GEO BON

Group on Earth Observations
Biodiversity Observation Network

2022 HIGHLIGHTS

27 february 2023

GEO BON Secretariat
27 February 2023

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Welcome message

In 2022, the GEO BON Secretariat restarted office work and in-person meetings. Veronica Wrobel, our Communications and Engagement Officer, joined the team and boosted our capacity for outreach across the GEO BON network and with our partners.

With a consolidated Secretariat, we powered through a very busy year producing no less than ten science briefs with Future Earth and other partners. The year culminated in our engagement in the historic 15th Conference of the Parties to the UN Convention on Biological Diversity in Montreal.

Our network grew to 2,500 members from 140 countries adding more than 400 new members. Two new biodiversity observation networks joined our growing global family: Omic BON (thematic BON) and EuropaBON (regional BON). A new structure, Knowledge-to-Action Hubs, has taken off with a K2A Hub on indicators and another one on biodiversity models.

New projects and new partnerships have been forged. GEO BON is making a smooth transition to increasing our capacity to support biodiversity monitoring worldwide.

We welcome all our members to join this effort as we look to implement biodiversity monitoring for action in 2023.

GEO BON Secretariat

Message from Co-Chairs

Dear colleagues,

What a remarkable end to 2022! We can now celebrate a newly adopted global biodiversity framework, the Kunming-Montreal Global Biodiversity Framework (GBF). GEO BON's work is recognized in the GBF where we have been specifically invited to support countries and subnational organizations with the implementation of the global biodiversity monitoring framework. This is a very exciting opportunity for us to align our network's strategic and implementation plans with this grand imperative.
We are in this position because of the dedication of so many GEO BON members. You have helped build our reputation as a network willing to offer its knowledge and support to the greater collective good.

The Herculean effort to produce ten science briefs during the year is testimony to this commitment. Many GEO BON members dropped everything with short notice to contribute time and work in this effort. We also offered a series of webinars with our partners to communicate the conclusions of these briefs. Our webpage hosting the briefs has received thousands of visits and downloads, and the webinars on our YouTube channel have hundreds of views.
Congratulations to the Genetic Composition Working Group for championing the need for a genetic diversity indicator in the monitoring framework. Their tireless outreach was a huge part of the reason we now have a headline indicator on genetic diversity in the framework. We need to keep this science engagement and communication up in 2023.
GEO BON was also invited to participate in the Convention on Biological Diversity expert workshop on the monitoring framework in Bonn. We fought for strong, science-based indicators, and to keep our indicators at the heart of that process. We learned through this process that strong science is not enough, and we need to improve the understanding, adoption, and use of GEO BON indicators by different countries. We have more work to do via the Knowledge-to-action Hub on Indicators to make GEO BON's indicators (and the EBVs they use) widely understood and available for use by countries.

GEO BON members continue to lead international workshops on frontier topics in biodiversity monitoring. We have seen many high-profile publications arise from this ongoing work. We will continue to develop the most effective strategies to communicate these findings and promote the excellence of GEO BON's science and collaborations.
We also made progress on our vision to establish a Global Biodiversity Observing System (GBiOS). We held a special session at the World Biodiversity Forum in Davos, thanks to funding from the European Space Agency and NASA. It was very well attended and generated a report detailing clear next steps. We turned this work into a brief and a side event at COP15 on Biodiversity. We will begin fundraising for GBiOS in 2023 so that we can support the research, planning and technical needs to realize this grand project.

The BON in a Box 2.0 project is making good progress to its first function version that will be ready for feedback and testing in different BONs around the world. Here is a video on GEO BON's YouTube channel communicating what BON in a Box is about. It is an exciting platform that we hope will federate monitoring communities and apply state-of-art models and data to guide the design of BONs in support of the monitoring framework of the GBF.

Message from Co-Chairs

We now know that the work of GEO BON's Secretariat is well supported by the collaboration between the Quebec Centre for Biodiversity Science in Canada and the Humboldt Institute in Colombia. There is great potential in the future to expand on this model whereby we distribute the work of the GEO BON's Secretariat across a network of hubs, especially in the context of GBiOS.

We would like to end by thanking the entire Secretariat team – Adriana Radulovici, Katie Millette, Jean-Michel Lord, and Veronica Wrobel – for their dedication to GEO BON's mission and their tireless commitment to supporting our members and communicating what we do far and wide.

We look forward to working with you in 2023!

Maria Cecilia Londoño &
Andrew Gonzalez

Projects: BON in a Box

Implementing the UN CBD's Global Biodiversity Framework requires us to work together to monitor biodiversity and guide action worldwide. The goal of BON in a Box is to support organisations who want to monitor and preserve biodiversity, by providing tools and visibility. On this platform, organisations will benefit from other organisation's EBV and indicator pipelines to help them report on the targets. GEO BON will provide a module to help the choice of sampling sites based on the network's criteria. Finally, the projects portal will make small conservation projects findable, to better share ground expertise.

A presentation video is available here.

In 2022, we have laid the base foundation for the platform. The backbone is a multi-language pipeline infrastructure. Its modular approach allows it to create pipelines that can be easily fitted to an organisation's reality. Take a Species Distribution Model for instance: though it feeds on global data layers by default, it can be changed to local occurrence data or local land cover classification for more precision. Next year, we will merge some EBV and indicator pipelines provided by the Colombia BON.

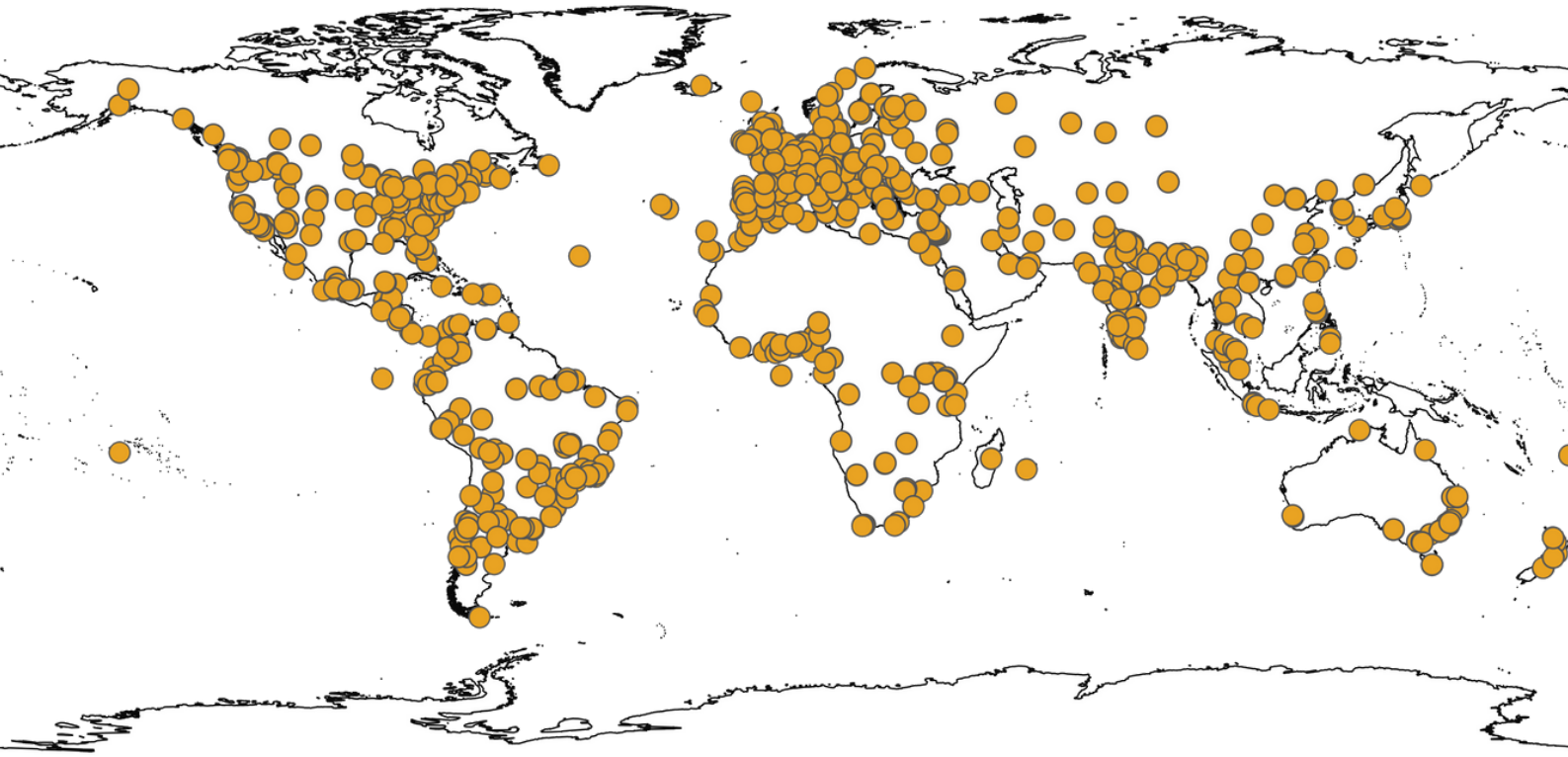
The tool to help the choice of sampling sites went through two major steps: a series of meetings with the observation network in the province of Québec, and the writing of a dedicated software package. Next year, two case studies will be proposed : one for Québec and one for Colombia. These will serve as an example to later replicate the methodology in regions with no existing BON.

The conservation projects portal has been through early design and mock-up phases, notably meeting with possible users in Colombia. These meetings have reframed the formally known "Search portal" around projects. A first version should be available by the end of the year.

GEO BON network

GEO BON

Group on Earth Observations
Biodiversity Observation Network



MBON
Marine Biodiversity Observation Network

FWBON
Freshwater Biodiversity Observation Network

Soil BON

MICBON

Colombia BON

China BON

French BON

Arctic BON

EUROPABON

APBON
Asia Pacific Biodiversity Observation Network

Remote Sensing Task Force

Data Task Force

Policy Task Force

Genetic Composition WG

Species Populations WG

Species Traits WG

Community Composition WG

Ecosystem Structure WG

Ecosystem Functioning WG

Ecosystem Services WG

BON Development WG

Genetic Composition WG

Leads: Sean Hoban, Margaret E. Hunter, Anna MacDonald

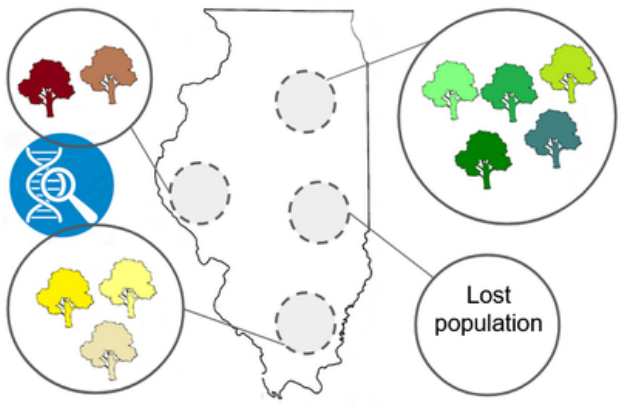
During 2022, the **Genetic Composition Working Group (GCWG)** focused heavily on 1) the inclusion of genetic diversity within the CBD post-2020 Global Biodiversity Framework (GBF), especially work on indicators and interactions with CBD focal points, and 2) ensuring the availability of appropriate tools and resources to enable monitoring and reporting on genetic diversity.

GCWG members led and contributed to several **relevant papers** in 2022, including:

- Proposing EBVs for genetic diversity in the paper: Global genetic diversity status and trends: towards a suite of Essential Biodiversity Variables (EBVs) for genetic composition. Our Co-Leads led a large collaborative group of 26 scientists to describe the state of the art of Essential Biodiversity Variables and their importance for conserving genetic diversity. The paper describes four important measures of genetic composition, recent efforts to compile data from hundreds of studies around the world, advances in modeling, data standards and repositories, and communication to policy makers. The paper is published open access in Biological Reviews, one of the leading journals for reviewing the state of biological sciences.
- Summarising international approaches to reporting on genetic diversity and proposing a unifying reporting mechanism: This paper, Bringing together approaches to reporting on within species genetic diversity, reviews approaches to monitoring genetic diversity and adaptive potential in species, monitoring that can help them survive environmental and climate change. The approaches cover DNA-based data as well as demographic and geographic proxies, and expert-based assessments. The review explains what genetic threats or concerns are covered by each monitoring approach, and advocates for a unified reporting mechanism.
- Announcing a collaborative approach to building capacity in conservation genetics in the paper: The Coalition for Conservation Genetics: Working across organizations to build capacity and achieve change in policy and practice. This paper presents the Coalition for Conservation Genetics, a collaboration of working groups within SCB, IUCN, and GEO BON, plus the GBIKE network. These four international networks have pooled resources and expertise to quickly respond to policy needs, achieve consensus on scientific research, and reach a more global community.

GCWG has started a new project to test recently-proposed indicators for genetic diversity. The first phase involved development of a standard data collection form and guidelines, and identification of sources of existing data. This work is summarised in an Authorea preprint: Monitoring status and trends in genetic diversity for the Convention on Biological Diversity: an ongoing assessment of genetic indicators in nine countries (with Supplemental Information). It is a critical time to conserve genetic diversity, particularly through the upcoming United Nations Convention on Biological Diversity (CBD) post-2020 Global Biodiversity Framework (GBF), whose final negotiations occured in December 2022. In this paper we summarize significant advancements in indicators that assess status and trends in genetic diversity without needing DNA data- in an affordable, simple manner using existing data. Specifically, we describe ongoing deployment of indicators in nine countries on six continents; specify indicator calculation; and describe a roadmap for uptake and use of genetic diversity indicators. We are confident all nations can successfully report these genetic diversity indicators, and in doing so, better conserve the world's biodiversity. The second phase of the project is now underway, with teams from nine countries working to evaluate genetic indicators for c.100 species per country.

Genetic Composition WG



Indicator 1. Proportion of populations large enough to maintain genetic diversity	Indicator 2. Proportion of populations still exist (not lost)	Indicator 3. Species monitored with DNA data (y/n)?
0.33	0.75	1

Example of genetic diversity indicators, for four hypothetical populations in Illinois, USA. One tree = 1,000 plants (five trees = 5,000 plants). Colors illustrate genetic variation within and among populations. In 2020, 2 of 3 extant populations census size is <5,000 (Ne<500 considering an effective to census size ratio of Ne/Nc = 0.1) and thus too small to maintain genetic diversity (indicator 1). Three of four historic populations are maintained (indicator 2). DNA-based methods have been used to monitor genetic diversity in two populations (indicator 3 - a value of 1 means that the species is monitored with DNA-based methods).

GCWG members have engaged extensively with delegates and policy-makers during 2022, to make science-based recommendations for inclusion of appropriate wording on genetic diversity goals and targets within the CBD post-2020 GBF. For example GCWG members:

- Presented on genetic indicators to a global CBD webinar: "Monitoring Framework: Proposed Headline Indicators" Part 1 and part 2 in November.
- Attended virtually "the Geneva meetings" to further network with CBD policy makers and share our previous recommendations on genetic diversity wording for Goals and Targets (e.g. Hoban et al 2020).
- Produced, upon request, metadata documents for the Biodiversity Indicator Partnership and UNEP-WCMC on the "Ne 500" indicator: The proportion of populations or breeds within species with an effective size greater than 500.
- Attended COP15 and hosted a side event focusing on genetic diversity on December 10th. At this side event, through short presentations, engaging examples, and conversation, we: discussed the importance of genetic diversity; explained feasible and affordable genetic diversity indicators that do not require DNA data; connected indicators to Goal A and Target 4 text; presented outcomes of recent national level indicator deployment in nine countries; and facilitated discussion among Parties on capacity, needs, and partnerships. The diverse co-hosts of this event represent organizations from 15 countries and 5 continents, and many international institutions, highlighting the global importance of this topic. We showed that monitoring and reporting on genetic diversity status and conservation is feasible and necessary.
- Summarised the evolution of language used over the past three years in CBD goals and targets for genetic diversity and highlighted current recommendations in an Authorea preprint: Genetic diversity Goals and Targets have improved, but remain insufficient.
- A few members participated in the Science Summit at the UN General Assembly 77 in the session "The key for a successful UN's Post-2020 Global Biodiversity Framework" on the need for standards to measure biodiversity with molecular tools.
- Collaborated with the Coalition for Conservation Genetics to help them prepare statements, policy summaries, and information documents on genetic diversity and the post-2020 GBF, shared with CBD Secretariat, delegates, SBSTTA, OEWG, and IUCN leadership.

Species Population WG

Leads: Walter Jetz, Melodie McGeoch

The very end of 2022 brought about a long-delayed but pivotal moment for global biodiversity: The adoption of the Kunming-Montreal Global Biodiversity Framework (GBF) at the UN Biodiversity Conference. Among the most significant news is the adoption, alongside, of a "Monitoring Framework" that formally recognizes the importance of measuring actual progress toward the shared commitments. This puts a spotlight on the years of preparations around Essential Biodiversity Variables for Species Populations (SP EBVs) and the indicators of biodiversity status, trends, and knowledge they support. Four of the Working Group's EBV-based indicators were formally adopted to address the goal and target components of the Kunming-Montreal global biodiversity framework.

GBF: Species Population Health (Goal A, Targets 3, 4)
The Species Habitat Index was adopted as an indicator for Goal A and Target 4 which aim to maintain and enhance the "integrity, connectivity and resilience of all ecosystems" and genetic diversity of species populations and halt human-driven extinctions. The Species Protection Index was adopted as an indicator for Target 3 which stipulates the 30 by 30 goal and specifically calls for "ecological representation" within protected area networks. See here for background and indicator dashboards.

GBF: Species Invasions (Target 6)
The past year saw the publication of the Country Compendium of the Global Register of Introduced and Invasive Species (GRIIS) that includes a compilation of data across 196 country checklists and all major taxonomic groups. GRIIS is foundational to reporting on Target 6 and its Headline Indicator - Rate of invasive alien species establishment. In December 2022, the COP (CBD/COP/15/L.12) invited states, organizations and experts to continue to support GRIIS, and advised that it is essential that such data on invasive alien species populations are regularly updated and curated. See here for GRIIS background and here to explore geographic patterns.

GBF: Species Population Knowledge (Target 21)
This year, we have contributed significant resources to the understanding of global vertebrate and invertebrate species distributions, including range maps for all extant mammal species, global country checklists for butterflies and odonates, and others. Our data contributions directly support Target 21 which aims to ensure "best available data, information and knowledge, are accessible to decision makers, practitioners and the public." In addition, our *Species Information Index* was adopted to support measurement of progress in Target 21. See here for Index background and to explore.

Global SP EBV data Resources made public in 2022:
Butterflies: (*Dataset*) (*Map*). doi:10.1111/geb.13475.
Mammals: (*Dataset*) (*Example Map*). doi:10.1111/jbi.14330
Odonates: (*Dataset*) (*Map*). doi:10.1111/jbi.14457
Invasive Species: (*Dataset*) (*Map*). doi:10.1038/s41597-022-01514-z

Species Traits WG

Leads: Jens Kattge, Mark John Costello

Species traits are qualities of species' organisms, like body mass, length or height. Due to intraspecific variation, different individuals of a species have different trait values, e.g. different body masses. Together, they define a density distribution characteristic for each species and population. The dynamics of species traits, i.e. changes of these trait density distributions in time, provide critical information about species responses to changing environmental conditions and serve, e.g., as early warning stress indicators.

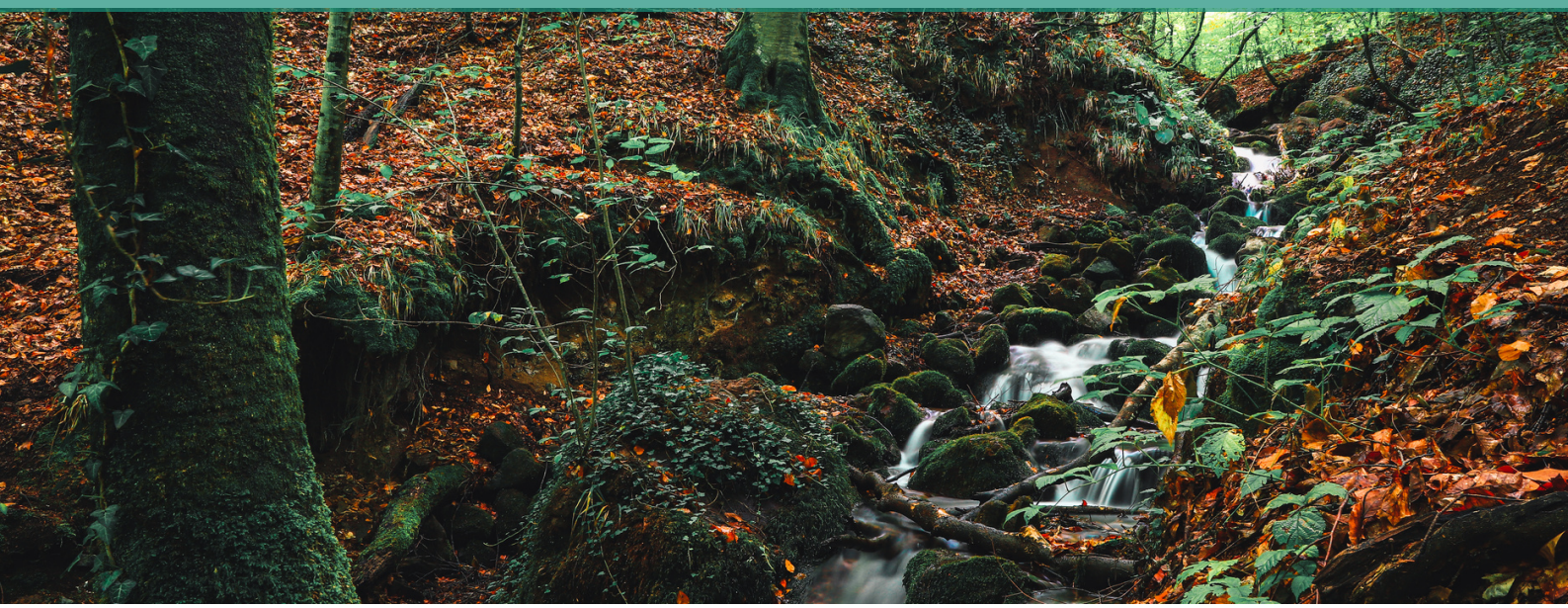
The EBV class 'Species Traits' is defined as derived measurements required to study, report, and manage the change of traits of species or populations in time. The traits of interest are related to morphology, physiology, phenology, movement, and reproduction. Monitoring the density distributions of these traits within species or populations is a data-intensive observation. The Species Traits WG aims to identify ongoing or developing monitoring campaigns and create links to GEO BON.

As changes in species traits are highly informative for species fitness, dedicated monitoring systems exist in fishery, forestry and agriculture for economically relevant or affected species and populations. In the context of phenological observation networks and bird counting campaigns, citizen science produces data useful for trait monitoring. Species traits are part of standard measurements of some ecological observation networks, e.g. ICP Forest, ICOS, TERN, and NEON. In addition, high expectations for broad-scale monitoring exist concerning technological development, i.e. movement trackers and satellite-based remote sensing.

However, most monitoring efforts are domain-specific, i.e. for specific taxonomic or geographic groups of organisms. The Species Traits WG considers extending the number of chairs to at least represent the most general domains: terrestrial flora, terrestrial fauna, marine, and freshwater biodiversity.

Ecosystem Structure WG

Leads: Gary Geller, Susana Rodriguez-Buritica, Rubén Valbuena



A key step for the Ecosystem Structure Working Group was to bring in two new co-leads. Susana Rodriguez-Buritica is with the Humboldt Institute in Colombia, which has been a key GEO BON partner for years. Her skills in spatial ecology applied to biodiversity conservation in Colombia have already proven valuable. Rubén Valbuena is a Professor of remote sensing of forests at the Swedish University of Agricultural Sciences with expertise in vertical ecosystem structure, particularly lidar. Through GEO BON, Rubén received a Microsoft grant to study forest vertical structure in the Amazon (project AMAZECO); he also presented at CBD COP-15 on the role that Earth Observations can play in GEO BON's Global Biodiversity Observing System (GBiOS). Susana and Rubén now complete the co-leadership of the Ecosystem Structure WG alongside Gary Geller of NASA who has been a co-lead since the working group started.

The AMAZECO project team included Rubén, Eric Görgens (Universidade Federal dos Vales do Jequitinhonha e Mucuri), Carlos A. Silva (University of Florida), Mauro Asís (INPE), Danilo de Almeida (Bangor), Jean-Pierre Ometto (INPE) and Michael Keller (NASA and US Forest Service). AMAZECO generated Essential Biodiversity Variable (EBV) products related to ecosystem height, cover, and structural complexity for the entire Brazilian Amazon using airborne and satellite lidar. An R-based workflow produced those ecosystem trait products in a globally consistent manner and included a new R function to create large-scale maps from satellite lidar data. EBV product maps for other Brazilian regions including the Cerrado and Atlantic Forest were also generated.

Understanding the congruence between ecosystem structure and biodiversity is vital for advancing the ecosystem structure EBVs and their derived indicators. A key product in this regard is the globally mapped Forest Structural Condition Index (FSCI; Hansen et al. 2019), which accounts for forest change in terms of structural properties such as canopy height and forest cover, as well as disturbance. In Colombia, this product has been updated yearly and incorporated into species distribution modelling (SDM) initiatives like Wallace and BioModelos. At the same time, this indicator has been contrasted with biodiversity records to assess the level of congruence in describing habitat suitability based on structural properties. Current work is also underway to

refine forest structure variable estimates (canopy height, plant area index, total cover) based on multiple sensors (multispectral and SAR) and GEDI data in order to refine alpha diversity forest mapping. FSCI has also been incorporated into SDMs in the context of the BioModelos and Wallace activities, which will help assess the importance of structural indicators in predicting future species distribution shifts.

The Ecosystem Distribution EBV, which is equivalent to the "ecosystem extent" terminology often used elsewhere, appears as CBD Headline Indicator A.2 in the recent CBD Global Biodiversity Framework Monitoring Framework. It is also one of the five accounts within the UN System of Environmental Economic Accounting (UN SEEA), a work that is being coordinated with GEO BON through Rubén's participation in the SEEA WG on Forests. As such, it is one of the most basic pieces of ecosystem information needed to understand how ecosystems are changing and to guide policy and management. However, monitoring it is commonly done using land cover as an approximate surrogate, a practice that has a variety of important limitations including a coarse set of classes, classes that do not map to actual ecosystems, and update frequencies that are often very limited. Consequently, current needs are not being well-met and it is clear that improvements in ecosystem extent mapping and monitoring are needed. With this in mind, GEO is conceptualizing an "ecosystem extent atlas" and in December the Committee on Earth Observation Satellites (CEOS) approved an activity to explore how new technology and space-based sensors can help improve ecosystem extent mapping. Gary co-leads that CEOS activity and expects the Ecosystem Structure WG to participate once this new activity gets started.

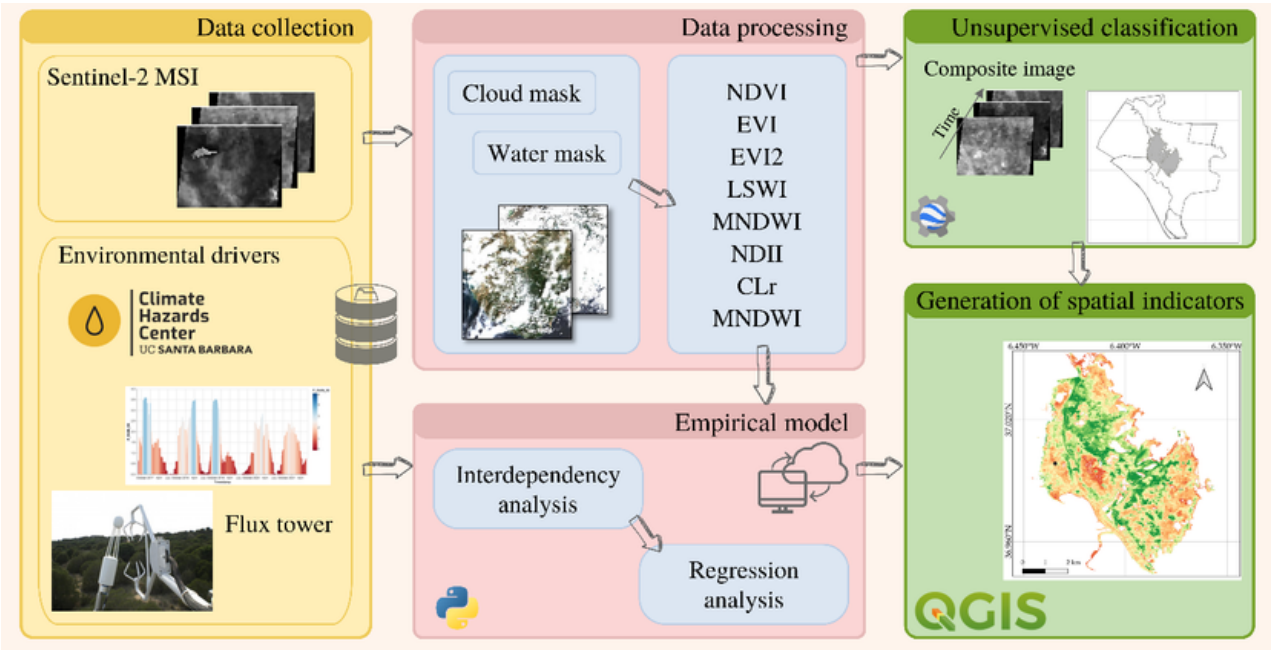
Ecosystem Structure, particularly its role in biodiversity and the need to monitor it, was discussed at the World Biodiversity Forum in June, in Davos, Switzerland. In particular, it was highlighted in a GBiOS workshop co-organized by Gary and in which Rubén participated.
Lastly, the key plan for the coming year is to produce a peer-reviewed paper describing Ecosystem Structure EBVs and summarizing their role in generating key derived products such as indicators. As part of that activity the working group is expected to be restructured and its membership updated.

Ecosystem Function WG

Leads: Ghada El Serafy, Pedro J. Leitão

Progress:

After revising the list of EBVs for the Ecosystem Function class, based on recent progress in defining ecosystem functions and agreeing on a typology, the WG activities have focused on two relevant EBVs, Primary Production (or productivity) and Disturbance regime and ecosystem disturbance as EBV. Great progress was made in developing a workflow and a tool assessing the capabilities of sentinel-2 data for spatio-temporal upscaling of flux tower Gross Primary Productivity measurements. The study has been recently published and can be found here. The WG has proposed to extend the workflow to include different types of sensors and new EBVs.
Progress has also been made in the operationalization of the Disturbance Regime EBV that needed 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 ecosystem responses. The WG agreed to collaborate further on this activity in 2023 towards the production of a review paper on the opportunities and challenges for the global monitoring of disturbance regimes.



Upcoming activities:

Plenty of research on EFs has been done in the last few years. The WG has agreed to review and update the implementation plan based on new needs, research, and activities on the current research landscape.
Additionally, the WG activities have narrowed and tend towards the definition of a conceptual framework to harmonize the WG research efforts. The conceptual background is needed to prioritize activities within the group. Brainstorm activities will be organized together with a conceptual exercise based on a scientific review of EFs and EBVs to define the approach and method and add additional knowledge in the context of the WG.
The WG is currently looking for a third co-lead to support the WG coordination activities. Get in touch with Ghada and Pedro if you are interested and available to engage.

Ecosystem Services WG

Leads: Ana Sofia Vaz

Changes in leadership

María Vallejos and Odirilwe Selomane stepped down as leads of the Ecosystem Services Working Group at the end of 2022 being replaced by Ana Sofia Vaz, a long-standing member of the WG who has contributed substantially to the development of the cultural ecosystem services tasks in the working group.

EESVs webinar

The Ecosystem Services Working Group, with support from the GEO BON Secretariat organized a webinar on Essential Ecosystem Services Variables (EESVs) based on the highly anticipated paper from Balvanera et al. (2022) published in *Current Opinions on Environmental Sustainability*. You can find the webinar here.

General Questionnaire and Follow-up meetings

Following the timing of the move of the GEO BON Secretariat to Montreal, our WG felt it was time to hit the reset button, and revisit what the focus of the WG could look like going forward. For this reason, we developed and ran a survey with WG members, to determine what would be interesting for them to focus on. The questionnaire was followed by two hands-on meetings with the whole group. These exercises allowed us to see several alignments with the general strategic plan for GEO BON, including the need and motivation to: 1) strengthen collaboration and knowledge exchange within the WG, 2) interact and promote joint initiatives with other WGs and BONs, 3) the need to mainstream ESSVs and to promote their use for several groups not only academic and governance but also at the business level, 4) to focus on gap filling in terms of other indicators and metrics specifically beyond biodiversity towards social-cultural dimensions, 5) the expansion of the ecosystem service concept to further, priority and emergent research areas such as (e)DNA and soils, and 6) to find ways to deal with inequalities and injustice in the access, use and appropriation of data on ecosystem services across scales and communities.

New ESWG action plan (in progress)

The ESWG started to delineate the new action plan in line with the new GEO BON strategic plan. The new ESWG action plan has new objectives to be tackled in the next years. The new action plan will focus on 1) strengthening interactions within and outside the ESWG, promoting ways to bring its members together while engaging with wider initiatives (such as ESP and IPBES) which overlap partially in their visions and can support the implementation of an observatory of ecosystem services, aligned with the idea of GBiOS; 2) mainstreaming EESVs, with clearly identified indicators, metrics, metadata useful for multiple end-users (from academics and policy, to society and businesses), aligned with K2A hubs, 3) systematize and address already identified gaps in ES indicators (and data), including the articulation of such with emergent technological fields of research and under a multidisciplinary principle of knowledge (including with social/cultural researchers). We have a first set of ideas from the WG members inputs which will now need to be well-aligned with the general strategic plan and further detailed during the beginning of 2023.

Funding

Many of the active members of the Ecosystem Services Working Group were dedicated to the submission of a COST Action proposal, led by Sofia Vaz, focusing on the mainstreaming of digital data to assist in the assessment and monitoring of conservation indicators, many of which are intrinsically related with the EESVs. The proposal involved partners from 34 different countries and 2 international organizations, GEO BON being part of it.

Publications

Balvanera et al (2022)

As part of its Task 1 (on Essential Ecosystem Services Variables), the Ecosystem Services Working Group lunched a highly expected publication in *Current Opinions on Environmental Sustainability*, proposing a set of Essential Ecosystem Services Variable (EESV) and indicators which where already illustrated for exemplary ecosystem services confirming their readiness for global operationalization and to monitor progress towards achieving the Sustainable Development Goals.

Leadley et al (2022)

As part of its Task 2 (Dialogue with policy bodies), the Ecosystem Services Working Group was involved in the collaborative paper showing that bending the curve for biodiversity is possible, if policy actions are implemented urgently and in an integrated manner. Connecting these actions to biodiversity outcomes and tracking progress remain a challenge.

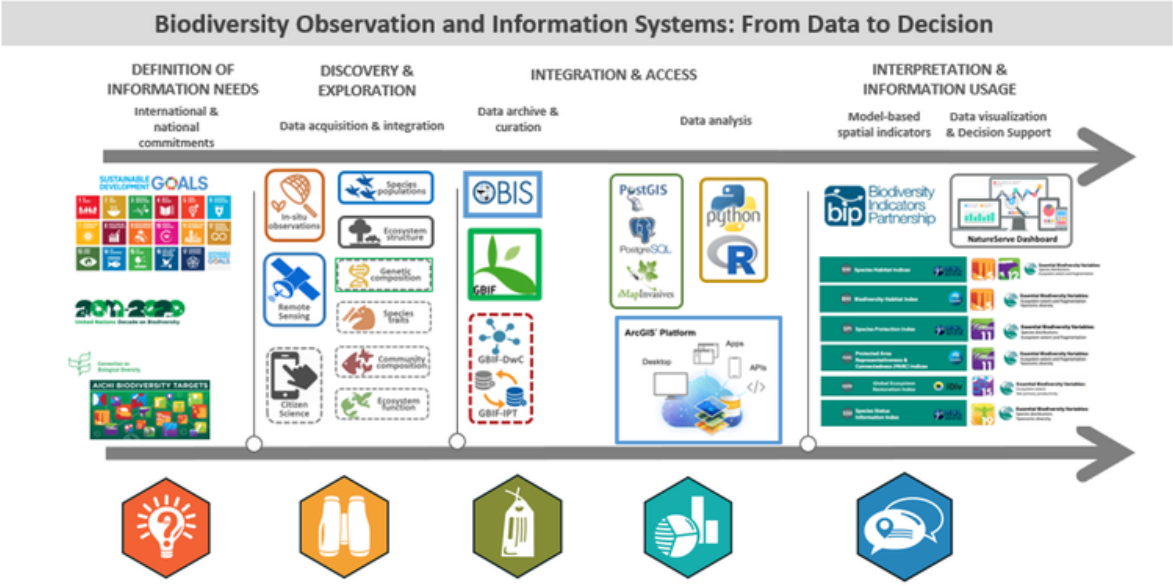
Cardoso et al (2022)

Gosal et al (in prep) Earth observation indicators for landscape aesthetics

As part of its Task 7: Cultural Ecosystem Services (Dialogue with policy bodies), the Ecosystem Services Working Group used and refined freely available deep learning models, for automating the classification of natural and human elements relevant to cultural ecosystem services from digital online data. In parallel, the Ecosystem Services Working Group is working on a global set of Earth observation indicators to inform on the multiple dimensions of landscape aesthetics, both for the supply and the demand side. Both researches advance the way EESVs indicators pertaining to cultural interactions can be assessed and monitored.

BON Development WG

Leads: María Cecilia Londoño, Mike Gill, Petteri Vihervaara



With a new GEO BON strategic plan in development including plans for the formation of new Knowledge to Action Hubs (K2As) including one for indicators and another for BONs, the working group focused on finalizing existing products that will form the foundation for improved capacity for the establishment of Biodiversity Observation Networks (BONs). This included completion of a first draft of the BON Development Manual (with submission to the GEO BON Secretariat), advancement of version 2.0 of BON-in-a-Box and submission of a manuscript on Biodiversity Observations for 2050 (Gonzalez et al.) to Ecology Letters.

Related efforts have included the application of the 9-step BON Design Process in several regions and countries including the Bahamas (production of decision support system and related indicators for improved Marine Protected Area management effectiveness), Tropical Andes (Tropical Andes Observatory design and biodiversity dashboard for Peru, Bolivia and Ecuador), and Ghana and Uganda (streamlined biodiversity data to indicator production workflows for mainstreaming biodiversity). In Europe, designing of the biodiversity monitoring systems on national and regional scales has been developed by EuropaBON and European Biodiversity Partnership Biodiversa+ including 23 active countries represented by ministries of the environment and/or national environmental protection agencies. This work will continue during 2023. Currently, EuropaBON has involved already over 1000 members to join the network. In addition, partners worked via funded projects in the Arctic (development of a data visualization platform for the Arctic BON).

The above projects represent different modular components of a data to decision workflow (Figure 1) that follows the established 9-step BON Design Process developed by GEO BON. This modular approach has allowed us to establish a National Indicator Reporting Toolkit initiative that will accelerate the transfer of technology and best practices for biodiversity monitoring and reporting. This initiative is a partnership between NatureServe, Esri and the Global Partnership for Sustainable Development Data with 8 national partners (Kenya, Tanzania, Rwanda, South Africa, Namibia, Ghana, Bahamas, and Costa Rica) as pilots. Implementation of this initiative is planned to begin in 2023 and outputs will specifically be linked to BON-in-a-Box to allow cross-integration.

French BON

Leads: Yvan Le Bras, Jean-Denis Vigne

The French Biodiversity Data Hub ("Pôle National de Données de Biodiversité" - PNDB) has led the French participation to GEO BON since 2015 (through the Ecoscope initiative). Recently PNDB joined forces with the Biodiversity Information System on Public Policies ("Système d'Information sur la Biodiversité" - SIB). Thanks to this co-leadership, this national BON proposes a concerted coordination of all biodiversity data and metadata from monitoring programs, from expertise to research around an innovative Essential Biodiversity Variable (EBV) operationalization pilot (basis of EBVOSC case study proposal). This pilot is made of open practical solutions providing a particular high degree of FAIRness (Findable, Accessible, Interoperable, Reusable) of biodiversity digital objects, from raw data to indicators through source codes.

Key highlights:

1. Co-leadership for the French BON through a recent partnership between the French Biodiversity Data Hub and the Biodiversity Information System on Public Policies. Thanks to this co-leadership, French BON proposes a concerted coordination of all biodiversity data and metadata from monitoring programs, from expertise to research.

2. Proposal of a Global Open Science Cloud (GOSC) case study named EBVOSC. Our aim is to operationalize EBVs by targeting the highest levels of FAIRness (Findable, Accessible, Interoperability, Reusable) for both data and source code implementation, so that data and tools can be widely shared and reused. To do so, we are capitalizing on ongoing work linked to our membership to the "DataONE" network for data and metadata, and the "Galaxy for Ecology" initiative we are leading for source codes.

3. The SIB catalog: fed by public policy data: DPSIR (linked to INPN and OpenOBs : 120 M occurrence data)

4. French BON is currently developing an integrated framework for 1) extracting EBV information from raw data using Ecological Metadata Language, (EML), and EDI EML Assembly Line R package and related MetaShARK R Shiny app, 2) running ecological analysis workflows and 3) producing biodiversity indicators for research, expertise and policy makers thanks to the Galaxy-Ecology collaborative platform.

Highlighted events:

- EBV workshop at the International Conference on ecological sciences the 23th of November 2022, at Metz (France): from raw biodiversity data to operational indicators through Essential Biodiversity Variables. The workshop presentation is available here.

- Launch of the GAIA Data project: The objective of GAIA Data is to develop a global device for access to data, products and services allowing to observe, understand and predict in an integrated way the history, the functioning and the evolution of the Earth system subjected to global changes.

Publications:

Royaux C, Norvez O, Jossé M, Arnaud E, Sananikone J, Pavoine S, Pelletier D, Mihoub J-B, Le Bras Y (2022) *From Biodiversity Observation Networks to Datasets and Workflows Supporting Biodiversity Indicators, a French Biodiversity Observation Network (BON) Essential Biodiversity Variables (EBV) Operationalization Pilot using Galaxy and Ecological Metadata Language*. Biodiversity Information Science and Standards 6: e94957.

Royaux C, Sananikone J, Arnaud E, Norvez O, Ainsa A, Morin S, Pamerlon S, Archambeau A-S, Le Bras Y (2022) *French Biodiversity Data Hub: Linking local to global biodiversity through international initiatives and open science clouds.* Biodiversity Information Science and Standards 6: e91374.

Colombia BON

Leads: Bibiana Gómez, Helena Olaya

During 2022, the Colombia BON supported several projects, ongoing and new, for the development of indicators and evaluation of Essential Biodiversity Variables (EBV):

BON-in-a Box 2.0, a project that began this year and seeks to establish an integrated biodiversity information system by (i) calculating biodiversity status change indicators, (ii) supporting the design of BONs to assess progress towards the CBD goals and (iii) ensure that these two elements support actions for the conservation and restoration of degraded ecosystems. The project is developed by researchers from Humboldt Institute (Colombia) and Quebec Centre for Biodiversity Science (Canada). This year, during workshops with experts, types of models, user needs, data and information sources, previous resources and advances available for each component were defined, and work was done with the Canadian team to define the development of workflows.

AudioClim, a project funded by Microsoft and GEO that seeks to develop a flow analysis of passive recordings to estimate the vulnerability of Neotropical amphibians to climate change. Preliminary results show that it is possible to automatically identify sound marks in complex environments with high precision (>0.8) and in a fraction of the time required by a manual analysis (23 hours of continuous recording were analyzed in 1 hour of computation). These results show the enormous potential that artificial intelligence techniques have in acoustic monitoring and in general for monitoring biodiversity. The workflows have been implemented in Python and are available as open source in the SoundClim project's private GitHub repository.

Biodiversity Information and Monitoring System for Colombia's Protected Areas (IBIMIS), is a project supported by The American Museum of Natural History and the National Aeronautics and Space Administration (NASA). The results of the 19 meetings and 2 consultation workshops held this year can be summarized as: a) updating the system architecture scheme; b) the identification of baseline improvement priorities for the calculation of indicators in relation to coverage maps, distribution models of terrestrial and marine species, species connectivity maps, updating both terrestrial and marine footprints; and, c) computer development of components that facilitate indicators calculation of the National System of Protected Areas monitoring system SIM-SINAP.

BioModelos increased its numbers of available models (endemic birds, large rodents, carnivores, fish, beetles, orchids and epiphytes), experts, groups, users and downloads (589% since 2020). 4000 BioModels of plant species were developed for the present and projected in climate change scenarios (year 2030). The maps are hosted on an institutional server and will be released in 2023 after going through an inspection process. On the other hand, progress was made in the curation of multi-temporal models of birds, this allowed obtaining 845 BioModels with low uncertainty available in the Google application "BioModels GEE", useful for evaluating trends in the distribution of Colombian birds in 21 years. These maps will be the basis for the development of almost real-time biodiversity loss alert systems. The development of an API was completed, which allows the connection of BioModelos databases with Wallace application, a project financed by NASA and supported by the American Museum of Natural History in New York plus City University of New York. The purpose was improving the development of BioModels with experts. The API programming routines can be found on the PEM Github repository and the Wallace-BioModelos version can be found in the project repository. Finally, based on the identification of user needs and supported by NASA, in association with researchers from AMNH and CUNY, a package was developed in the R programming language "changeRangeR: An R package for reproducible biodiversity change metrics from species distribution estimates" that allows the calculation of IUCN evaluation metrics, as well as facilitating work routes for the estimation of richness, endemism and phylogenetic endemism maps of species.

BioTablero: within the geographic consultation module, the information on natural, secondary and transformed coverage, protected areas and the human spatial footprint index at the national level were updated. A new indicator of forest loss and persistence was included, which is evaluated for the 2000-2005, 2006-2010, 2011-2015 and 2016-2021 time periods. Finally, in the geographic viewer module, a fourth tab called portfolios was generated. In this tab, the contribution of multiple portfolios of conservation areas to different goals were calculated (i. Threatened species; ii. Threatened ecosystems; iii. Surface and groundwater storage; iv. Carbon storage; v. Avoided deforestation; vi. Key connectivity corridors, vii. Key areas for restoration) for the consultation areas used by BioTablero. This information will soon be available in BioTablero production environment.

China BON

Lead: Haigen Xu

China BON serves as the largest biodiversity monitoring network in Asia, and it consists of 749 sites, including 380 bird sites (2,516 line transects and 1,830 point transects), 159 amphibian sites (2,076 line transects and 310 groups of fence traps), 70 mammal sites (348 plots and more than 10,200 infrared cameras), and 140 butterfly sites (721 line transects). China BON plays an increasingly important role on biodiversity research and application and beyond. Through continuous monitoring for a decade (Yi et al. 2022) and joint efforts from numerous stakeholders, China BON has made the following achievements:

1. Created the method for the design of the biodiversity monitoring network. A sampling method based on complementarity analysis (an algorithm to select sites with most different species composition) and stratified sampling was established to solve the core problems of sampling site selection and network design for biodiversity monitoring.

2. Formulated China's first technical standard system on biodiversity monitoring for 13 biological groups and 7 ecosystem types. Biodiversity monitoring technologies integrating traditional survey, infrared camera, DNA metabarcoding and high-throughput sequencing were implemented.

3. Developed a database system and information management platform for biodiversity monitoring. The automatic judgment and species identification technology for infrared camera image based on artificial intelligence and deep learning has been developed, and the correct species identification rate reaches 90% for large and medium-sized mammal species.

4. Constructed essential biodiversity variables (EBVs) such as species richness, abundance, distribution, habitat structure and quality of more than 2,450 species of birds, amphibians, mammals and butterflies, and collected the dynamic change data of species diversity in the country and key areas.

The theory and methods for the design of China BON have received positive comments from GEO BON. The data and monitoring results have been applied to the implementation and update of national biodiversity conservation strategy and action plan, and development of national reports on the implementation of the Convention on Biological Diversity and technical standards for biodiversity conservation and management. Nature magazine featured the China BON and affirmed the significance of this network in 2021. The network was selected as one of the top 10 scientific and technological advances in China's ecological environment research in 2021. The State Council Information Office's White Paper on Biodiversity Conservation in China (2021) highlighted China BON as an important achievement and affirmed its important role in biodiversity conservation.

Publications:

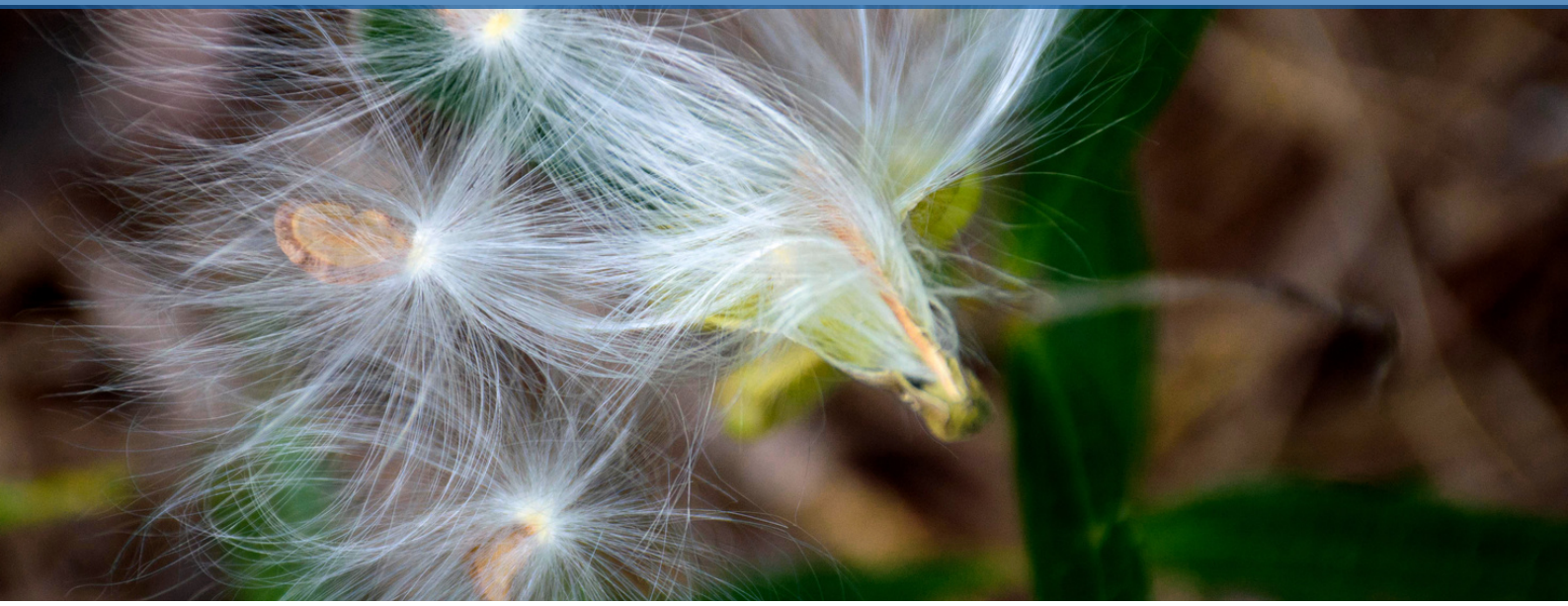
Haigen Xu et al. *China's Bird Diversity Observation.* Science Press, Beijing, 2022

Fangzhou Ma, Chenbin Wang, Yanjing Zhang, Peng Cui, Haigen Xu. *Rapid loss of China's pollinator diversity*. Science, 2022, 377: 1055.

Jianfeng Yi, Fangzhou Ma, Jiaqi Li, Wei Liu, Yun Cao, Yaqiong Wan, Chenbin Wang, Mengmeng Chen, Dandan Yu, Haigen Xu. *China Biodiversity Observation Network for better global sustainability developments.* Eco-Environment & Health, 2022, 1: 201-203.

Asia-Pacific BON

Leads: Hiroyuki Muraoka, Runi Sylvester Pungga, Yongyut Trisurat



APBON (Asia-Pacific Biodiversity Observation Network), established in 2009, is a network for observing and assessing biodiversity and a platform for engaging with scientific policies. Our mission is to increase the exchange of knowledge and expertise between institutions and researchers concerning biodiversity and scientific research in the Asia-Pacific region, thereby contributing to evidence-based decision making and policy making.

Terrestrial:

- **Phenology research** on forests in East and Southeast Asia *1 *2
- **Satellite remote sensing of biodiversity**
  - Tropical forests and tree flowering
  - Himawari AHI satellite is useful for phenology observations
  - Mapping forest fragmentation / connectivity by satellite imagery for assessing integrity of forested landscapes in Himalayan regions in India
- **Impact assessment of climate change** on biodiversity and species distribution
- **Knowledge for biodiversity conservation** in cityscapes and regions
- SATREPS project for biodiversity conservation in Sarawak, Malaysia *3
- **Mapping protected areas** in the Hindu Kush Himalaya *4
- Collections of herbarium specimens (flora and fauna) in Sarawak
- **Systematic observation, data center, and platform** in SinoBON
- **New DNA sequencing technique** for the evaluation of species and genetic diversity
- **Nature-Based Solutions** to global climate change mitigation and adaptation
- Data and knowledge needs to avoid a possible tradeoff in infrastructure for carbon neutrality and biodiversity (e.g., solar energy systems)
- **Integrity of forested landscapes is key** for biodiversity conservation and ecosystem functions and services

- **Valuable ecosystems**, such as peatlands, rangelands, and wetlands, are degrading because of the climate crisis; forgotten and exploited systems like karsts also need attention. Assessments of climate change induced impacts on biodiversity are urgently needed.
- **More research** needs to be carried out on carbon, issues **relevant to climate change, and addressing the SDGs.**
- **'Master site' concept** to connect in situ and satellite observations of biodiversity and ecosystem functions (e.g., the carbon cycle) and scaling up to a broader spatial scale

Freshwater:

- **3D model of various organisms** for the online specimen database (ffishAsia / floraZia) *6
- "Mekong integrated water resources management project"—**Improved community fishery governance in Cambodia**; illegal fishing and threats to the resource; socioeconomic and food security benefits; resource management; gender and ethnic minorities.
- Understanding the **implications of water infrastructure development and climate change on fish yields** and welfare values in Cambodia.
- Impacts of illegal fishing, environmental change, population growth, and hydropower dams on fish biodiversity in Cambodia.

Coast and marine:

- Established AP–MBON
- Hosting a series of online workshops and sessions, including symposium on healthy oceans as **UN Decade of Ocean Science** *7 *8
- Review and case study paper on genetic analysis of **important marine areas (EBSAs)** for coral around Japan *9
- Developing and applying innovative new technologies on marine biodiversity observation in Asia-Pacific Region, such as **remote sensing and deep learning** techniques and environmental DNA *10 *11
- Projects in response to the **UN Decade of Ocean Science** (deep sea, **seagrass** and **mangrove mapping, and pole to pole biodiversity**).
- Elucidating current distribution of **seagrass beds in SE Asia, their temporal changes and protection status** *12
- Networking of Harmful Algal Bloom research in Asia-Pacific Region.
- Promotion of **Social-Ecological System** study such as understanding importance of Blue Carbon ecosystems to local people *13

EUROPABON Europa BON

Leads: Henrique Pereira, Jessica Junker

The Europa Biodiversity Observation Network is happy to report back on its many highlights for 2022, which marked the end of the second year of the EuropaBON project. A promising start of our first year of officially being endorsed as a regional BON with GEO BON, was the launch of the EuropaBON RIO collection, where you can find a range of EuropaBON-related documents, including our Grant Proposal, project reports and scientific papers.

Furthermore, we submitted and published one of our key deliverables, the User & Policy Needs Assessment Report, which is an analysis of the information provided by more than 350 experts in policy, science and environmental protection. In September, EuropaBON's Coordinator Prof. Henrique Pereira (iDiv) and Dr. Hilde Eggermont, Chair and Coordinator of Biodiversa+, signed a key collaboration letter, merging the two leading initiatives to promote and support transnational biodiversity monitoring. This key collaboration will allow to build on, enrich and operationalise relevant outcomes from EuropaBON through Biodiversa+.

We also attended a number of important events to further promote EuropaBON, recruit new members for our growing network, and establish and strengthen collaborations. These included amongst others, the World Biodiversity Forum (WBF) in Davos in June, the European Congress of Conservation Biology (ECCB) in Prague in August, and the 15th Conference of the Parties to the United Nations Convention on Biological Diversity (COP 15) in Montreal in December last year.

Finally, EuropaBON organised a number of workshops, webinars and stakeholder conferences.

One of these included an expert online workshop in April on identifying Essential Biodiversity Variables for the future European Monitoring system that respond to policy needs identified in EuropaBON's User & Policy Needs Assessment.

In May, we hosted another online workshop on Novel Biodiversity Monitoring Methods, where, with the help of more than 200 participants, we gathered information on how to bridge the gap between innovation and applied practice.

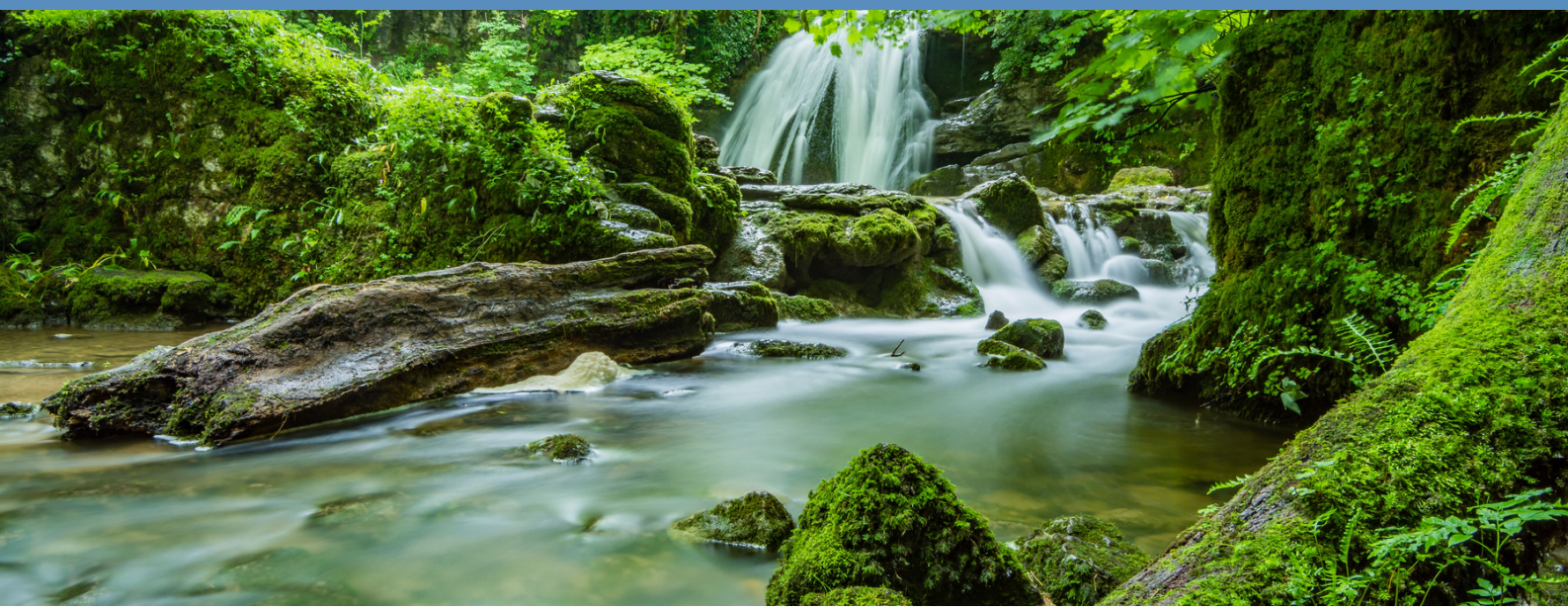
We also held EuropaBON's second stakeholder conference in November in Brussels, Belgium and online. Organised in a collaboration with Biodiversa+, the event aimed to address the challenges and opportunities of integrating biodiversity monitoring information to support public and private policy and decision making in Europe.

We would like to thank all our partners and the now more than 1000 members in our network for their input and support and we look forward to continuing our work with them in 2023. We will need all the support we can get this year, as we will deliver on our promise to develop an EU-wide framework for monitoring biodiversity and ecosystem services to the European Commission by the end of 2023. So, stay tuned for upcoming EuropaBON events in 2023 and the latest news and results via our project website.

Please join our network here and help us design Europe's new biodiversity monitoring system.

Freshwater BON

Leads: Eren Turak, Andreas Bruder, Jennifer Lento



Mapping the global freshwater biodiversity data landscape

The Global Biodiversity Information Facility (GBIF) provided FWBON a small amount of funding to explore the current freshwater biodiversity data landscape in 2022. The GBIF freshwater landscape project aims to assess the type and frequency of freshwater data that is mobilised to GBIF as well as reasons for repositories not submitting to global repositories. The existing collection of freshwater data within GBIF will be analysed to determine the number and types of companies that contribute freshwater data, and how these vary geographically and temporally for each taxon group. Ideally, the percentage of large institutions that could potentially contribute to global repositories, such as museums, biodiversity organisations, conservation agencies and universities, will be assessed to determine future focused engagements of mobilisation. In addition, reasons for not mobilising freshwater data to global repositories will be investigated. In this case, repositories of freshwater data that were published in scientific literature but not represented in GBIF currently, were identified and authors invited to participate in a survey that explores reasons for not mobilising such data.

Since September 2022, the FWBON team has been working on both objectives of the paper. The project is hosted by the Council of Scientific and Industrial Research (CSIR) in South Africa. The first major output of this project will be a manuscript describing the attributes of freshwater biodiversity datasets from across the world. To help all co-authors to provide input in a consistent manner and to make this process easier for everyone, we have designed two survey forms. For those who prefer to work in a language other than English the forms have been translated into Arabic, Chinese, French, Portuguese, Spanish and Turkish. Currently there are 160 contributors to this project from 52 countries. The results of the project will aim at identifying possible geographic, temporal and taxonomic gaps of representation, and proposing opportunities for engaging with the stakeholder groups identified in mobilising freshwater data to global repositories. The publication is envisaged to be submitted for review end of February 2023, and budget has been kept aside for it to be an open access publication.

First in-person workshop of the FWBON Coordination Committee in Davos, June 2022

The FWBON Coordination Committee (Co-Chairs and Regional Coordinators) held our first in-person meeting in June 2022 in Davos, Switzerland. The 3-day workshop provided the opportunity to discuss and prioritise short- and long-term goals of FWBON, identify regional and global projects to support those goals, and develop an action-oriented approach to ensure the work of FWBON is relevant and contributes to GEO BON's vision of a Global Biodiversity Observing System (GBiOS). The workplan developed for 2022-2030 focuses on (i) building the strength of the FWBON network; (ii) developing recommendations for harmonised freshwater biota sampling protocols; (iii) facilitating and mobilising data access, sharing, and interoperability; (iv) contributing to regional and global indicators and reporting structures; (v) creating products useful for sound management of freshwater ecosystems and their catchments; and (vi) positioning FWBON as a global leader and source of expertise in freshwater biodiversity monitoring and assessment. Over the next years, the Coordination Committee will initiate projects that support this workplan and through engagement with the FWBON membership.

Science Brief on inland waters in the post-2020 Global Biodiversity Framework

FWBON led a team of 22 experts and practitioners to complete a Science Brief to help negations on the Post-2020 Global Biodiversity Framework during the CBD COP 15 in Montreal. The science brief contains recommendations for amendments to the GBF specific to inland waters including: integrated spatial planning (target 1); ecological restoration objectives for rivers and wetlands (target 2); protected areas and other effective conservation measures (target 3). It also contains key messages about data monitoring and reporting including: data infrastructures; ecosystem mapping; citizen science and Indigenous Knowledge; and indicators of biodiversity condition at different levels of biological organization i.e. ecosystems (milestone 1), species (milestone 2) and genes (milestone 3).

GLOSAM: IUCN SSC Task Force on Global Harmonization of Macroinvertebrate Sampling Protocols

Invertebrates are functionally vital to aquatic ecosystems and directly or indirectly affect human health and well-being. Freshwater macroinvertebrates are also widely used as indicators of ecological health in biomonitoring and bioassessment programs across the world. There is a huge global team of researchers and practitioners involved in freshwater biological monitoring and ecosystem assessment, meaning that a global assessment of freshwater ecosystems based on macroinvertebrates is attainable if an adequate level of harmonization of the protocols can be achieved. Still, in many countries, invertebrates are rarely monitored, standardized monitoring protocols are rare, and data are lacking on the abundance of species and their changes in space and time.

In 2022, FWBON leaders have gathered world-leading experts on freshwater invertebrate taxonomy and monitoring to create the IUCN SSC Task Force on Global Freshwater Macroinvertebrate Sampling Protocols (GLOSAM). The Task Force will (1) support the collection and analysis of freshwater benthic macroinvertebrate samples to monitor biodiversity and conduct bioassessment, (2) establish globally accepted, standardised biodiversity collection and data handling steps for both bioassessments and species inventories, with awareness of specific biogeographic requirements, and (3) develop and promote guidelines to ensure the collection of ecologically-relevant data of known and acceptable quality, and support, promote, and facilitate regionally comparable bioassessment schemes (tools, assessment systems). Currently, the Task Force is creating a global overview on the monitoring programs for ecosystem condition based on invertebrates and for their biodiversity and writing an overview paper describing the need for harmonization as well as gaps and challenges of such programs.

MBON
Marine Biodiversity Observation Network

Marine BON

Leads: Frank Muller-Karger, Isabel Sousa-Pinto, Masahiro Nakaoka

MBON Dear Colleague letter

The Marine Biodiversity Observation Network (MBON) has produced a "Dear Colleague letter" inviting the broader science community to form a Community of Practice. The MBON calls on nations, scientists, sponsors, and stakeholders to work together as a community of practice to support Marine Life 2030 and other programmes focusing on marine biology observations to enable dialogue, coordination, and cooperation between programmes. Please see this Dear Colleague Letter and join the MBON/Marine Life 2030 Community of Practice (GEO BON Members).

Sharm El-Sheikh– Climate Change Conference November 2022

MBON and the Marine Life 2030 Ocean Decade Programme were present at the UNFCCC COP27 official side event "Observing and understanding climate change and biodiversity from the coast to the deep ocean", co-organized by POGO and the University of Southampton and held on 15th of November 2022. The participating global networks discussed developing the capacity for observing and understanding marine ecosystems to support tracking, forecasting, and stewardship of these ecosystems to address the intertwined pressures of climate change and human development and quantify biodiversity changes from the wetlands and coasts to the deep ocean. The session emphasized the importance of integrating biological observations into ocean monitoring, and the need to link observations to policymaking. Dr Veronica Relano, leader of the Marine Life 2030 affiliated project Somos Oceanos talked about local community involvement in the conservation of marine life for sustainable development in the context of climate change: a challenge for Marine Life 2030 and other Ocean Decade Programmes. Watch the session on YouTube here.

David Obura co-leads Science Brief on the Sustainable use of Biodiversity
MBON SC member David Obura from CORDIO led an international team of experts in developing a science brief about the Sustainable Use of Biodiversity: Sustainable Use Targets of the Post-2020 Global Biodiversity Framework. This brief builds on the IPBES thematic assessment of the sustainable use of wild species but extends its focus to incorporate species within modified ecosystems such as farmland and urban areas, aiming to address the sustainable use of all species and provide a set of key messages with supporting information. This brief was prepared as a follow-up to the "Science briefs on targets, goals and monitoring in support of the post-2020 global biodiversity framework negotiations" that were coordinated by Future Earth and GEO BON in support of the WG2020-4 meeting in Nairobi, Kenya in June 2022 (CBD/WG2020/4/INF/2/Rev.2).

New Marine Life Projects Support Conservation and Healthy Ecosystems
On behalf of the National Oceanographic Partnership Program, NOAA and partner agencies, including NASA, the Bureau of Ocean Energy Management, and the Office of Naval Research have awarded several new proposals. The Principal Investigators and project titles can be found here.

MBON at the 2022 UN Ocean Conference
MBON partnered with the Interdisciplinary Centre of Marine and Environmental Research (CIIMAR), the Atlantic International Research Centre (AIR Centre), the National Oceanic and Atmospheric Administration U.S. Integrated Ocean Observation System (U.S. IOOS), the Ocean Best Practices System (OBPS), the Ocean Biodiversity Information System (OBIS), and the Global Ocean Observing System (GOOS) of the Intergovernmental Oceanographic Commission (IOC) to hold an in-person side event on 28 June 2022 as part of the UN Ocean Conference (UNOC) which joined Heads of State and Governments, thousands of experts, business leaders, scientists, and civil society representatives together, providing a space for meaningful dialogue and seeking collaborations *to conserve and conduct responsible use of the oceans for sustainable development* (SDG14).
Participants developed the following statement as an outcome of the event.

Marine Life 2030 at the UN Ocean Decade Forum
Supported by the MBON, Marine Life 2030 showcased a video at the UN Ocean Decade Forum held on 30 June 2022, as part of the UNOC. This side event celebrated the challenges and outcomes envisioned for the UN Ocean Decade in science, innovation, and technology, as well as changes in society required for sustainable uses of the ocean. The Forum showcased several endorsed UN Ocean Decade Actions and provided a space for announcements from partners.

Discover more about Marine Life 2030 UN Ocean Decade endorsed programme by watching the welcome video.

Omic BON

Leads: Raïssa Meyer, Pier Luigi Buttigieg, Neil Davies

The newly established Omic BON and its partners aim to promote coordinated biomolecular observations for global insight and action.

Our vision is a sustainable, reactive, and globally integrated omic meta-observatory that monitors biodiversity at the molecular level. A meta-observatory is a distributed observatory to which anyone performing well-documented and metadata-rich observations - from citizen science initiatives to established long-term observatories - can contribute. The observations conducted independently across time and space are integrated into a coordinated body of observations.

We aim to transition the fragmented observation of biomolecular biodiversity into coordinated contributions to a meta-observatory for collective insight and action.

Omic BON was officially endorsed in May 2022. It has become the first thematic BON focused on a methodology, underpinning the importance of omics techniques to understanding biodiversity.

Omic BON's webpage highlighting our key objectives and planned activities is live.

Omic BON's founding charter has been drafted and circulated to its partners for review and endorsement.

Building from its early relationship with Marine BON, Omic BON has started coordinating activities with GEO BON's Genetic Composition WG, Freshwater BON, and Asia-Pacific BON.

Beginning efforts to secure global interoperability, Omic BON has formalised its relationship with the Ocean Biomolecular Observing Network (OBON)-an endorsed programme of the UN Decade of Ocean Science of Sustainable Development.

Remote Sensing Task Force

Leads: Andrew Skidmore, Nicholas Coops

- Regular meetings with GEO BON management team regarding the next steps and structures within GEO BON and where remote sensing fits
- Contribution to the GEO BON Global Biodiversity Observing System (GBiOS) to support the monitoring framework for the Global Biodiversity Framework. Our group is especially focused on how remote sensing and spatial data can 'fill the gaps' in time and space between in situ field observations.
- Contribution to the GEO BON strategic plan (2022-2026)
- Developing an Action Plan for 2023 for the operationalization of Earth Observation to TRL 6-9 (Technology Readiness Level).
- Planning for the GEO BON conference in 2023.
- Follow up work on developing grant proposals and policy impacts of remote sensing biodiversity products required for monitoring Essential Biodiversity Variables (EBVs) (Skidmore, Coops et al. 2021).

Skidmore, A. K., N. C. Coops, E. Neinavaz, A. Ali, M. E. Schaepman, M. Paganini, W. D. Kissling, P. Vihervaara, R. Darvishzadeh and H. Feilhauer (2021). "Priority list of biodiversity metrics to observe from space." Nature ecology & evolution 5(7): 896-906.

Data Task Force

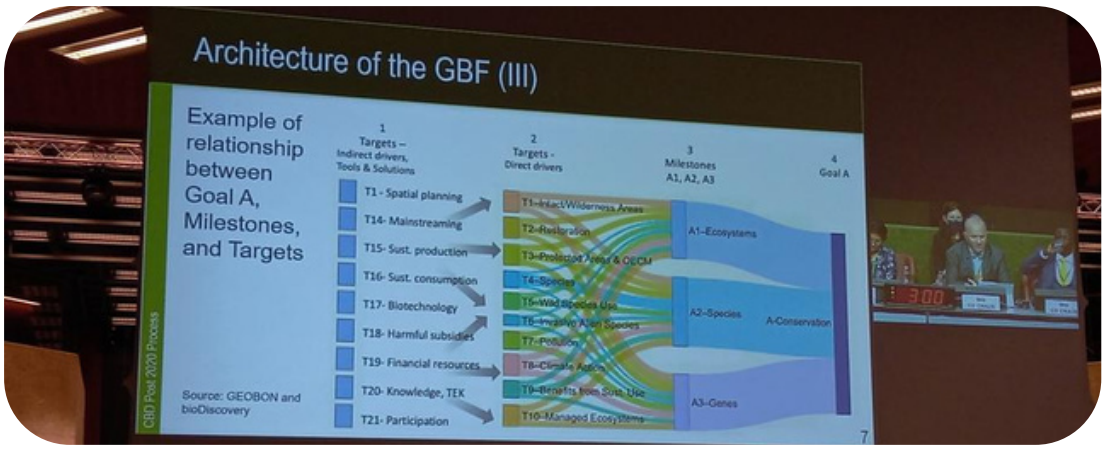
Leads: Néstor Fernández, Robert Guralnick

During 2022, the Data Taskforce has continued the development of a data standard and a data infrastructure for open-access to Essential Biodiversity Variables: the EBV Data Portal. A specification of the EBV-Cube standard has been consolidated, which now provides an operational specification for organizing and documenting spatiotemporal biodiversity datasets with contiguous space-time data. The new EBV-Cube version includes technical improvements for handling multidimensional data with a large number of biological entities (such as species or ecosystem types) together with simplified metadata to describe the characteristics and the provenance of the data. New EBV datasets have been also made available, now including around 30 datasets covering EBVs from sub-national to global scales.

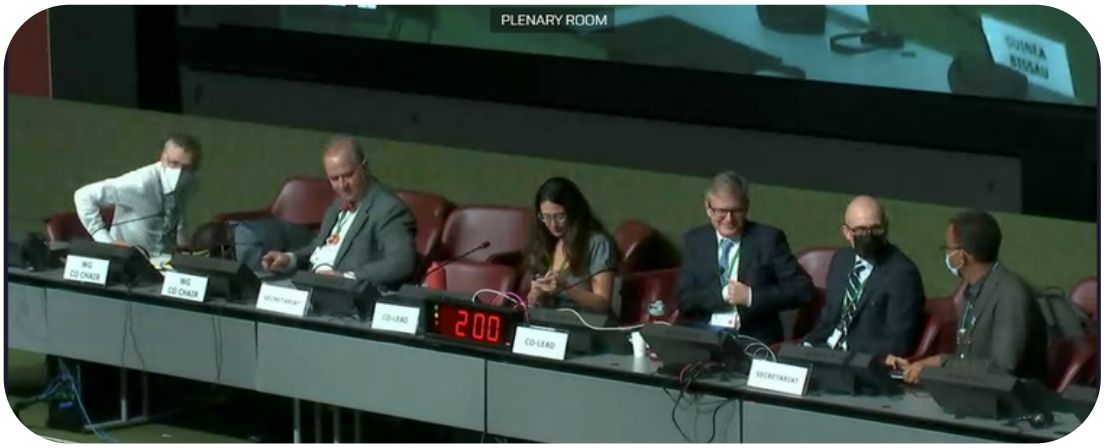
The EBV-Cube standard and the GEO BON Portal were also the topic of a dedicated session of The Biodiversity Information Standards (TDWG) Conference 2022. Topics discussed included future needs for connecting across biodiversity standards to make data more traceable from capturing the observations to delivering modelled EBV datasets. The EBV-Cube initiative was also presented in several other workshops and conferences, including among others the World Biodiversity Forum 2022, the European Congress of Conservation Biology and the EuroGEOS Workshop. The GEO BON EBV Portal has also partnered with several other biodiversity data platforms including eLTER and research networks such as EuropaBON and NaturaConnect.

Policy Task Force

Leads: Cornelia Krug, Laetitia Navarro



At the beginning of 2022, GEO BON, together with the bioDISCOVERY programme of FUTURE EARTH, published an extensive scientific information document as advice in support of the post-2020 global biodiversity framework (CBD/SBSTTA/24/INF/31). During the resumed meetings of the OEWG, SBSTTA, and SBI in Geneva in March, Parties to the CBD made several references to this scientific information document and it was considered helpful in providing clarity on several topics. A pared down version of the document was also published in *One Earth*.

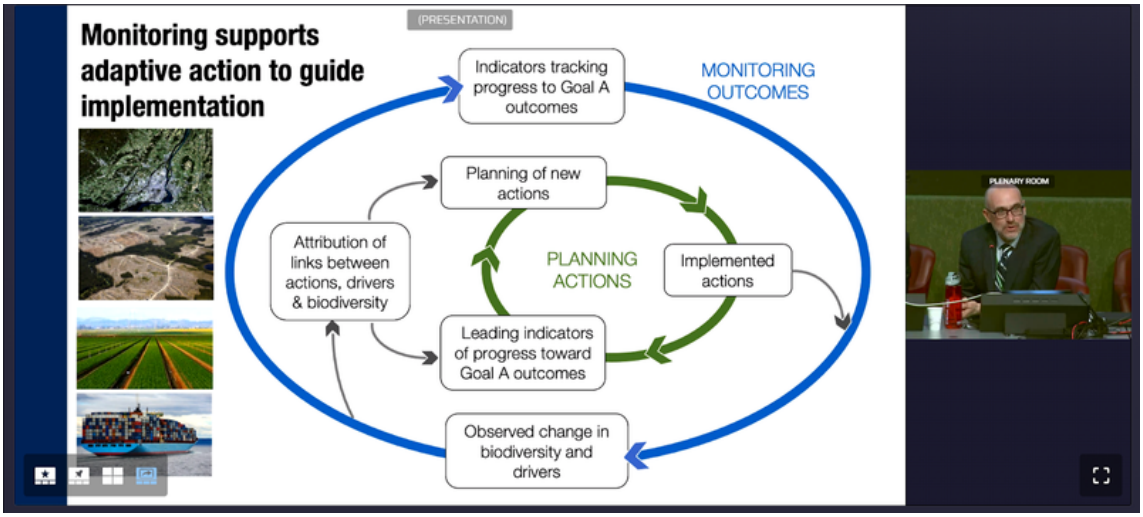


GEO BON was present in-person and remotely during the joint SBSTTA-24, SBI-3, and OEWG-3 meeting. Topics of particular interest included negotiations on the indicators in the monitoring framework to the GBF, national biodiversity observing and monitoring systems, and the capacity-building activities and other support to use and report on biodiversity indicators. A summary presentation and discussion of the information document was also given during a side event at this meeting.

Given the welcomed response of the scientific information document and the sentiment for clarity on other topics, collaborative work among GEO BON members and FUTURE EARTH continued throughout the year. Several short briefs on targets and topics related to the post-2020 GBF were produced, including on ecosystems, protected and conserved areas, pollution, climate change, sustainable agriculture, monitoring, ecosystem restoration, and sustainable use of biodiversity. In addition, GEO BON produced a brief on GBiOS (Global Biodiversity Observing System) while Freshwater BON and partners a brief on inland waters. All the briefs are available here.

A compilation of most of these briefs was provided by the CBD to Parties in time for the fourth meeting of the OEWG in Nairobi (CBD/WG2020/4/INF/2/REV2). Again, the information within the documents was referenced several times during negotiations.

An Expert Workshop on the Monitoring Framework was convened in Bonn, Germany (June-July) to evaluate the information and feasibility of implementing the headline indicators of the monitoring framework. As a selected participant in this meeting, GEO BON justified the importance of using indicators based on standardized methods as well as gave support and guidance to indicators developed by GEO BON. Further information was provided by GEO BON to Parties in the form of a meeting information document (CBD/ID/OM/2022/1/INF/2).



GEO BON's policy work culminated in Montreal during the fifth meeting of the OEWG and COP 15 in December. With a delegation of 11 people strong, GEO BON was incredibly active throughout the negotiations, several side events and forums taking place over the 16 days. The adopted Kunming-Montreal Framework and the many new and strengthened existing collaborations formed at COP 15 will bring exciting and impactful work for years to come. A separate report on GEO BON's participation to COP 15 is being prepared and shared with the community in due time.

Looking forward to 2023

The new year is announcing to be another exciting and intense year. The Secretariat is soon completing its Strategic and Implementation Plans, with a new GEO BON structure, governance and set of activities for the next few years.

Our major event in 2023 will be the GEO BON Global Conference - "Monitoring Biodiversity for Action", 10-13 October 2023, Montreal, Canada. After a few years of online meetings, this in-person event will allow GEO BON members, partners and interested parties, to meet in beautiful Montreal and share knowledge on best practices and new technologies for biodiversity observations and monitoring to support transformative policy and conservation action.

Follow us on social media for the latest updates on our activities:

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