indicators.	All EBV Working Groups and EBV Framework Task Force	All GEO BON clients and users	Regional and global biodiversity assessments based on EO, in-situ, citizen science and models (using ready to go toolbox).
Guidance on EBV application for national and regional BONs	All EBV Working Groups, BON Development Working Group and EBV Framework TF	National and regional BONs	Application would ensure Flexible and harmonized approach to national and regional biodiversity observations
Proposed marine EBVs for EOVs published	Marine BON	All GEO BON clients and users	Contributions to sub-global and global assessments
Essential Ecosystem Service Variables published	Ecosystem Services Working Group	All GEO BON clients and users	Contributions to sub-global and global assessments
Group of Nations working together to pilot interoperable BONs applying EBVs and Ecological Narratives	BON Development Working Group and nations in group (e.g. Colombia, Brazil, South Africa, China)	CBD Parties and GEO members	Examples to serve as templates for organizations and nations to design and implement interoperable BONs

Table 24. Priorities for BON Development for 2018

Deliverable	Responsible	Users	Use
Tools for the design of a freshwater BON	Freshwater BON	Sub-national, national, regional governments, Ramsar Convention Parties, GEO Wetlands, CBD Parties and GEO Members	Lower the threshold for organization to design and implement freshwater biodiversity monitoring
BON in a Box Version 2 fully operational with full tool database complement	BON Development Working Group with help from EBV Working Groups and BONs	Sub-national, national, regional governments	Lower the threshold for organizations and nations to design and implement interoperable BONs, promote development of new tools and accelerate technology transfer and sharing
Existing and currently developing National BONs endorsed by GEO BON	GEO BON Secretariat, BON Development Working Group and Candidate BONs	National BONs	Raise visibility and connections for National BONs
Assessment and Web Mapping of Existing BONs	BON Development Working Group	CBD Parties, GEO members and IUCN	Assist IUCN global audit of biodiversity monitoring and provide a framework for best practices and for identifying key gaps

Table 25. Priorities for Policy relevant outputs for 2018

Deliverable	Responsible	Users	Use
State of the Arctic Reports	Arctic BON	Arctic Council and global assessments	Contributions to sub-global and global assessments and serve as examples of the outcomes/value added of integrated biodiversity observations
Brochure promoting the value of long-term and integrated biodiversity observations for decision-making	Policy Task Force	National and regional clients (particularly CBD Parties and GEO members)	Promote and illustrate how BON design and EBV frameworks can result in more informed decision-making
GEO BON established as a hub for communicating requirements to CEOS	Remote Sensing Task Force	The entire biodiversity observation community	Improved EO data for biodiversity observations
Position paper on Linking IPBES conceptual framework to BON Development	BON Design Sub-Group of BON Development Working Group	IPBES, CBD Parties and GEO members	Guide design process for BONs ensuring close links to CBD and IPBES assessment processes

2. 6.2. Priorities for 2020

Table 26. Priorities for EBV Development for 2020

Deliverable	Responsible	Users	Use
Final list of EBVs endorsed	EBV Working Groups and EBV Framework Task Force	All GEO BON clients and users	
First global EBV datasets (across all EBV classes) available on the GEO BON data portal showing status and trend, with ability to disaggregate at different scale, and continuously feeding models/indicators for national/global reporting	EBV Working Groups, EBV Data Task Force	All GEO BON clients and users	Contributions to sub-global and global assessments
Recommendations for data/metadata and monitoring standards for all EBV classes and all realms	EBV Working Groups, Thematic BONs, and EBV Data Task Force	National and regional BONs	Biodiversity Monitoring and/or Mobilization of EBV data that allow interoperability across realms and across spatial scales.
Subset of EBVs identified where RS can directly serve and deliver this as requirements to CEOS (with agreement in place)	Remote Sensing Task Force and GEO BON Secretariat	The entire biodiversity observation community	Improved EO data for biodiversity observations
Data Analysis tools for monitoring data from line transects and camera traps	Species Population Working Group	Sub-national, national and regional BONs	Made available via BON in a Box this would promote interoperable analytical approaches.

Table 27. Priorities for BON Development for 2020

Deliverable	Responsible	Users	Use
Marine BON operational	MBON	All GEO BON clients and users	
Freshwater BON Operational	FBON	All GEO BON clients and users	
New (up to 15) national, regional and thematic BONs developed or enhanced with GEO BON's assistance in place and visible on the website	BON Development Working Group and GEO BON Secretariat	National and Regional BONs, IPBES, CBD Parties and GEO members	New national BONs would serve as framework examples for other nations and themselves produce more, high quality biodiversity observation data
BON Development Manual with online decision matrix for BON design available	BON Development Working Group and all EBV Working Groups	National, regional, thematic and sub-national BONs	This would guide and facilitate BON development and enhancement using a flexible but interoperable design process
Gaps in global observation system identified and prioritized for BON development	BON Development Working, EBV Working Groups, Thematic BONs, and EBV Data Task Force	IUCN Spp Monitoring Group	Global Audit of Biodiversity Monitoring

Table 28. Priorities for Policy relevant outputs for 2020

Deliverable	Responsible	Users	Use
3 Global Biodiversity Change Indicators (minimum) produced using EBV concept and data	Some EBV Working Groups with support from the Policy Task Force	CBD Parties, national, sub-global and global assessments	To model, predict and assess biodiversity change at multiple scales to better inform policy
IPBES Socio-ecological indicators developed and associated papers on the process and outcomes	Ecosystem Services Working Group	IPBES, CBD Parties	
Political/intergovernmental framework in place for GEO state members to recognize and promote their national/regional BONs	BON Development Working Group	GEO State Members	Solidify process for GEO members to commit to enhancing or developing BONs based on GEO BON guidance